M.C. Elish: [00:01:23] Hello and welcome to the Databite: Destruction and Repair, Integrating A.I. Systems. My name is Madeline Claire Elish. I'm a senior research scientist at Google, although a former program director of the AI on the Ground initiative at Data & Society.

M.C. Elish: [00:01:44] I will be your host for tonight alongside the marvelous event team who is working behind the curtain, the digital curtain, Rigo, Angie, Eli and C.J.

M.C. Elish: [00:01:57] For those of you who don't know us yet, Data & Society is an independent research institute studying the social implications of data and automation. We produce original research and regularly convene multidisciplinary thinkers to challenge the power and purpose of technology and society. We're going to be spending the next hour together. So let's begin by getting ourselves grounded. If you're joining us from a computer, use the features at the bottom of your screen to participate. This, you can ask and upvote questions via the Q&A function at the bottom of your screen. Use the closed captioning function for subtitles and view links and prompts in the chat window. So we're all sitting in front of our computers, but we're all obviously embodied humans in physical space. So I want to also ground us by offering a digital land acknowledgement that has been written by data and society. Our host today, Data and Society, began on the Lenapehoking, a network of rivers and islands in the Atlantic northeast, which we now refer to as New York City. I myself am located on the on the lands of the Ohlone and the Romitaish, which we now refer to as the San Francisco Bay area. Today we are connected via a vast array of servers situated on stolen land. We acknowledge the dispossession of indigenous land by the data- driven logic of white settler expansion and uplift the sovereignty of indigenous people, data and territory.

M.C. Elish: [00:03:45] We commit to dismantling the ongoing practices of colonialism and its material implications on our digital world, knowing the interface with power differently based on our race, class, gender and ability. That's grounding, let's start engaging and in fact, let's practice together so you can share where you're joining us from in the Q&A, in the Q&A function. You can visit the link posted in the chat, native-land-CA to find out more about your location. If you haven't already, you can visit this website and check out whose land you're on. So while you're doing that, I just want to say again, I am so very excited to have both Dina and Will here today to be talking about Sepsis Watch. And I'm just so excited for our conversation. Thank you and thank you all online for joining us.

M.C. Elish: [00:04:48] Our topic tonight is health care. Health care is at the forefront of everyone's minds these days. The Covid-19 global pandemic has brought many things to focus, and doctors underscored systemic health care inequities that characterize the U.S. Health system as Covid-19 has disproportionately affected communities of color, particularly black, LatinX and indigenous communities. The pandemic has also underscored how so term. {Problem with video. Not clear}

M.C. Elish: [00:05:27] ... have to be undervalued under. That's what's at stake when we talk about health care and health care workers today. When we talk about this recent, the research project focused on sepsis watch, and it began several years before the current pandemic. So only at the end of our discussion, I do look forward to discussing what this project has to tell us about the shifting nature of health care going forward, both the increasing use of AI as well as the increasing use of remote and telehealth care.

M.C. Elish: [00:06:08] For now, setting that stage, I want to introduce our speakers and kick off our discussion with background on the project. But first, I've gotten to say a little bit about myself. I want to introduce our other panelists. Dina, could you tell us who you are? Where you coming from?

Dina Sarro: [00:06:30] Hi, Madeleine. Thanks for having me. My name is Dina and I've been a nurse since 2007. I live in North Carolina and I spent most of my career up until six months ago working in critical care in the hospital, taking care of the sickest patients. About six months ago, I graduated from nurse practitioner school and I'm living on the coast of North Carolina as practicing as a cardiology nurse practitioner.

M.C. Elish: [00:07:01] Awesome. Thank you. Will, where are you coming from?

William Ratliff: [00:07:05] Hey Madeleine, hey everybody, this is Will Ratliff. I'm calling in from Hillsborough, North Carolina, which is just a little west of Durham. I've lived in that area for about eight years and I am an innovation program manager at the Duke Institute for Health Innovation, also known as DIHI. We are an innovation team that's part of Duke University that sits between the School of Medicine and the Duke Health System. My role as the innovation program manager, I lead the identification and management of innovation projects, project pilots of which Sepsis Watch began as one of them. I co-lead the management and design and the exploratory analysis for shaping those solutions and then help lead implementation and measure impact if they're able to be put into practice. So my background, I have a background in health care I.T. and strategy consulting and then more recently got my MBA from the Duke University Fuqua School of Business. Happy to be here.

