

Cardiac Arrest

Hannah: Early on in Dr. Peter Laussen's career, something happens that changes everything.

One night at the hospital, one of Peter's residents is monitoring a baby who just had heart surgery. The baby is struggling to recover. But he has a lot of other problems too – kidney failure and trouble breathing. The resident knows the baby's condition is deteriorating...but she doesn't know why.

So, she calls a senior colleague at home. She tries to explain what she's seeing. That the baby doesn't look right, that the treatment isn't working.

Peter: The senior colleague says, I don't believe it, doesn't make sense. You're not thinking about this correctly.

Hannah: She can't get him to understand and how could she? There's dozens of machines beeping at once. Even though the data is all there, it's fragmented.

Peter: The senior person at home couldn't see it, was trying to take that information in and couldn't assimilate it. And so nothing was done.

Hannah: The baby codes. He's in cardiac arrest. The team scrambles to save his life. Which they do. But the event leaves Peter frustrated.

Peter: We can rescue patients very well, but that's not our metric. Our metric is our ability to prevent something.

Hannah: When Peter looks back at the data, the proof is right there. The patient was spiralling. He needs a way to take the scattered pieces of data, and use it to make better, faster decisions about his sickest patients.

Peter: That was an event for me that said it's time. Stop talking about it. Let's start doing it.

[MUSIC]

Hannah: Welcome to SickKids VS, where we take you to the frontlines in the fight for child health. I'm Hannah Bank. And this is SickKids VS Cardiac Arrest.

ACT ONE

Hannah: Heart rate. Blood pressure. Oxygen levels. For a child in the SickKids Intensive Care Unit, or ICU, these vital signs are clues to their condition. They also generate data. And that data can mean the difference between life and death.

Peter: In our ICU here, we admit around 2,400 patients a year. That's into our 42 beds. About 800 of those have primarily cardiac disease of various forms.

Hannah: That's Dr. Peter Laussen, who you heard at the beginning of this episode. He's been at SickKids for the past eight years. He's treated critically ill kids almost every day of his 30-year career.

Peter likes to understand how things work. As a kid growing up in Australia, he would take apart and fix up old cars with his father. It's a skill that serves him well now. Because no child who comes into SickKids ICU is the same. They may come in with heart failure, an infection, severe asthma or a bunch of conditions combined. Part of Peter's job is to figure out what's going on and what to do about it.

Peter: Intensive care is really this intense environment between humans and technology. And a lot of information is being presented to clinicians at the bedside real time and quickly.

Hannah: So quickly there's no way a nurse or doctor could look at the reams of data produced every minute and calculate what that means for a patient. But it means something.

Peter: Right now, you see a number on a screen or a wave form that appears on a screen for 10 seconds and then they go. We needed a better way to actually see longitudinally what was happening with that information and not to see them as discrete signals, but to see them as signals that actually interact with each other. That what's happening with the heart rate there's usually a change in blood pressure or a change in oxygen saturation, for instance.

Hannah: So Peter and his team start using a computer program to capture the data. Then they create a data management platform to continuously store the physiologic signals coming from each patient.

Peter: So right now, we're collecting what I call a Niagara Falls of data every second. So there's about 200,000 cubic feet per second of water going over Niagara Falls. And we're collecting 200,000 bytes per second of data out in the ICU.

Hannah: Which means every day, each patient generates an ocean of data. It's just too much to process.

Peter: It's beyond our capabilities.

Hannah: That's where artificial intelligence, or AI, comes in.

Peter needs to translate this flood of data into actionable information. To turn the ones and zeros into real time practice in the hospital. And for that, he doesn't need another doctor. He needs a computer scientist.

Anna: Hi, I'm Anna Goldenberg. I am a senior scientist in genetics and genome biology at SickKids Research Institute.

Hannah: Anna grew up in Soviet Russia. She goes to the US as a Jewish refugee when she's 17. She falls in love with computer science. She eventually ends up with a PhD in machine learning, a field of AI which studies how a computer can improve its function and action with experience.

She becomes fascinated by how data can drive changes in society – specifically medicine. But she's not a physician, so she can't make sense of the data without a clinician weighing in.

Anna: To make progress in our field in AI in healthcare, one really needs both: One needs computer science and medicine and medical expertise. So for me, it was clear that I wanted really to be close to the data and the position opened at SickKids that when I read it, I thought "This, this is perfect."

Hannah: Anna joins the SickKids Research Institute. Shortly after, a colleague introduces her to Peter.

