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In this episode, Taren Grom, Editor-in-Chief of PharmaVOICE Magazine meets with Kate Broderick, Ph.D., Senior VP of Research and Development, Inovio.

Taren: Welcome Dr. Broderick to our WoW podcast program.

Dr. Broderick: Hi Taren. It's so lovely to be with you today. It's such an honor to take part. Thank you for having me.

Taren: We're so delighted to have you. Doing a little bit of research on you, I know that you're an accomplished scientist and a recognized vaccine expert and you have been driving the development of a COVID-19 vaccine in the Inovio labs of San Diego, and we're all very jealous of your location. Since the earliest onset of the disease, our timing for this podcast couldn't be more perfect. I understand you led the team to be the part of the first line of defense working to combat COVID-19 with science. Tell me why COVID-19 in particular ignited your fire at this particular point in time.

Dr. Broderick: Well, Taren, I think I could probably speak to everybody who's listening to the podcast, they had seen for a year, 2020 has been I don't think as a scientist I could have ever predicted we'd be in the situation we are today. Yet still at the end of 2020 there's definitely light at the end of the tunnel.

From a scientific background regarding kind of my career, my personal passion has always been sort of infectious diseases, and I had the great honor to work on vaccines for Ebola, for Lassa fever, HIV, MERS, SARS, Zika and all other kind of diseases that have been in the public eye at one time or another; that I think we could probably all agree that COVID-19 is a step above the rest.

And I will remember to this day, Taren, probably for the rest of my life standing in my kitchen drinking a cup of tea on December 31st of 2019 flicking through the BBC website and seeing a report of a disease outbreak in Wuhan, China and thinking wow, that's kind of right up my alley, I wonder what will ever come of that. And now reflecting back on that moment, it's almost mind-bending to see how this virus has shut down the entire globe.

So, really, just infectious diseases have always been a huge threat and frankly to be perfectly honest, Taren, I think we've kind of dodged a few bullets in the past and unfortunately COVID-19 has been the one that stuck.

So it's such an honor and an inspiration to be able to be part of a scientific team working towards a potential vaccine strategy for this disease, and hopefully come 2021 we'll all be able to see the benefits of vaccines against this awful virus.

Taren: Well, I can't thank you enough for the hard work in moving the needle on this. Tell me I also understand – and this sounded crazy to me, but here we are, you led your team to design a DNA medicine in under three hours. Dr. Broderick, how is that possible?

Dr. Broderick: I know and I do recognize that does sort of sound a little bit almost unbelievable I guess, but what has – if there's anything positive come out of the situation in 2020 is really being that new and innovative vaccine approaches have really come to the forefront. At Inovio we work on DNA medicines. Not to go into huge amount of detail, but suffice to say that we use really just the genetic sequence of the virus in this case, but that could be also a bacteria or a cancer cell. I use that kind of small piece of genetic material to design our vaccine really just on a computer.

So basically kind of another sort of moment that will stick in my mind was the minute that we received the genetic sequence from the Chinese authorities and over in Wuhan and that was on the 10th of January. We uploaded that into our computer algorithm that thankfully, Taren, we've been working on for many, many years prior to the pandemic start. I uploaded it and three hours later the computer spat out a fully designed COVID-19 DNA-based vaccine. That was a huge moment for us, Taren, because that really allowed us to really sort of pull the trigger on all the additional efforts that have taken us into the clinic in this quite remarkable year.

Taren: Wow. So two really prophetic moments, December 31st and then that moment really kind of gel in together to lead you to where you are right now. Tell me where you are, what's the state of the development at Inovio right now.

Dr. Broderick: So sort of fast forward I guess from the 10th of January, we did all the testing that we would normally do for any vaccine candidate. We just did it very fast and instead of doing it in sequence, we did it in parallel. So we were able to kind of squash down those timelines and actually get into treating our first patient – our first subject I should say – in the clinic within 83 days, which was just mind-blowing to me.

Taren: Wow.