M.C. Elish: [00:08:15] Awesome. Well, it's so great to have you both, because I have had many conversations with each of you over the years. Today, we are also celebrating the release of a report that I co-authored, along with Elizabeth Watkins', called *Repairing Innovation, A Study of Integrating A.I. in Clinical Care*. Over the course of researching this, this this system. I got to know each of you both. And yeah, again, it's just I'm just so psyched to be able to talk to the people who were so integral to the research on the day that we are releasing this report. I want to take a step back and talk about we're sort of throwing around this word Sepsis Watch as if everyone in the audience knows what we're talking about, but obviously they don't. So first, I want to take that first word because not everyone may even know what sepsis is. Dina, could you just tell everyone what is sepsis and why should we be caring?

Dina Sarro: [00:09:42] Sure. So sepsis is a medical emergency. And when the body gets an infection, any simple infection, if it is distributed throughout the body, the body has an inflammatory response, a systemic inflammatory response to an infection. And if untreated or undertreated, the body's organ systems eventually shut down and leads to death. It's a leading cause of death worldwide, and it's really come to the forefront of medicine back in 2002 with the International Surviving Sepsis Campaign. So it was with this campaign that sort of sepsis came to the forefront and health care leaders have been trying since to figure out the best way to identify and treat it.

M.C. Elish: [00:10:40] Right, because it's a really, really, really, really serious condition. It's widespread and it's also notoriously difficult to diagnose in time to be treated effectively. So enter the kind of need for a system that could support diagnosis and care of patients. So Will, tell us about what is Sepsis Watch?

William Ratliff: [00:11:10] Sure, so Sepsis Watch at a high level is a few things, actually, it's a fusion of a few things. And I think to just underscore what Dina was saying, you know, when Dr. Cara O'Brien approached us with this proposal, that was Sepsis Watch or became Sepsis Watch in 2015. And she was sharing some of the detailed mortality statistics. And just by saying, if left untreated, you know sepsis leads to a very high rate of mortality within a couple of days. And so it was certainly a high-impact project that we were excited to get going on. But at a high level, Sepsis Watch is a real-time digital phenotype for sepsis, and I'll go into detail about what that means. It's a machine-learning model that uses that real time phenotype. So how to identify sepsis in real time. And the model predicts a patient's risk of needing that phenotype within the subsequent four hours of the model prediction. And then we use that model output in a custom-built application and back end technical infrastructure to visualize those predictions on all patients in the Duke University Hospital Emergency Department. And then we work with and collaborate and support nurses like Dina, who is a critical leader in this effort to use that app to

identify and oversee the treatment of patients who are at high risk of sepsis while in the emergency department. So a little more background about the project.

M.C. Elish: [00:12:52] Will, can I just pause you briefly and so just to put it in like one sentence, this is a complex system that helps predict the risk of a patient developing sepsis in an emergency in the Duke Emergency Department in order to provide better care.

William Ratliff: [00:13:12] Exactly.

M.C. Elish: [00:13:13] OK, so please tell us more.

William Ratliff: [00:13:17] Sure, so to walk a little bit through in more detail, so in in 2015, Dr. Cara O'Brien and other clinical leaders at Duke approached us with the problem of improving sepsis care. So as we mentioned it, sepsis is quite harmful and deadly if left untreated. And moreover, within North Carolina and also nationally in the United States, identification and appropriate treatment of sepsis has room for improvement. And as of 2015, when Cara approached us, we set about identifying really as the first step what does sepsis mean, as you can identify it in the real time? And so through that task, we started by defining sepsis or what sepsis means at Duke. And so it involves two or more of the SIRS criteria. So these are sort of real-time data that's available in the electronic health record that we could use to identify and create a definition that it helps to identify sepsis in real time. And so that makes use of these various vital signs and laboratory data to define sepsis. So we took that definition, the real time definition, and we actually looked over a 14-month time frame of patients that went through the Duke University Hospital and found that the vast majority of these sepsis events were happening in the emergency department.

