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Improving Preterm Birth Outcomes with Virtual Cervix Technology

ReachMD Announcer:
Welcome to ReachMD. This medical industry feature is titled “Improving Preterm Birth Outcomes with Virtual Cervix Technology,” featuring Dr. Mirella Mourad, maternal-fetal medicine specialist at NewYork-Presbyterian and Columbia. This audio is a production of NewYork-Presbyterian with world-class doctors from Columbia & Weill Cornell Medicine.

Dr. Mourad:
Preterm birth is one of the hardest things that a family can face because it really can happen fast, and it can change everything.

Erin Welsh:
Dr. Mirella Mourad is a maternal fetal medicine specialist at NewYork-Presbyterian and Columbia.

Dr. Mourad:
The emotional stress and the trauma these patients face with their babies, you know, not being able to be discharged home with them and being admitted to the intensive care unit can be very emotionally burdensome. Preterm birth is one of the most common causes for neonatal morbidity and mortality.

Erin Welsh:
And unfortunately, giving birth preterm, before 37 weeks, is strikingly common.

Dr. Mourad:
Preterm birth affects about one in 10 pregnancies, so 10% of deliveries in the United States are preterm, which is a very high number.

Erin Welsh:
But despite the major risks associated with preterm birth and the high prevalence, preventing the condition has proved to be a difficult puzzle to solve.

Dr. Mourad:
It's not a kind of one problem, one disorder where you can find one treatment that will be a good fit for everyone. You have different phenotypes, different causes, and there hasn't been a lot of innovation in the field of obstetrics.

Erin Welsh:
Each pregnancy is different, and every person's anatomy is unique, so a modern, personalized approach is vital for identifying and treating preterm birth effectively. But historically, obstetrics has lagged behind other specialties. In fact, some tools for diagnosing and treating preterm birth are more than half a century old.

Dr. Mourad:
So when a patient comes to me and says, "Why is this happening?" I say, "A lot of the times, we don't really know." We don't even understand what causes normal labor to even begin to understand what causes preterm labor and deliveries.

Erin Welsh:
That's why Dr. Mourad and her team have pioneered a diagnostic tool that has the potential to finally close the persistent research gap that's long slowed innovation in obstetrics, a patient-specific virtual model of the cervix, also called a digital twin.

Dr. Mourad:
It's definitely a thinking outside of the box kind of approach. These models are going to help us understand what is going on with the

uterus, with the cervix, with the pelvis. They're going to replicate what is happening in the pregnancy.

Erin Welsh:
This groundbreaking research combines imaging, biomechanics, AI, and data science to better predict risk, personalize treatment, and catalyze innovation in maternal fetal medicine.

Dr. Mourad:
I'm hoping that what we're building with the digital twins will finally match the sophistication of our patients' biology and will help us create better and more effective and innovative treatments.

Erin Welsh:
I'm Erin Welsh, and this is Advances in Care. Today, I'm speaking with Dr. Mirella Mourad about how this digital twin technology could revolutionize treatments for preterm birth and catapult the field of obstetrics forward.

Dr. Mourad, thank you so much for joining me today.

Dr. Mourad:
Thank you so much for inviting me to your podcast.

Erin Welsh:
To start us off, could you tell me a little bit about what makes you so passionate about this specialty?

Dr. Mourad:
What makes me so passionate about this specialty is there is so much to discover and so much to learn. During my fellowship here at Columbia, I was really moved by the heartbreaks of some of my patients who experienced a preterm delivery. A pregnancy is supposed to be a happy time in a family's life, and so for a mom to come back home kind of without the baby because the baby's being ad- is admitted to the neonatal intensive care unit or even worse because mom delivered extremely prematurely, but most of the time families reach a good outcome, and it is a happy field. I know other doctors in the hospital are always happy when they're on our labor floor assisting with something, and I can see the excitement in their, on their face when a baby is born and mom and baby are healthy. So to me, it's the best specialty to be in, and my heart was always set on obstetrics from the very beginning.

