# Technology & Innovation in Pediatric ICUs: A Progressive Look at North America

## Speakers:

Maya Dewan, Sanjiv Mehta, Matthew Zackoff, Jean Anne Cieplinski-Robertson

Maya Dewan:

Hello, and welcome to the WFPICCS World PICU Awareness Week 2025 podcast series. I'm Maya Dewan, the Critical Care Division director at Cincinnati Children's, and someone who loves to study and use innovative technologies. It is a great privilege to have with me today three outstanding critical care experts who I will now have introduced themselves.

Sanjiiv, would you start?

## Sanjiv Mehta:

Hi guys, I'm Sanjiv Mehta. I'm a pediatric critical care physician at the Children's Hospital in Philadelphia. I'm interested in systems and technology innovations to help reduce deterioration inside and outside the ICU, and take part in our analytics and informatics work within our division.

## Matthew Zackoff:

Matthew Zackoff. Hi, I am Matthew Zackoff. I'm a critical care physician at Cincinnati Children's Hospital Medical Center, where I split my time between taking care of patients, overseeing the critical care fellowship program and co-directing the PICU Innovation Accelerator, where we leverage innovative simulation tech system science to improve the care of a critically ill patient.

And Jean Anne.

Jean Anne Cieplinski-Robertson:

Hi everybody. My name is Jean Anne Cieplinski-Robertson. I'm the senior director for nursing here at Children's Hospital of Philadelphia in the critical care, sphere, I am mainly operations and oversee our, nursing, department, but also, have a dual role within our digital and technology services department representing the Department of Nursing, and have a, great love for quality improvement and how we can use technology to help improve patient, care, as for our staff and families.

Maya Dewan:

Welcome everybody, I think this is going to be a really great chat today. So this is the time of year to recognize the incredible work done in pediatric intensive care units around the world.

This year, we're focusing on a crucial theme, technology and innovation in the PICU. The goal today is to highlight how PICU is everywhere from cutting edge hospitals in major cities to more resource limited settings can drive change. Today we're going to explore how innovation in the PICU is being driven throughout predictive analytics, frontline collaboration, and we're going to discuss how the future of critical care is being shaped globally by both digital tools, but also the real importance of human insight.

In this episode, we're going to focus on some incredible work being done here in North America.

So I'm going to start with my first question, and I would love to hear what are the most promising technological in innovations that are currently shaping PICU care?

## Matthew Zackoff:

I can start. What I would say is I am probably more excited, not necessarily by the new technologies, but rather that seems to be a much enhanced focus on how to optimize the use of available technology to not just allow access to unlimited.

Data and information about how to present or leverage that data in a more meaningful way that actually facilitates enhanced bedside recognition guides or refines behaviors, or allows a system level view of the ICU,

# Sanjiv Mehta:

I love that Matthew, and I would agree, I think the biggest, like the category of promising technology right now I think in ICU is really about tools and technologies that are making a lot of the information contextually relevant and presenting it at the point of decision or action,

thinking about various predictive analytics platforms and data visualization software that is allowing us to really capture salient signals, at the moment when you want to digest and use that information. Kind of more novel uses of AI to summarize content within the medical record to really support clinicians in terms of thinking about how to find signal front noise, and then really thinking about the number of resources that are coming on board that can provide the information you need at the moment you need, whether it's supporting diagnostics or management or information gathering.

Jean Anne Cieplinski-Robertson:

Yeah. And I think for me, and I agree with both of you, I, I think it is taking the tools, it's more, being more precise. It's decreasing the cognitive burden, when I think of the ICU nurse at the bedside, the amount of stimuli, in a shift that they receive, from alarms going off To pumps, to just everyday stuff.

I am really looking forward to how we can really make that a little bit more precise so that the nurse knows what to respond to what is actionable and, and really deleting the noise, which to me is a bigger threat, because if you have too much cognitive burden, you could lose sight of what is really happening with your patient.