William Ratliff: [00:14:54] And so with that knowledge, we targeted the solution in the workflow to help the emergency department care teams and those who could support them to improve the care in that location. So we created the machine learning model that would predict the patient's likelihood hour over hour of meeting that sepsis definition criteria while they were in the ED. This involved, as you can imagine, quite a few, actually forty-two thousand inpatient encounters that we analyzed and about thirty-two million data points. And so then fast forward to November of 2018. We have developed the infrastructure and we're able to go live with a solution that displays patients on this Sepsis Watch application. So as they come in to the emergency department, we assess their status of whether or not they meet that sepsis definition. If not, we predict using that machine learning model their likelihood of meeting the definition within the next four hours. And so I'll pause there. And we have sort of had a journey for sure since November of 2018. But I can say more about that in a minute.

M.C. Elish: [00:16:14] Yeah, thank you. I think some helpful context for those who don't know a whole lot about the development of machine learning projects in health care, first of all, models that are actually implemented in practice are not very widespread. There is a lot of research about how machine learning can improve health care. A lot of it stays in the kind of research phase. And so what was particularly unique about this Duke project at the Duke Institute for Health Innovation at D HI was that you all were really implementing something which most people only kind of study in theory. And you were sort of seeing how it could actually be an effective intervention in practice. And what you've talked about so far is that this you know, I got involved a couple of years into this project where there had already been a lot of time defining the problem, defining how you were going to address the problem, gathering together all of the stakeholders, beginning to build the app. I mean, this is a multi, multi-year project, even like cleaning the data from electronic health records took a long time, right?

William Ratliff: [00:17:40] Yeah, I mean, it was when I say, certainly not meaning to gloss over that three-and-a-half-year time span. So, you know, the teams, you know, interdisciplinary teams that were involved in this, you know, one of which were our ROT nurses led by Dina actually, you know, from the concept really shaped the solution to solve the problem well, before we got to a point of being able to implement it.

M.C. Elish: [00:18:10] Yeah. So this kind of brings us to the piece that I think is especially under focused on, which is that you use the word solution and, you know, it strikes me if you if you read a lot about like the possibilities of health care in A.I., A.I. is a solution. Right? And what studying what you both know, working on this project and what we the researchers found looking at this project on the ground is that the technology itself is never actually a solution. The technology, in order to be effective, has to be actually integrated into the hospital, into the clinical workflows. And that is actually really difficult to do and takes a lot of care and attention and expertise. And so that actually brings us to the role of the ROT nurses who were tasked with monitoring Sepsis Watch and communicating that risk score to the doctors who were treating the patients in the emergency department. So Dina, I wonder if you could sort of take us through what is the workflow like we heard about the sort of tech side of it, you're holding an iPad in your workstation. Like what? What happens?

Dina Sarro: [00:19:51] Right.

Dina Sarro: [00:19:51] So before we had the iPad, the day in the life of an ROT nurse is to spend time on every unit of the hospital, talking to the nurses, talking to the charge nurses to see if they're worried about any patients, if there's anybody that should be on our radar, that we can help provide support to patients who may be getting sick. They're sort of on that line. Second role is we carry a pager and several phones and we respond to pages of emergencies throughout

the hospital where the nurse members of a team that responds to these emergencies to try to provide extra support to the patients. So now you introduce Sepsis Watch the app. And we were given iPads, well trained, and we're carrying around our iPad throughout our day while we're doing all these other things and monitoring it, essentially, we at the beginning of the shift, we would receive a report from the nurse on the shift before about who they're already watching on the app. And then throughout our day, we're checking it. And acting on patients that pop up as being at risk for sepsis.

M.C. Elish: [00:21:17] And what does it mean to act on that risk score popping up?

Dina Sarro: [00:21:25] So as patients sort of pop up and are flagged on the app, they're risk stratified into low, medium, high risk or meeting the definition of sepsis. And for these patients, we would sort of review the chart, triage them, and if they were at high risk for sepsis or met the definition, then it was our role to notify the attending physician in the emergency room that they have been flagged by this new system.

Dina Sarro: [00:21:58] So we would make a phone call very simple, we would make a phone call down to the attending physician in the emergency room.

M.C. Elish: [00:22:05] Right. So you say "very simple", but actually what saw in practice was that it was actually very far from simple. So I think it was sort of conceived so the DIHI folks knew that this was a really complex, really situated practice in the hospital. But I think there was this sort of thought that like, oh, the nurse will just like call down to the attending physician. Again, if you don't work in health care or in hospitals, you may not know that that that actually like is pretty unusual, would you say?