Peter: He said you should meet Anna. She's not long been here. She's a machine learning expert. And she'll be able to utilize the data that you're producing. And even though it's small right now, it's obviously going to accelerate. So I met with Anna and we talked about what was possible.

Hannah: From there, things take off. They develop a team, both local and international, including a computer scientist, a software engineer, a data scientist, a nurse practitioner, a critical care doctor, and a cardiac surgeon, with members as far away as Israel and Australia.

Peter: And one of the areas that we were particularly wanting to look at is, is there a defined event that occurs in critical care that you can use as sort of the endpoint. So the machine can do the analysis and give you an idea as to whether this event will occur. And the one we took was cardiac arrest.

Hannah: It is that same problem from years ago that started him down this path. The baby in the ICU that coded. Now is his chance to find a way to stop it.

MID-ROLL COMMERCIAL

ANDREW: We don't want to wait for kids to get sick– we want to see it coming. And thanks to artificial intelligence, we are closer than ever to that reality. So, if you want to help kickstart the next big breakthrough in kids' health, visit sickkidsfoundation.com/podcast to donate.

ACT TWO

Hannah: Peter and Anna are about to make a big discovery in the field of AI and medicine. And we'll get to that. But there's a key piece they're missing.

Anna: We want and I think AI can enable that better future. And it requires funds. There is there is no way around it.

Hannah: That's where SickKids Foundation comes in. And its supporters. One of them is Jodi Kovitz. Years earlier, Jodi's daughter Lily battles a series of infections at SickKids, culminating in a life-threatening allergic reaction to a medication. Lily survives. But the moment changes Jodi's life.

Jodi upends her career, her mindset and ultimately how she spends her time. She leaves her job as a lawyer, starts working in tech, and eventually starts Move The Dial, an organization which works to increase the participation of all women in technology. And she starts talking to the fundraising team at SickKids Foundation.

Jodi: I knew that I wanted to be involved strategically. I also had the experience of, you know, some really challenging moments with patient care.

Hannah: In 2017 she becomes a co-chair on the Tech4SickKids advisory council, a new fundraising initiative driving technology at the hospital, including artificial intelligence and big data.

Jodi: Being part of the technology community, I wanted to come up with an innovative way to engage our community in a way that worked for them.

Hannah: A year later, all that community building starts pay off. Toronto tech entrepreneur Amar Varma makes a \$1.75M donation to fund a brand-new chair position in biomedical informatics and artificial intelligence. And it goes to Anna Goldenberg, giving her the resources for world-leading research. The Chair is the first of its kind at a Canadian children's hospital. It's a big deal. She describes it as "AI for good."

Working together, Anna and Peter's team develop something revolutionary:

Peter: We were able to come up with the algorithm that was very intriguing in that we could demonstrate in our patient population that we could potentially predict a cardiac arrest in 70 percent of cases five minutes before it occurred.

Hannah: Which doesn't mean they can always stop it. But they can see it coming.

Anna: But what can happen if it's too close to an event, what can happen is a team can be assembled. So even if prevention is not possible because the time is too short, sometimes it is still possible to be right there. So to not suffer necessarily the consequences.

Hannah: Consequences like: brain injury and other life-long disabilities. Not to mention the psychological trauma to them and their families.

Peter: So it's not a matter of checking a box live or die. It's patients not only have to leave here, they've to leave here with a quality of life that makes them productive members of their family and society and everything else that goes with that.

Hannah: Anna and Peter are trying to make that warning bell go off earlier and are aiming to put it at the bedside of ICU patients in about two years. They can't implement it until it's accurate every single time.

Anna now has a team of 24 people hard at work on the cardiac arrest project but also many others. They're examining ways to use AI to help predict if patients with a cancer predisposition syndrome will develop tumours before the age of six, saving them from invasive testing. They're examining ways to detect and prevent sepsis, one of the leading causes of in-hospital deaths.¹ And they're developing wearable tech to catch early signs of a relapse in kids with aggressive brain tumours.

Jodi: *What* I have learned is that small acts actually can drive very big change. And it's the collection of all of our small acts. And even if one doesn't have the time or the ability or interest in doing what I've done, it doesn't mean that one can't do many small acts or one small act that contribute towards driving this big change.

Peter: I think proofs of concept are really important. So rather than going for the big win, it's seeing the problem, understanding it and then starting. And there may be small incremental steps, small proofs of concept. But boy, do they build.

EXTRO

Hannah: From SickKids Foundation, this is SickKids VS. Thanks for listening.

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¹ <https://www.ncbi.nlm.nih.gov/pubmed/20959728>