Erin Welsh:
That's really lovely. And speaking of there being more to learn in this field, could you give me a general idea of where we are right now in terms of how preterm birth is diagnosed?

Dr. Mourad:
So the instruments in our toolbox are very limited for that. For preterm birth, the two main things that we have is a patient's history because we know that anything that happens in a prior pregnancy, a patient is at risk for in a future pregnancy. But that doesn't really help us with first-time parents, right? And then the second tool we have is the cervical length assessment on ultrasound.

Erin Welsh:
Okay. And can you tell me more about the cervical length assessment? Like, how does that tool help predict preterm birth for folks who are going through pregnancy for the first time?

Dr. Mourad:
The common scenarios that I see in my clinic is a first-time mom coming in for her routine anatomic survey, and she is incidentally diagnosed with a short cervix.

And we know a short cervix is a risk factor for a preterm delivery. And so this patient, this is her first pregnancy. She isn't aware of any risk factors, and she's coming in for what is supposed to be a happy ultrasound, and then we have to talk to her about and counsel her about what the remainder of the pregnancy's going to look like. And I wanted to just mention also, like, our instruments, how static they are in time. So they're just assessing one point in the pregnancy and are not continuously, um, looking for risk factors, right? So, a patient could have a normal cervical length at the time of the anatomy ultrasound, but a couple weeks later, something may happen and- you know, the patient is at risk now, and sometimes we don't discover that until there are more advancements in, in the, in the cervical dilation.

Erin Welsh:
Right. And so you have these snapshots that don't necessarily do anything to predict what might happen in the future.

Dr. Mourad:
Exactly. They're merely like associations.

Erin Welsh:
I see. And so as you're kind of keeping an eye on these measurements, what are some of the tools that you can use to intervene if the risk of preterm birth increases?

Dr. Mourad:
The current treatments that we have are very limited, and we have a medical treatment which involves, uh, progesterone supplementation, and that's based on, you know, large systematic reviews, and benefits are still questionable. And we know that progesterone doesn't work for all patients. And then the second treatment is the cerclage procedure, which is a procedure that was invented in the 1950s and not much has changed regarding the technology or the way we use it. And it's basically a suture stitch that's placed around the cervix and a knot is tied to keep the cervix just physically closed.

Erin Welsh:
Got it. And so as you've been saying, the tools that you have to predict preterm birth and intervene are quite limited. I mean, some of these treatments are almost one hundred years old. And I know that maternal morbidity and mortality remain really unacceptably high in the US. Why do you think that obstetrics has lagged behind other specialties in developing predictive tools and more innovative treatments?

Dr. Mourad:
So the field of obstetrics has not received the same, um, funding nationally as other fields. And research in the field of women's health has always lagged behind. And so it's not surprising that obstetrics has not received the same attention as other, uh, fields in medicine.

Erin Welsh:
Yeah. And it showcases a real need for innovation. And I understand that you're now adding a much-needed modern tool to this obstetrics toolkit, these patient-specific digital twin models of the cervix. And so for people who are new to this concept, can you explain what a digital twin means, especially in the context of the cervix and the uterus?

Dr. Mourad:
A digital twin is a replication of something in the physical world, and they've been used in the world of engineering for decades, and they model and study the mechanics of different building structures, bridges, aircrafts, but their application to the human body, and especially to pregnancy, is relatively new and is very exciting. So what we do when we are trying to build a digital twin is we obtain images from clinical ultrasounds that patients have as part of their pregnancy. Um, and we use those images to calculate certain tissue geometry like the cervical length, but also we look at the, the diameter, we look at the thickness of the lower part of the uterus, the angles between the cervix and the uterus. And then we use an aspiration device that provides us with information about the stiffness of the cervix. And we combine this information to create a model, like a real-life model, to understand what is happening with the uterus and cervix. And so, I'm very excited about my work with Dr. Kristin Myers, who's a professor of mechanical engineering at the School of Engineering at Columbia. Dr. Kristin Myers has the ability to apply different loads and different forces to the, to the cervix and see how the cervix is going to react. For example, at this estimated fetal weight, what happens to the cervix? Is it going to shorten? Is it going to, uh, remain stable? We just have the ability to simulate many different clinical scenarios and try to understand how the cervix responds to that.