William Ratliff: [00:22:44] Um hmm.

M.C. Elish: [00:22:44] Would you say there is like definitely a hierarchy of doctors give orders to nurses. Nurses carry out orders.

Dina Sarro: [00:22:57] That's correct.

M.C. Elish: [00:22:57] What was the reaction of the doctors when the project first started?

Dina Sarro: [00:23:10] So the reaction was a little cool, perhaps, in general, and I will say we had had years of training and on our end as the ROT nurses, of what was expected. There were some emergency room physicians also involved in the workflow who told us how they wanted us to make these phone calls, what they expected from us. But there are a lot of attending

physicians in the emergency room. Not all of them were completely familiar, intimately familiar with the project as we were. So as you imagine, if you're a busy emergency room physician taking care of patients and you get suddenly an unexpected phone call from a nurse you don't know to tell them about a patient that's at risk for sepsis, it was not always welcome.

M.C. Elish: [00:24:11] And so this gets to this dynamic that we talked about in the report, which is that Sepsis Watch disrupted existing ways of caring for patients. That was in part the point. Right? Like innovations are disruptive because they change the way we do things supposedly right? To make them better. There was a problem with how patients were being cared for, and this intervention was meant to disrupt existing ways of dealing with that. But also what ends up happening in disruption is that that sort of breakage needs to be repaired. And so, you know, it isn't sort of physical breakages, but actually like breakages of power dynamics and, you know, even sort of institutional governance, ways of thinking about how people do their work. So it's like interpersonal as well as inter-organizational. And so, you know, what we talk about in the report is that the ROT nurses began to develop these kinds of strategies to be sure that the reception of the risk score that was being conveyed by the ROT nurses was actually being used by the doctors. One of the things that wasn't anticipated by the DIHI team was the fact that ROT nurses began to contextualize the risk scores by going into the patient's health care record. So Dina could you just sort of talk briefly about how nurses began to do that kind of contextualizing work?

Dina Sarro: [00:26:11] Sure, this is actually very interesting to me because, in my mind, way back in 2015, as this was being developed, this was the vision I had in my head, was that, of course we would look into the patient's chart and we're skilled nurses, and we want to sort of be part of this, be an active part of the solution. So how we started to look into the patient's chart was -- I'm going to back up a little and just say the first week when the reception was chilly, we pivoted very quickly and made some immediate changes, as did the emergency room, number one, the emergency room leaders, the physicians involved in Sepsis Watch really got the word out to their providers who might have been unfamiliar. And we very quickly identified just a couple of nurses who would be working on Sepsis Watch through this sort of rocky start. And it did not take long before the reception was more well-received. Ok, but in making a phone call down to a busy emergency room doctor by a nurse that doesn't know them, we did a few things.

Dina Sarro: [00:27:28] We went down to meet the emergency room doctors. We wanted to put faces with names. And by looking through the chart, we were able to make the most of that phone call, that brief phone call that we had through the doctors, instead of calling down and saying, for example, your patient has been flagged for high risk of sepsis, is that something you're considering? We would maybe watch the chart for a little bit, see if the patient was stable, see what the labs were, based on the information in front of us, and call down and say something

to the effect of "I see this patient came in with this problem. I see that you've already drawn these labs and administered these medications. I want you to know they have popped up as high risk for sepsis. Is this something that you're thinking? Do you want us to monitor?" And that sort of made it less like a robo call. If that makes sense.

M.C. Elish: [00:28:32] Yes, so what it sounds like is that maybe from a sort of designer perspective, even as they were having these kind of multi-stakeholder conversations, there was this sense that, like the risks for would sort of speak for itself.