#### Maya Dewan:

Matthew, you spoke in your introduction about the PICU innovation Accelerator at Cincinnati Children's, and so I'd love to hear a little bit more about how you feel and are currently using tools like ai, predictive analytics and remote monitoring to improve outcomes in the PICU.

## Matthew Zackoff:

Sure, so there are lots of examples of the use of these various tools being trialed around the country, around the world, and in various different ways.

You can look at it from two different lenses, one is that lots of different centers are using different technological approaches to fill the same role versus the various ways that people are using the generated data to promote behavior change. And so an example would be algorithms embedded into the electronic health records that perform predictive analytics.

In a simple sense, they scan the health record, assign points or value to certain clinical data that's associated with a higher risk of morbidity or mortality, and then generate a score or warning for clinicians. There are many different examples of algorithms striving for the same result, but can take different paths with regard to the data that's queried and the intelligence of the algorithm.

And when I say intelligence, that means is it constrained to set items versus does it have the ability to learn and grow in accuracy or precision over time? At the same time, researchers, clinicians, educators are using the output of these algorithms in lots of different and innovative ways. Locally, we're using our version of predictive analytics in two very specific ways.

First is we use it, as a generated alert to improve team level situation awareness by triggering patient identification as high risk prompting bedside discussions followed by the generation of mitigation plans for anticipated decompensation events. But at the same time, we've integrated this data into our simulation program to allow real-time identification of who's the sickest kid in the unit, who are we most worried about, and then allows us to subsequently replicate them in real time to allow the team who's caring for that actual sick patient to practice what that decompensation event looks like.

During that shift so that when it does happen, or if it does happen, they know what they're looking for, they're prepared in terms of what to do, and so allows the team to practice. The mitigation plan allows us as, as educators, as scientists, to refine it based on what we learn from the sim, and then the team can be primed to intervene efficiently if or when that decompensation event occurs.

#### Maya Dewan:

I think that's a really great example, Matthew Zackoff, of, how we actually impact the care in, in the ICU, and so Sanjiiv, I'm going to ask you, what do you feel like really separates cool tech things that are really interesting and exciting from the tech that actually changes care or really makes an impact at the bedside?

## Sanjiv Mehta:

Maya, I love that question because I think there's a lot of cool tech that gets a lot of hype sometimes and doesn't always translate into impact of

the bedside, I think our learnings are really that, the cool tech quote unquote, that really impacts care are times when the technology really fits into human system technology.

Workflows where the technology was designed and implemented would be problem or the action in mind. First, rather than let's use the tech for what we want, you can think about. I'm going to call this cool tech and some people might disagree, but Right. We have a critical care outreach team that is really responsible for doing proactive ICU monitoring for patients who are at risk of iteration needing the ICU. And rather than, build one fancy algorithm right now is integrating a number of existing processes and tools in a rapid response system into one collated place. And so presenting a lot of information about a subset of patients in a easy to digest way. And that's really answering the question, the CCOT needs, which is.

Who are the patients I need to help address and support on the floor, and how can I prioritize them?, I would say the other big area where I think about how can tech really empower and improve care are things that are really focused on augmenting workflows that might already exist, or helping people think about new workflows.

So there's a lot of Using AI to solve every diagnosis, but taking a step back, a lot of people are really trying to really just augment and provide a second level of safety or layer of support to their existing work. So as I'm thinking about my diagnostic differential diagnosis for a patient using tools that we have within our system, whether it's an internal large language model or, the more recent Visual DX application to really, check myself and provide more, support to what I'm thinking and doing already and so The really empowering tech is ones that are building on the human skills and capabilities already there and augmenting them rather than trying to do everything that, we're doing right now.

# Jean Anne Cieplinski-Robertson:

Yep, for both of you, I completely agree. I think so often the cool tech or the cool toy comes out and we just layer it on without really thinking about what is the problem we're trying to solve, what, how can it impact our care, or are people adapting it? And if we just, if we don't put it out there the right way, it becomes another cool thing in the background that people aren't using in, in a manner that it's, that it should be. And I, and I think the technology should supplement our care, not replace our care, as we move forward.