Erin Welsh:
I mean, after such stalled innovation in this field, this is such a necessary leap forward. And so what does this process look like in practice? Like, if you're assessing a patient's risk for preterm birth, what does their digital twin tell you?

Dr. Mourad:
Yeah. So first, it's definitely a thinking-outside-of-the-box kind of approach to risk stratification. For example, if a patient of mine comes to the clinic, gets her ultrasound, from the ultrasound, I'm able to give that data to Dr. Myers and her lab, and they are able to create a model and try to predict what the outcome for this pregnancy is. As I mentioned before, not every short cervix is going to cause a preterm delivery. So even if I'm telling the patient that your cervix is short, some patients I'm going to say, "Listen, your cervix is short, but the other factors in the model are reassuring, and it doesn't look like you're at risk for a preterm delivery." In the same way, I can maybe predict ahead of time the model is showing me that your cervix may shorten, that you're at risk for a preterm delivery. It would be great to even predict when that's going to happen to tailor interventions and treatments based on that. So we are in the very early beginnings of this, but my hope is for us to be able to use these digital twins to get more predictive information about what's going to happen, and then tailor treatments differently and personalize the treatment more for our patients.

Erin Welsh:
Right. Precision medicine. I mean, it's, it's incredible. So you mentioned like cervical stiffness, you mentioned ultrasounds. What are the data that you're feeding into these models, and how might they help inform decision-making?

Dr. Mourad:
So the ultrasound measurements are coming from ultrasounds that we already perform. So instead of just looking at cervical length—from that same ultrasound—so we're not adding anything new, we're just gathering more data. We're measuring more things, and then we input them into the model that Kristin Myers has created. The new thing that is innovative and different is the cervical stiffness, and that's a device that touches the cervix, and a small pressure is applied…um, and we measure the amount of cervical tissue that is aspirated into that small device. And it gives us in-information about the biomechanical properties or the softness or the stiffness of the cervix. And together this information is used to create the model.

Erin Welsh:
And if I understand correctly, what's so transformative about these digital twin models is that they can change as you input more information and all of this new data, right?

Dr. Mourad:
Exactly. I think AI is going to help us, you know, analyze large data sets and is going to be able to help us predict which patient is going to have which outcome. So it'll help us understand what happens in normal pregnancy. It'll give us information on the risk stratification for complications, and as you mentioned, personalize the care and even help us build more innovative treatments.

Erin Welsh:
So what might those new treatments look like?

Dr. Mourad:
Definitely new devices. I think it's important when we're testing new devices to start by testing them on these digital twins. And so I think this is going to give a lot of people opportunities to test their devices in the digital twin space prior to attempting this on patients. I think this is a very big advantage of the work that we are doing, and it'll help us design a more personalized device for every patient.

Erin Welsh:
Definitely. And thinking about the additional benefits of these digital twin models, I know you're also researching how these could be used to treat a wide variety of preterm birth conditions, including placenta accreta spectrum disorder. And I understand that this is a, a fairly common condition. About one in 300 to 500 births are affected by placenta accreta. So can you describe what this is and maybe some of the different clinical pictures, like how this can present and the risks associated?

Dr. Mourad:
Placenta accreta spectrum disorder happens when the placenta does not detach normally after the delivery of the pregnancy. So it's abnormal attachment of the placenta to the uterine wall.