M.C. Elish: [00:28:52] And in fact, it didn't. It needed to not only just be sort of carried from one place to another by a voice of a nurse, but to actually be integrated into how doctors were doing their jobs, and that required the kind of expertise of the ROT nurses, which again, I think is just a really, really important lesson for thinking about what does it actually take for a tech driven intervention to solve a problem. And it actually takes this combination of technology, but also human expertise and what we talk about as repair work, but what we might sort of say is, is that you can't have one without the other, right. It's a complex sociotechnical system that is needed to address these problems. You know, we could obviously talk all day about this project and again, I would offer the report, if you're interested in more details or a lot of the publications that the DIHI team, the Duke Institute for Health Innovation team, has published about this work, there are, I think, a dozens of papers. So if you're really interested in the technical details, please do check those out. I guess, you know, before we open it up into questions from the audience, I guess I want to sort of ask, what can Sepsis Watch tell us about about the future? As I sort of mentioned, health care is an increasingly critical space to think about and change and innovate, but also filled with all kinds of pitfalls. And AI is certainly something that a lot of people are reaching toward. Telehealth, remote communication, which is something that was really at the heart of Sepsis Watch, also really at the forefront. So I guess I want to sort of take a step back from the Sepsis Watch project itself and ask what can Sepsis Watch tell us about going forward? Will, I want to actually start with you and with the DIHI perspective and say, what's next and what have you all learned from doing Sepsis Watch?

William Ratliff: [00:31:34] Absolutely. So I think, you know, to highlight some of the points that were just made as we look forward, I would say first and foremost, the Sepsis Watch implementation and approach was certainly more than a tech forward solution.

William Ratliff: [00:31:56] The process through which we collaborated and actually were guided candidly by Dina and her colleagues and Dr. Kara O'Brien and the operational leaders was quite enlightening for us in to the requirements that are needed to thoughtfully implement a something into clinical care, be it a machine learning model or otherwise. To give an example, the governance team, the governance committee that we set up that Dina was a member of,

along with another one of our ROT nurse colleagues and ED physicians and nurses and the clinical leaders and ourselves, along with the Performance Improvement Group, we tried to make it a priority to both invigorate the folks who are on the front line doing this care, namely the ROT nurses and ED care teams, by showing progress, by trying to show improvement in Bundall Compliance.

M.C. Elish: [00:33:03] What is Bundall Compliance?

William Ratliff: [00:33:06] Yeah, so the standard of care that the Center for Medicare and Medicaid Services leads on sepsis and others, private insurers and others follow is sort of a standard of care that when sepsis is diagnosed, it's a bundle or a package of interventions that Dina certainly knows better than I do. But that essentially helps to rapidly mitigate the state of the disease, namely through antibiotics, IV fluids, taking a blood culture so that the patient, the origin of the infection is determined. And additional antibiotic treatments can be put into place. And so we would try to use that as a CMS does. So all US health care systems and hospitals report by quarter actually their SEP 1 or Sepsis Bundle Compliance Metric. And as a proxy for how good of you as a health care organization for identifying and treating for sepsis? And essentially you have a numerator of randomly select patients who are diagnosed with sepsis and that is your denominator. So your random set and your numerator is the patients who got the bundle in time, so got all those bundle components. So like I mentioned, the IV fluids, the antibiotics, et cetera, within three hours. And then there's another set of requirements to be completed within six hours. And so a priority for us was to show that the hard work of the ROT team and the ED care teams was having an impact. And so we, every week actually, I would send out an email to the our team and to the governance team showing our improvement in bundle compliance week over week, whereas we had seen a retrospective look at how we had done at Duke prior to that. And as a preliminary result, we were excited to see that we've seen about 80 to 100 percent improvement in that in that metric. So I would say one big thing for me is to be able to integrate and understand and solve the problem. You need to make sure that the folks that are guiding you and that you're relying on to work with to make it a reality can know and can feel inspired by the fact that they're actually making a difference.

M.C. Elish: [00:35:52] Yeah, so you said about Bundle Compliance, does that? I realize like something we forgot to talk about at the beginning, we've been talking about this as a sort of success of a technology implementation into workflows. But we haven't talked about whether the technology is actually getting to the point that it was supposed to get to, which is to improve care of sepsis.

M.C. Elish: [00:36:19] So, yeah, what does Sepsis Watch look like as a success from the patient perspective?

William Ratliff: [00:36:29] Sure. So this is sort of a preliminary look that we've taken. And we're actually currently doing a deeper analysis across a few different cohorts to compare prior to Sepsis Watch versus after Sepsis Watch.

William Ratliff: [00:36:49] But essentially, we're seeing again that bundle compliance as a marker of improvement. We're seeing about a hundred percent give or take increase in improvement of bundle compliance at Duke University Hospital compared to the two years prior against that since November of 2018 performance and then similar improvements at the two community hospitals where we've also implemented the Sepsis Watch.