Maya Dewan:

Matt, do you have any thoughts?

# Matthew Zackoff:

Sure. I couldn't agree with more, with everything that's been said, I can paint it in a slightly different lens. And so in education research, there's a concept called, conceptual frameworks where to effectively test an intervention, you first have to have alignment between your hypothesis, your research question, your intervention, and then the assessment strategy, to actually allow you to interpret your outcomes. Did my intervention not work because my measured outcome? It doesn't actually measure the impact of my intervention, or was my intervention just not effective? that alignment is achieved through an overarching framework that could be more clearly described as your theory has how x, y, or Z happens.

How do people recognize the signs of impending shock? How do people learn how to efficiently manage traumatic brain injury? how do teams identify the cause of decompensation and address it when? Patient is new to the unit. And so for each of those questions, what is my theory as to how those skills, behaviors, or actions are learned, prompted, or supported?

And what outcome can be measured to state that improvement has occurred? And only once you have all of that can you effectively determine what tech-based intervention even has the potential to impact your outcome, of interest given its alignment with your theory as to how to drive improvement.

## Maya Dewan:

As we've been talking about these cool technology, opportunities within the PICU and we've been focusing on the machines, I'm going to pivot a little bit and talk about people as the system.

So it's not just about the machines, it's not just about the technology, it's about the people that really are using it.

So Jeanne, I'd like to ask you, can you share an example where human insight or collaboration with technology you really feel like has transformed care?

Jean Anne Cieplinski-Robertson:

Yes, I, I can give an example here at Children's Hospital, at one point we, were testing nurses get secondary alarms sent to a device, usually

a phone, and some staff were getting 800 alerts in a 12 hour shift, and the nurses kept saying, something's off here, something's wrong. I can't. Particularly respond to 800 different alerts and which ones are actionable and which ones aren't. And I think through that work, what we determined was looking at the evidence, what is best practice, and really reformulating how we took that tool or the technology of sending secondary alerts important for nursing to their Devices, but putting it in a meaningful way And we refined it where we were able, where we were actually able to drop the number of alerts from 800 down to less than a hundred in some cases, which I think is incredible. I think, the next iteration of that is now we're adding a new tool in our world, that's We're calling, hopefully alarm manager that will help nurses get even more precise, not just about the general, but how does it affect that patient and really narrow the alarm parameters to make alarms really meaningful and eliminate the noise, so that we can respond in an appropriate, away, and be able to pay attention a little bit more and hopefully reduce that cognitive burden.

So there's exciting work coming for the future.

#### Sanjiv Mehta:

I love that, Jeanne. I'll build on that. I think that second part you asked about Maya, where you focus on collaboration, I think is really important as there's a lot of innovations that aren't really, don't even depend on complex technology, but are about the systems of care and getting people together at that right point in time.

And I think about some of our respiratory therapy and nurse-led, evacuation readiness testing and ventilator weeding protocols. And so we recognized opportunities to really, acknowledge that so many people were having frequent assessments of a patient and really could drive care forward in a more rapid way.

And, developed a system where we could safely, accelerate how fast children were able to get, wean their ventilator settings while still sharing that information with the entire team to make sure there was shared awareness of how that ventilation weaning was going, we're able to really allow our, collaboration between the recipe therapist, nurse, and physician to drive, decrease in ventilator days for our patients with ARDS and, improve care.

## Matthew Zackoff:

Yeah, I think everything you guys have said makes complete sense and totally agree there. There's just, there's a ton of examples of people pushing the next best thing, the new fancy tool, this great warning score. Here's the pathway that's going to prevent all sepsis from ever happening again And on paper, they look like they're going to be impactful, but people forget that their use is dependent on people, right? You can create the best warning score in the world, but if the bedside team doesn't know what it means, how to integrate it into their workflow or have confidence in output. Nothing is actually going to change. And unfortunately we see that over and over again, pulling from our earlier example of our local predictive analytics work, and the warning tool associated with that, and Maya can put on her earmuffs because she created, said tool that alert itself doesn't do anything to save lives. Right. The number itself doesn't save children. Right? But what does

responsibility to respond to those triggers to achieve that shared situation. Awareness of risk that each person has their role to play in mitigating that risk and putting that plan into action when the time comes.