Dr. Broderick: So we've completed our phase 1 clinical trial and that's kind of a small clinical trial where you just ask questions about safety and about immunogenicity, that all looked fantastic. We're really excited by the safety profile that our vaccine generated and also our immunogenicity profile. And really that was the catalyst, Taren, for where we are now which is running our phase 2 study with an eye to starting our phase 3 so the big one, the one where you ask does the vaccine actually protect you against COVID-19 disease, and we're aiming to start that in early 2021.

Taren: My mind is blown. It's amazing. Talk to me a little bit about the difference between a typical vaccine and your DNA type vaccine.

Dr. Broderick: Yeah, absolutely. What I'll call kind of typical or conventional vaccines, I do just want to say those have been absolutely instrumental in saving probably hundreds of millions of lives that are in the globe and are obviously key, key parts of global health access. This isn't meant in any way to be critical, but one of the complexities of what we call conventional vaccines – those are the vaccines of course that you and I got as kids and our children all got, that kind of thing – is that their development timeliness are really quite lengthy. So the fastest in history that a vaccine has ever been developed was four years and that was for mumps, but really that was an exception and if you kind of look back, generally it takes in the kind of 10-year plus timeframe.

So really the circumstances we find ourselves here in 2020 allowed us to kind of really look at some of these more innovative approaches with DNA being one of those that's able to kind of take that design and development side of vaccine development and really shrink it down because of the methodologies that we use. And as I kind of mentioned earlier, that's really about just looking at the genetic sequence of the pathogen as opposed to looking at kind of like a whole protein part, which is just a much, much more complex molecule. And that really allows us to move much faster than conventional vaccine approaches.

Taren: Fascinating. You talked too about the fact that you've changed up the dynamic of your clinical process and did it in parallel rather than sequentially, do you think that that is going to be the new way forward for conducting clinical trials based on the efficiency you've seen during these COVID times?

Dr. Broderick: I think that's a great question, Taren. I guess I would hesitate to say that that's going to be our new normal because I do want people to recognize that these were unbelievably extenuating circumstances and certainly I don't think I could ask my team to consistently work 20 hours out of a 24-hour days, seven days a week.

Taren: Understood.

Dr. Broderick: I don't think that's sustainable. However, I do think there are definite lessons to be learned from the circumstances we're in today, things like regulatory interactions and manufacturing insights, that kind of thing. I think things definitely can be learned that can be applied in the future, but could I say that we'll now start to be able to knock out vaccines in under a year on a regular basis? – I don't think that's realistic, but I certainly think that we will now be able to shrink those timelines down from multiple 5 to 10 years maybe two to three years, something like that, so still definite improvements to be made.

Taren: Fair enough. I think that there is some issue with it in how accelerated the vaccines have been during this timeframe that this is now, as you said, the new normal and I agree with you, I think it's somewhere in between. So taking those learnings and applying them and becoming far more efficient obviously keeping safety in mind, so awesome.

Dr. Broderick: Yeah.

Taren: I also understand you spoke at the WHO meeting in Geneva, what was that experience like presenting all this data to those folks?

Dr. Broderick: Yeah, that was a bit of a kind of pinnacle of career moment for me, Taren. I was almost a little bit humbled to kind of – this was a meeting that the WHO called in February and I believe it was even before they declared a pandemic and we really kind of asked scientists, clinicians, infectious disease specialists to kind of come fly into Geneva from all over the world. So it's really kind of a who's who of infectious diseases and I was kind of a little bit humbled to be sitting there amongst some of these amazing authorities on vaccines and infectious diseases, but it really kind of as I sat there in this huge hall in Geneva in the WHO headquarters it really became apparent to me how serious the situation was, Taren. There was no way under any circumstances that all these people were going to drop everything and make a trip to Switzerland for something that was an incredibly critical. And never have I attended a scientific meeting before where I'd have to kind of push my way through media scrum to get into the building. The whole experience was almost a little bit surreal, but it was such an honor to be part of that and to be included in those discussions, quite, quite unremarkable experience.