M.C. Elish: [00:37:22] And I guess there are a couple of questions, I'm sort of seeing really great questions in the Q&A, so I want to get to them. I want to put one more thing on the on the table to sort of spur questions and further discussion, which is, you know, Dina something that we've talked a bit about and actually I've spoken to other colleagues at DIHI about is, you know, a lot of medicine now is thinking about turning to telehealth. And that is another kind of innovation that is disruptive in some good ways, but may also require some repair work. I'm wondering from the perspective of a clinician like, are you doing telework, like have some of the things that you learned doing Sepsis Watch influenced how you're thinking about any of this kind of remote clinical care?

Dina Sarro: [00:38:29] It is, and I think that as we rely more and more on technology in medicine, we sort of have to get used to these types of innovations. Health care providers aren't always historically accepting of just brand new innovations. It takes a lot of convincing, I think, when new research comes out to make a change in health care, the way things are done. So, yes, I have been doing some telehealth appointments in my cardiology clinic as well as inpatient appointments. And it's challenging. I find it very challenging. Yes. Although-.

M.C. Elish: [00:39:20] What's challenging about it?

Dina Sarro: [00:39:20] I think that there's two layers. The first being the technology is challenging for a lot of the patients who I work with, primarily elderly patients, a lot of them in rural North Carolina. A lot of times they are unable to get the technology to properly work. So then you spend a lot of your short visit time trying to help them troubleshoot. That's the first thing. And the second thing I was trying to figure out why I'm so much slower, why it takes me so much longer to do a telehealth visit. You would think it would be quicker. You're taking out the physical exam portion. And I think it's because I normally, during my visits, I'm spending part of the time in with a patient documenting, looking at my computer, which they can see me doing, looking at the patient, sort of making that eye contact. But during-

[00:40:18] Multitasking...

[00:40:20] Exactly. But during a telehealth visit, all the patient can see is sort of from shoulders up. So I feel it's very important to make eye contact through the whole visit, to keep that relationship and build that rapport with patients, especially if they're seeing me for the first time. So I don't have any time to document during that visit. If I was going to visit with you right now, you wouldn't want to see me like this because I don't look engaged. So it's a very tough balance.

M.C. Elish: [00:40:59] Yeah, yeah. And I feel like this is something that, you know, there have been a lot of comments about. Technology is supposed to give more time to the patient, but it ends up not. And I think that this is right?

Dina Sarro: [00:41:15] Yes, I would agree with that.

M.C. Elish: [00:41:20] And I think that one of the big lessons I feel like is, is that, not the only one. Right. But one lesson is that, you know, and we know this historically too, that a lot of purportedly labor saving technologies, actually create more labor, but they push that labor sort of out of the frame. Right? And so it's important to be sure that the labor that is required to actually carry through the whole care process gets recognized and gets sort of accounted for when we talk about, you know, time, it takes expertise, that it takes all of the kinds of things that go into valuing certain kinds of work anyway.

M.C. Elish: [00:42:11] I would love to keep asking my own questions, but actually we have some fabulous questions coming up.

M.C. Elish: [00:42:18] So let me start with one question. This this audience member says thank you for your presentation. Would the panelists comment on what difference they feel it makes to have interdisciplinary perspectives involved in this project of designing Sepsis Watch? Was there a moment when you noticed the value of these perspectives at the table? Could you say more about the value of ethnographic research to inform the design of workflows identified by nurses Dina? Let's take the first part of that question. And I would be really curious to know are there any specific moments or stories that either of you can remember about the importance of having this these multiple voices at the table?

William Ratliff: [00:43:21] One that - well go ahead Dina and ask you about something that was before my time with DIHI.

Dina Sarro: [00:43:29] Go ahead Will.

William Ratliff: [00:43:29] One of the more poignant lessons that was shared with me as I joined the team midway through this project was actually from an interaction, I believe Dina that you and my colleague Nathan Frazier had in terms of how to think about designing the solution like way back when, I was just interested about your recollection of that sort of remember that the visualization diagramming of thinking beyond detection. And once you identify sepsis like, then what?