And so the tech can be the EST for part of that system, but it's the humans working with it and around it that are actually the drivers of care transformation and thus warrant as much, if not more investment.

## Maya Dewan:

I feel like the word that I've heard you guys say over and over again is team, right? And whether we're thinking of just the people at the bedside, whether we're thinking of the broader hospital system or US plus technology, there's been a huge emphasis in this conversation around team.

So I'd like to ask the next question really focused on that. So how can we empower our local teams to lead innovation? So to find the problems and to work on fixing themselves instead of just implementing solutions that other people have created for them.

And so I'd love to hear some thoughts, Matthew Zackoff, I'll kick it to you first, but thinking about how that identification of problem and problem solving can occur more organically in every ICU.

#### Matthew Zackoff:

Yeah, no, that's a great question, kind of what I, when I reflect back, if, if care in the PICU looked exactly the same everywhere all the time, I wouldn't have done it. Like, the exciting part of critical care is the fact that each child's unique. The combination of physiology you're

managing, embedded within that patient's unique history and support system requires a personalized approach in each and every situation. PICU are similar in that there's a unique combination of expertise, resources, disease prevalence, system factors, community factors that influences how critical is care's practice in every individual context. And so therefore, each system should be in the driver's seat to take learnings from other centers and innovate upon them to achieve better alignment.

With their local context and needs. And so an example of that is that we're currently rolling out a situation awareness bundle of best practices at several other PICU with a focus on prevention of cardiac arrest. And so while there are a few key components that have been studied that have been shown to be associated with reducing that risk.

They need to be implemented in some form at each site. The entire framework of this multi-year grant is supporting user-centered design to adapt and implement these best practices at each center through a coproduction approach. In other words, each site innovates upon our model to adapt it to their context and ultimately generates new innovative approaches that may lead.

Further interventions at the next site or back at our own home site as to how we can do things better. And so it's that local innovation, that local drive is how we don't stay stagnant and keep finding the next best way to help save kids' lives.

Jean Anne Cieplinski-Robertson:

Yeah, Matthew Zackoff, I completely agree. I think from our perspective here, we have a professional governance model that we actually, expanded to include informatics with nurses that have an interest in informatics, that have an interest in how to use the technology to the best of its capability, the technology exists both within our critical care world, but also interacts with. At the enterprise at large, it's part of my role interacting with our digital and technology services department to bring, the frontline perspective and circle back and say, Hey, we would like to see this, or let's change this, or maybe we could use this. I think one of the other things we also did is recognizing, as we have all said throughout this, nursing doesn't act in a bubble or work in a bubble, so even within our own world, we've created our own little informatics committee, that we take ideas, look at projects, what could be enhanced.

It's multidisciplinary, it goes across. So we speak with each other to ensure that we have each unique perspective as we're formulating ideas or working on projects to help enhance, care, and I think that has been successful for us as we continue to move forward, with technology and the care of patients.

#### Maya Dewan:

I think technology and the way that we've talked about it today can be really beneficial to our patients. But I also kind of want to be sure that we're being thoughtful of the fact that technology and innovation cannot just help, but that there also could be some harm. And so, Sanjiiv, I'd like to get some thoughts from you on how we make sure that our innovations are not increasing disparities, but instead narrowing them and making our care better for every patient in the ICU. Sanjiv Mehta:

Yeah, that's a fantastic question and something that I think, every center in site, every researcher, really every. Every individual that is really trying to improve the lives of children is thinking about, as they go from personalized care for an individual patient to some of the system level care, there are definitely some larger guidelines and frameworks that, I won't touch on right now, but I think at a very Basic level, some of the key elements that we've been thinking about as we've been trying to revamp some of our predictive analytics for deterioration, from a research lens to really think about, how to identify disparities and how to address them at every stage from development to implementation. And so I think it really starts with having standardized and rigorous measures of what you're going to assess disparities on. And we have an excellent center for healthcare. Healthcare quality and analytics that has really developed some standardized metrics that you can use across institution to help really base your assessments and development, in standardized, metrics across institution. And two, it's really gathering that data and understanding the data you're using to inform the technology you're developing. So bias in the data that you're using to develop your technology, you need to understand and make sure you can address when you then are developing a predictive model, then before you even think about implementation, is understanding after you've designed, say, for example, an algorithm, what are the biases inherent in the algorithm? Really in the validation phase before you've even got to talent test or things like that? And the last aid, right? That last mile when you get from a validated model that you want to implement and do the human factors

work and finally get something to hopefully change for patients. An action at the bedside is really about having ongoing governance and, review both of the data and model performance.

And we, our institution, stood up a really excellent AI governance committee that really sets out guidelines and expectations on how are you going to check for and measure disparity both. In all of these stages and really moving forward indefinitely as you use this algorithm, because we know that with a lot of these more innovative technologies, the performance and the impact of them changes over time as humans behaviors change and change the underlying data that may be fed into that model.

#### Maya Dewan:

I think that's an outstanding answer and it's really something we have to be thoughtful about, to make sure that it's really benefiting all of our patients. And we've talked a lot about how the team, the medical team and technology can really work, to make the care patients better. But Jean, I'd like to ask you, what role should patients and families then be playing in the design of the future of critical care and how we integrate and build new technologies?

## Jean Anne Cieplinski-Robertson:

I absolutely think it's critical. I think how we, intend for families or patients to utilize technology or how we utilize, utilize technology with them sometimes can be a little misguided if we're not asking them is it being received in the way that it's intended, I think for many organizations, but not all, whether there be an informal or formal patient.

Family councils just to bring them along and say, Hey, this is what we would like to try. How do you think about this? What would you like to see differently?, I think there's many examples. We could do that every day. Just asking families, how would you prefer that we communicate with you? Did you understand?

And take the time to ask that follow up question. I have often said in the last few years what struck me about pediatrics is our customer. Is young and our customers only know technology. When you think of the age that's having children now. They've grown up in the information age, they've grown up in technology, so they are very familiar with tools usually, and they're, they are asking for us to communicate with them in that manner.

And I think it's exciting because it's a way that I think pediatrics will probably lead the future and how we talk to patients and families, how we communicate their ease of use with technology. But to Sanjiv and, and Matthew Zackoff's point, we also have to ensure that all families have equitable access and not all do, whether it be language barriers, social barriers, or other types of things we have to ask that communicate.

We have to ask them how do they communicate with us, but I strongly believe that they have to be front and center with us in developing, designing, and really Giving us the feedback of how we can do this better.

Maya Dewan:

Absolutely. I completely agree and I think you're right. I think they, they know best what the experience is and so going to them about how we really augment and improve it is, is the place to start.

Matthew Zackoff, as we start to think about wrapping up today's session, I'd love to ask you what really excites you most about the next five to 10 years of pediatric critical care?

Thinking about all these technology innovations, this team-based work that we've talked about today, what do you think is the most exciting thing?

Matthew Zackoff:

Personally, I'm just most excited when I can just plug the EHR right into my head and have my notes documented that way. But we'll see if that comes to fruition. But, no, what, what I'm actually like most excited about, I think is the fact that pediatric critical care, I think, is going to sit in the driver's seat of actually operationalizing and implementing and leveraging all of the cool tech and innovation that is out there because we have to.

Right?, and so the vast majority of our patients live on the margins where each kid is unique. It's this totally random combination of Genetics, physiology, community environment, right? And so the protocols and pathways might work within a standard deviation off of that, but most of our kids live outside of that.