Taren: It sounds like it was and again underlying the seriousness of this and as everybody was coming to grips with this disease in February really turned the world on its ear. Since then you have been obviously working very diligently at Inovio to develop your vaccine. Why do we think it took a pandemic to bring vaccines to the forefront because quite frankly a lot of vaccines have been abandoned by pharmaceutical companies. They're hard to make. They're hard to deliver. There's not a great public uptake of them. So what do you think it is about this time that makes it so different? Is it because it's so enormous, the consequences?

Dr. Broderick: I think probably a bit of all of that, Taren, and I do think that here in the Western world we're in a quite remarkable position where I don't know that we really remember or see firsthand the impact of infectious diseases whereas maybe in the developing world that's still very much part of their daily lives. And I do remember my mom like telling me about people, knowing people with polio and yet, I think later generations you just don't – that's not – I mean the worst probably we think of is influenza.

So I think COVID-19 has just brought the impact that a virus and infectious disease can have on anyone to everybody's doorstep, and I think people have been – it's been really a wakeup call for a lot of people. But I would absolutely second your statement saying that prior to COVID-19 if I can be completely honest, infectious diseases from a vaccine perspective, from a testing perspective, from a therapeutic perspective they really didn't get the love that they deserve, frankly. I have to be totally honest, I mean this was my passion and nothing would ever have changed that, but we were always kind of this stepchild if you know what I mean, nobody really wanted to hear from us kind of thing and obviously that's changed over the last year, which is fantastic that we'd have ton of situations Taren, where frankly the funding just wasn't there to get vaccines up and running. And I do hope again if something positive can come out of COVID-

19 I hope it's some sort of appreciation of the importance of studying infectious diseases of being proactive when it comes to vaccine development because I do hope that people can kind of reflect back and see maybe if we had some of these processes in place in advance, things could have gone even faster.

Taren: I couldn't agree with you more. If I could agree with you 120%, if that was statistically possible, I would. So tell me, you have a great passion for infectious disease, where did that stem from? Why is this your area of expertise?

Dr. Broderick: It's a great question. I don't know if I have a brilliant answer for you on that one, Taren, to be honest with you, but it's just I've been incredibly honored through my career to be able to go to Africa and work in Africa and see firsthand the impact of some just appalling infectious diseases on people's lives and travel the world really, that's just been one of the highlights of my job is to see that and maybe it's having that visibility to the impact of this has really fueled that passion, but it's always been something that I felt very strongly about and I'm just so grateful that myself and the team here at Inovio, really everybody in the infectious disease space and the kind of position to be able to pivot to trying to solve the COVID-19 program.

Taren: And it does sound like it is a collaborative environment even though you all might be competitors on paper, but it's a small enough community where you all are collaborating in a lot of ways. Is that a fair statement?

Dr. Broderick: Hundred percent. It's definitely a small field. We all know each other and yes, we might work for different companies or collaborate with different academic labs, whatever, but honestly I can definitely see that over the last year the level of collaboration really has kind of warmed my heart in a way because it really showed that all people cared about was finding a solution here. It wasn't about who's first and who's going to get the publication first or whatever. It truly wasn't that. I mean of course those are nice things to have, but in the situation we're in today there was no room for egos or competitiveness and it has been really nice to see that really without exception that has been the case.

Taren: That's wonderful. It warms my heart as well, so that's great news. And it's going to take that kind of collaboration as well to go forward in terms of encouraging people to take that vaccine. What do you think the industry as a whole needs to do to really make the general public understand the importance of the vaccine and give credibility that it's safe to take one of these vaccines once it's approved?

Dr. Broderick: You know, Taren, like a lot of people over the last year have asked me what keeps you up at night about this situation and what kept me up at night was never ever that we would get safe and effective vaccines. I have every belief in the scientific community's ability to do that. That was never a concern for me, but vaccines don't save your life. Being vaccinated saves your life and what keeps me up at night is when I hear the results of the few surveys and such like saying that at the moment only 50% of the US population is willing to take a COVID-19 vaccine.