Dina Sarro: [00:44:06] Yeah, I mean, I knew immediately that it was going to take an interdisciplinary approach. I'll back up quickly and say this is where Dr. Cara O'Brien had the vision. She knew from the beginning it was going to take input from everybody that was going to be involved in this project for it to be a success. Buy in, it's all about the buy in and I remember sitting with Nathan at a coffee shop and him showing us some of the we called it the dashboard at the time. This is what we were thinking. And myself and another coworker were saying, well, we don't necessarily like that there, is there a way we could adjust things? And we specifically asked for a few things, we asked could we have the lab take? For example, this is a lab that's very important in sepsis. Could we have that be displayed right on the front page? There was some talk, could we have phone numbers displayed on the front page? I mean, I think from the beginning, it was fascinating knowing that if we were going to be the ones carrying and using it, it had to be user-friendly and make sense to us.

M.C. Elish: [00:45:24] I have a quick story about... Will, sorry, no, go ahead.

William Ratliff: [00:45:27] Well, just to finish that thought. The other thing that I know from my perspective that was so informative and helpful as we started to finalize the workflow again, going back and revisiting it was around the you know, how you thought about triaging patients. So, you know, a patient that you see pops up on the application. You know, there are some patients that aren't at risk or have a relatively lower risk. And so the idea about how to manage that fluidly in a way that's not burdensome you know Madeiline, you're talking and Dina about, you know, not having added work unnecessarily and being thoughtful about how we use this app to identify and treat rather than having just one other place people have to look, so that the thought about having the sort of triage landing page and then moving some patients who are quote, unquote, screened out, meaning at that point in time were lower risk versus ones you're keeping an eye on with a monitoring status versus ones that you had to basically go forward and treat with the sepsis bundle. So that to me, was so instrumental in terms of weaving the workflow to fit that that thought process.

Dina Sarro: [00:46:50] That's right.

M.C. Elish: [00:46:51] I'm remembering actually people telling me stories about how, where several points in the design of the workflow and the app itself that changed following conversations with the ROTS or with other clinicians. Dina, did you want to add something otherwise I'll add.

Dina Sarro: [00:47:16] No, go ahead.

M.C. Elish: [00:47:19] When I first became involved in the project, Will was actually not yet an employee of DIHI. And so for me, actually, a story that strikes me as informative is the fact DIHI realized that they needed someone to full time be keeping track of and like ensuring all of these multidisciplinary conversations were happening, because that really takes a lot of time.

[00:47:59] It doesn't happen automatically. Right? So that's something that maybe interdisciplinarity doesn't. It takes a lot of time, multi-stakeholder stuff. It doesn't go smoothly. It takes a lot of time. And so the fact that Will was like resource to exist is a story.

William Ratliff: [00:48:17] And a lot of friends.

Dina Sarro: [00:48:19] And I will say Will and the [inaudible] were instrumental in helping to bring all the stakeholders together and giving everybody the attention that they needed and address the concerns that they had.

Dina Sarro: [00:48:36] It would not have worked and they had developed an app and then just handed it over and said, you are to use this and this is how it's used. I feel strongly it would not have been as successful.

M.C. Elish: [00:48:54] Right. Yeah. There was a lot of like...

M.C. Elish: [00:48:56] And I would just sort of quickly, quickly say that I think that the ethnographic perspective, one thing was, that even though there was so much engagement across multi stakeholder groups, there actually wasn't an effective feedback loop about what was actually the workflow, happening from kind of a meta level and sort of talking about the kinds of work that the ROT nurses were doing. It was so obvious no one had thought to tell anyone else about it. And so, in a way, having that sort of ethnographic mirror helped everyone connect more, I would think. So there's a really important question that I want to just voice, which is the questions, as I've heard a lot about the implementation of this technology and finding its clinical context, but I haven't yet heard about the impact that was on patients. Has there been a prospective trial, higher survival of sepsis in patients tagged by this technology?

M.C. Elish: [00:50:16] We talked briefly about that, but I want to open up a bit more space to add more comments around kind of what is the patient perspective here?