And so we, we have to innovate. Our kids are getting more complicated. The care system that we're working in is more complicated. And so if we don't. Leverage these new tools, whether it be predictive analytics at the bedside, whether it be immersive digital twin training technology to help people see these super rare conditions, how to manage it, whether it be, remote telementoring where you can.

Transport expertise across the world to take care of the one out of 10,000 type patient That appears to ensure that everyone across the country in the world is getting the same level of care and expertise and bringing everything to the forefront. So there's not really a child anywhere that's at a disadvantage because of where they're born.

Jean Anne Cieplinski-Robertson:

Yeah. That's exciting. I agree. I wish you everything that was in my head, something would. Unscramble it and be able to, be able to predict something or, or do something. I actually look forward also, in addition to that, really the ambient listening pieces, the documentation burden for nursing is huge.

And I think, to be able to walk into a room and say, Hey Siri or whatever you want, like to call it, document, X within defined parameters. And it does, and then I can focus more on the patient and, and I can actually focus on the, touching my assessments versus. What I'm actually typing into the computer and I think then pulling that information to say, now what, what's the next step?

So I think anything to reduce the cognitive burden, I think will be, key for nursing, as other disciplines within the room. So really, really excited for that. Sanjiv Mehta:

I love that. I want to live in that world that you both envision, I think what I'm probably most excited for is that many of the technological innovations over the last few years, and I'll highlight right, a lot of developing self-service, data analytic platforms, and some tools like I talked about for bringing contextual information to users is really, democratizing innovation, I think.

Like Matthew Zackoff really pointed out almost every provider in an ICU, regardless of their, their role is innovating on a almost daily basis for some patients somewhere. And there are so many opportunities where people want to innovate and create systems and processes and make them better. And the barrier is really sometimes getting the data to make a measurable change and getting the resources to collaborate and implement that change somehow in the Sociotechnical system and I really think that some of these evolving technologies are allowing us to support every single clinician who may not have experience doing this, to really take an insight they have and translate that from an insight into an innovation, and I think that's going to make care better, really across the world and across every PICU and for every patient, and is going to really empower us to lead this and collaborate and kind of go in unexpected directions.

## Maya Dewan:

I really love this conversation today, and I feel like it's made me even more excited, about innovative technologies and, and the future of critical care than I already was, I'm going to wrap up with one last question that I'm going to ask each of you to, to think about an answer. So I'll start with you Jean Anne. What, is one idea that today's listeners could take from this conversation to inspire their own work in their unit?

# Jean Anne Cieplinski-Robertson:

I think what inspires me is to really, you have a problem, an issue that you're trying to tackle, and then you layer technology and what is the best technology to help tackle that issue and, and not and not making assumptions. Then, going back to the front lines, the people that are actually using the technology, getting parents' perspective, getting other colleagues' perspective to really build upon, and creating the system and workflows, to help manage and again, I think anything that can reduce that cognitive burden I think will help to really, define and help to, improve patient care outcomes. And I think that is what's most important.

## Sanjiv Mehta:

Really well said, Jean Anne. I think one, takeaway that's really important is to keep people in the center of all this innovation, and that starts with really picturing that critically ill patient that child that you want to improve and change their care in some way or process and thinking about how you incorporate that vision and their experience into every innovation that you drive.

# Matthew Zackoff:

Yeah, I couldn't agree more. I think I'll echo this sentiment of from both of you of just. People, people, people. That's the takeaway, right? Un

until we're all replaced by robots running on AI care of critically I children is still dependent on people.

And so therefore, people should be the focus at the center of innovation, with technology as a tool to support, to find, to inform, to guide, people as opposed to what unfortunately, often happens is Starting with the cool tech at the center and trying to get people to buy in or adapt to it, which we've all experienced and ultimately doesn't work.

#### Maya Dewan:

I know I'm going to take a lot from this conversation and, be even more thoughtful as I think about how we use and design technology going forward. So I want to thank the three of you for joining me today and for helping us to celebrate this wonderful week. And we'll say goodbye now.