Frankly Taren, that's just not enough and that's what worries me the most and I know – and I don't mean this to be kind of critical, but I'm just not sure that we're doing enough to get the message out there to people. Firstly, why do we need a vaccine, that the vaccines we're developing are developed to be safe, that we haven't been cutting corners and that really frankly if enough of us don't take the vaccine, this pandemic will not end and I think people really do need to understand that.

Taren: Hundred percent again, 120% again. So as a leader in the laboratory, how do you inspire, how do you encourage up and coming researchers? And I'll switch that and you also have a particular focus on women in the lab.

Dr. Broderick: Yeah, that's always been a real passion for me, Taren, and it's unfortunate to say that in 2020 still men pretty much dominate the leadership positions and in science still, which is really, really disappointing and frustrating. So I'm in a very lucky position to be in a leadership position where I can kind of mentor all of my team, but specifically women to ensure that they are given the opportunities that they deserve from the hard work.

From sort of a leadership perspective I guess something I really enjoy is that mentoring and I enjoy getting to know members of my team and really seeing where they have their strengths and really trying to kind of hold men on those strengths and then putting them in position where they can utilize those strengths and really be geared for success and that's something that's really worked well for me and that's on an individual basis, but when you think about running a group or a team and in my case a team that's really multifunctional so people with very different backgrounds and expertise I think really this all comes down to inspiration and I'm ensuring that the team is inspired, ensuring this team understands what the goal is and I'm really kind of reiterating that so that they believe in the effort that they're undertaking as much as you do and I really do genuinely believe that's the best way to get efficiency and passion out of your team and that certainly worked very well for me here at Inovio.

Taren: That's fantastic and let's go a little bit more into the work you're doing with STEM because I know that this is an area of importance to you. Dr. Broderick, tell me about the work you're doing with STEM because I know this is an area of importance to you as you just described in terms fostering women in the workplace.

Dr. Broderick: Yeah, absolutely. And again Taren, it comes back to there's still multiple occasions when I'll go into meetings, collaborative meetings and I'll be the only woman in the room and that is, it's still remarkable to me to this day. And so I think what we need and I think what's definitely happening is really women in leadership positions to come together and do all that we can to ensure the inclusivity of women and diverse, more diverse inclusion in boards, in CEO – in C-level positions, just in general leadership positions in all aspects of STEM. And science I believe the graduates in classes from universities are 50-50 and male-female but that just frankly as we all know doesn't translate as you kind of move up the leadership positions.

I think with engineering it's something horrific like 10% of the graduating classes are female. So I do think that it is something we should all take responsibility to do to ensure that we're getting that message out to those future scientists, to those future mathematicians, to those future engineers and technologists and see if you might be female or you might be from a minority group that you are as welcome in this effort as anyone else.

Taren: Love it. And I hear this fire in your voice when you speak to this in this passion and I understand that you had a pretty strong role model in your mother. Tell me how she influenced you.

Dr. Broderick: Absolutely Taren. I could not have been more lucky and more blessed with my mom. She was for her generation my mom was in a pretty high level leadership role with her position in education and I think that kind of gave me the foundation to not even question whether I could or could not do this. From a gender perspective, it was just always accepted that that was the – of course, you could do whatever you wanted to do and even though she wasn't a scientist she very much encouraged my passion in that area and I'll be forever thankful for all the life lessons that she taught me and I do hope that she would be proud of everything that I have accomplished.

Taren: No doubt she would be very proud of you. And when you talk about her as an inspiration, who else do you look to for inspiration?

Dr. Broderick: Of course Taren, so many people I could probably bend your ear on this one for hours and hours. My husband definitely for one, he was diagnosed with MS in his late 20s and that's a horrifically debilitating disease and really cut out in your prime and yet he still manages to kind of keep a really sort of cheerful disposition about himself and so it's not sort of well to keep going in the face of adversity, that's incredibly inspirational to me. My current boss at Inovio, Dr. Laurent Humeau has just been just such an inspirational mentor for me and just in so many different ways, it'd take me hours to talk through. And then on the kind of celebrity side, Taren, I guess somebody like Michelle Obama; what grace and poise and dignity does that woman bring to every discussion she's involved in and just seeing strong, capable, intelligent women speaking their truth in such elegant way is just incredibly inspirational.