And patients who've had prior cesarean sections are at the highest risk for, uh, for this condition. We don't fully understand why. Um, it definitely has to do with how the cesarean scar has healed and it's, um, it's one of the most morbid and most obstetrically challenging conditions in obstetrics and is associated with a very high maternal morbidity as a result from postpartum hemorrhage from this abnormal attachment.

Erin Welsh:
And so then tell me, tell me more how you see the digital twin coming into play here. Like, how do you think you could use this same technology to better understand and manage placenta accreta?

Dr. Mourad:
Right now with ultrasound, you can't really get a very detailed kind of panoramic view of the entire placenta and how it's attached to the uterine wall. With these twins, you can potentially get that and it can help you preoperatively design your treatment. Right now, the most common treatment for, uh, placenta accreta spectrum disorder is a hysterectomy. But what if we had more information about exactly where the placenta is attached abnormally and exactly how much uterine wall we have, um, left to repair, for example, if we are to just resect that area of abnormal attachment? I think it's promising in the sense that it's going to give us a very detailed overview of the entire interaction of the placenta and the uterus and help guide our treatment selection for patients and personalize their care as well, so that you're not using hysterectomy as a one-size-fit-all kind of treatment for all patients affected.

Erin Welsh:
Right. I mean, a hysterectomy is such a major procedure, if that is the outcome. And so to be able to use these digital twins to more closely align with both the clinician and the patient goals, that would be a real game changer for everyone involved.

Dr. Mourad:
Exactly, and this is what this field is moving towards as well.

Erin Welsh:
And looking towards the future, especially in terms of, you know, how you envision this digital twin technology transforming obstetric care in this country, what do you think might be the impact if technologies like this were democratized beyond major academic centers?

Dr. Mourad:
That is the, that is the goal. So that's the goal of all of this work. And the next step would be to validate this across different campuses, different, um, university hospitals, and hopefully make this available to, to the rest of the community.

Erin Welsh:
I mean, that would be, that would be amazing just to see that in action. And so when you think, when you think like, you know, ten, fifteen years in the future, how else do you see approaches to patient care changing in obstetrics?

Dr. Mourad:
I would love to see us prevent what is preventable, and I would love to see obstetrics kind of catch up to the other fields in precision medicine because the stakes are very high. And so I'm hoping that digital twins will just give us the ability to understand the anatomy of every single patient and help us predict the outcome. One of the best outcomes that we can get to is by knowing who and when to intervene at a much earlier time. So not be like reactive to what we are seeing, but be proactive so no more surprises in the clinical space with relation to pregnancy and, and the complications of preterm birth. But from a single ultrasound or swab, help us get the information that we need to either reassure the patient or, ah, provide the patients with the extra treatments and interventions that she needs to achieve a good outcome.

Obstetrics has always been, like, the field that was, like, put in the corner and understudied, and it should be kind of one of the most studied because we're…you know, building societies. We want our moms to be healthy. We want our children to be healthy. And, um, and I think, you know, addressing this is going to be a game changer for the future.

Erin Welsh:
Yeah. No, I, I mean, absolutely. I think that this is such an exciting and much-needed innovation in obstetrics, and I really enjoyed chatting with you today, Dr. Mourad. Thank you for joining me.

Dr. Mourad:
Thank you so much for having me. I'm so glad to have the opportunity to talk about my work and talk about what I'm passionate about and hopefully increase awareness.

Erin Welsh:
Thanks so much to Dr. Mirella Mourad for discussing her incredible work to bring obstetric care into the future and revolutionize diagnosis and treatment for patients at high risk for preterm birth. I'm Erin Welsh. Advances in Care is a production of NewYork-Presbyterian Hospital. As a reminder, the views shared on this podcast solely reflect the expertise and experience of our guests. To listen to more episodes of Advances in Care, be sure to follow and subscribe on Apple Podcasts, Spotify, or wherever you get your podcasts. And to learn more about the latest medical innovations from the pioneering physicians at NewYork-Presbyterian, go to nyp.org/advances.

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