Taren: It's amazing. Those are awesome inspirational role models for all of us and we couldn't have a conversation about COVID-19 if we didn't talk about the lines that have all been blurred between work-life there is no balance anymore especially for women who are doing multiple duties. They're working full time jobs. They're schooling, sometimes taking care of elder parents. It's becomes quite overwhelming at times. How are you coping and how are you helping your teams cope?

Dr. Broderick: I could not agree with you more. This year, to me we're over 11 months into the pandemic, but it doesn't feel like 11 months and I can't decide does it feel like 11 seconds or 11 years, totally right. It's the weirdest kind of feeling and certainly for the first six months in the year I was easily working 15- to 17-hour days everyday straight for seven days a week and so was the whole team and I'm sure this applies to anybody who was working in the vaccine

development setting at that time, but you know what nobody complained about it on. We all knew we were there for the purpose. We all knew that we had trained our entire lives to meet this, this problem so we all just, we just go on with it and we just accepted it.

But boy, has it taken a toll and I see how that has taken a toll on my team. They are just exhausted and I just tried to encourage all of them, especially the moms because here in California and as might be case all over the country, all of our kids are in home school at the moment. So just trying to balance that huge amount of work demand with in my case home schooling a 5-year-old and an 8-year-old it is overwhelming to say the least and not sustainable frankly. So I think we can keep this going for a few more months, but I really think that we're going to need to think of new strategies but certainly from the case of Inovio we've obviously said to people kids come first, kids' safety comes first.

So make sure that you take care of them and work around that when you can and just to give like kind of a personal duty, last night I got home from work from the office and my son said, "Oh, it's poetry day tomorrow and yet no I haven't written any of the poems. I've got to write six of them and you also need to find me an outfit that makes me look like a poet." So it was like firstly what is an outfit that makes you look like a poet and secondly, are you kidding me, we've got to sit down and write six different poems. Anyway, it was just – it's like you just have to laugh because if you don't you would literally cry.

Taren: Most often those kids give you all that heads up notice, right and they're so funny.

Dr. Broderick: Yes, yes, love it.

Taren: Because this is our WoW podcast program, I always ask all of our interviewees to tell me about an accomplishment or a wow moment that shaped or changed the trajectory of your career and I know you've had many high points. So I'm going to put you on the spot to ask you to name one.

Dr. Broderick: Yes, and you're absolutely right. Again, like there's so many things and you know that trip being part included in that that first COVID-19 meeting in Geneva for WHO is certainly very inspirational, but definitely as I came to cast my mind back to earlier in my career, we at Inovio were involved in a clinical trial for a vaccine against a type of rare leukemia and it was a great honor to be able to go to one of the clinical sites in England in the UK and be with some of the patients as they were getting treated and my role there really was to kind of talk to them about the technology so that they understood and I'll answer really any questions that they might have and do that in person.

I distinctly remember sitting with just a lovely guy and his wife and he turned out to be exactly the same age as me and who was just so full of joy and excitement and enthusiasm about being included in this clinical trial and just such a pleasure sitting, talking to him and his wife and he said he would have signed up a hundred times if he could have and just the message that he left me with was can you go back to San Diego and tell you team that they're changing lives and they're changing lives everyday with what we do and to this day, Taren, I think about that guy

and I think about that's the reason that I get up in the morning and I hope that's the reason my team get up in the morning because we can actually change lives and that is so inspirational.

Taren: Dr. Broderick, you are an inspiration and I can't tell you how grateful I am for you spending this time with us and sharing your wisdom about how vaccines are so important and the work you're doing is so important and the need to bring up other women scientists and all those things that you're doing are really having such an impact on the industry. I can't thank you enough for your time and for your energy and for your passion to addressing infectious diseases. We need more people like you out there.

Dr. Broderick: Taren, it was such a pleasure speaking to you. Thank you so much for having me on and please stay safe and to all the listeners, please have a safe and healthy hopefully 2021.

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