William Ratliff: [00:50:29] Certainly, I can take a shot at that to start. So, like I'd mentioned, the sort of observational progress with the bundle compliance was an early promising indicator. But we are currently analyzing the impact of the sepsis watch and associated, you know Sepsis Watch as a solutions so not just the application, but that the workflow, the sort of the ROT approach and everything, comparing that cohort of patients who meet the sepsis definition or would be considered high risk. So comparing the similar time frames from before the application was implemented to after, we're specifically looking at the rate of in hospital mortality, the hospital length of stay, the requirement for ICU, and the length of stay in the ICU. And we're actually comparing a few different lenses of cohorts. So when you think about the real time definition of sepsis as being a good, but not exact ground truth as to what eventually gets diagnosed for patients who walk into the ED. There's a subset of that group. So that would be one cohort. There's a second cohort which would be thinking about those who Sepsis Watch identified via that real time definition, who then went on to be diagnosed with sepsis by a physician. That's a sub cohort in there. And then we're also looking to identify from the CDC's adult sepsis event definition, which is I won't go into detail right now, but that's sort of considered a very strong or gold standard to compare against. So that would be a third cohort that we're hoping to compare pre versus post. So in progresses, I guess, the short answer, but we are definitely working on it.

M.C. Elish: [00:52:33] And there are clinical trials. There's the registered clinical trial.

M.C. Elish: [00:52:39] One thing that I want to kind of add to that, which was really interesting for me as an anthropologist and social scientist to grapple with is that the paradigm that this intervention is working in is evidenced-based medicine, which is both the best thing that we currently have to improve health care. It's also got a lot of flaws because for all kinds of reasons. But one is that there are a lot of proxies that are used. So, for instance, bundle compliance. The fact that someone is getting effective treatment for sepsis, we are saying that that is, that that is the same as sort of having a better outcome once you get sepsis. It's not exactly the same thing. Right? And so there is this tension around both what is the problem that you're trying to have the technology solve? And is it the right problem because are you using the right proxy? And also, I think just an ongoing like reflection around, you know, are these metrics and this came up in discussions with doctors who actually weren't, who had even more pushback about the system, which is like, are metrics, even generally of evidence based medicine, like are they just metrics of compliance or are they actually improving care? And I think that these are open questions that we have to grapple with and that there is no simple answer. That brings me

to there are so many great questions. I'm so sorry not to be able to ask them all. I've frankly just been doing all the ones that were upvoted. But I think that this this question around, you know, the opportunities and frankly the dangers of using a lot of the existing metrics and datasets and existing sort of practices of evidence based medicine. There's a question here that is actually asking about the diversity of the data sets that were used. The question says, can you speak to the data set that's upon which the ML program was built on, and in particular the diversity of patient groups reflected in sepsis phenotypes used to train the program?

William Ratliff: [00:55:26] Sure, so recall, we looked at a 14 month time frame for training the models, those that included about forty two thousand inpatient encounters of adult patients who were entered through the emergency department and were hospitalized or discharged, and of that, twenty-one percent or so had a sepsis event. In terms of the diversity of patients or of patients' subgroups, our main limitation was just limiting by age at the time of the encounter start. So we intentionally tried to assess for a variety of different types of patients who may be presenting with sepsis or be at risk of sepsis to try to understand the problem a little bit better. So whereas we certainly did quite a bit of just quality assurance data checks for conformance, plausibility, completeness for both the patient data coming in and as well as the transformations of that data to support the model. But yeah, we tried to be as sort of neutral as possible with how we, you know, minimally altering the data set in terms of who was included or excluded from a cohort perspective.

M.C. Elish: [00:57:10] And is race data included? As we've been talking about, racially disparate health outcomes, was race included in as a feature in the data set?

William Ratliff: [00:57:23] It was not. And that was sort of a thoughtful decision, I think, to speak to the question a little bit more broadly. You know, there are certainly artifacts of, as you've talked about, Madeleine just...the society in which we live and the implications that can have on data quality, you want to be as cognizant and thoughtful in consistently asking that question about, is what we're doing keeping in mind these disparities, that may manifest in the data.

M.C. Elish: [00:58:06] This is something that I've had some really interesting conversations, and I know you all at DIHI have done some work around this idea of model cards to sort of tell how the model works, and it also explains what the quality of the data set are in some of the publications that you all have published. There actually is a model card that you all put together, also some of the statisticians who are working on this, Joe Futterman, have also done research that was really focusing, and they were essential to the model that was developed, is the idea that the this model was trained on local patient data and is only fit for this particular locale.

M.C. Elish: [00:59:03] And that that also was my understanding around how some of these questions of the diversity of the data set were attempted to be addressed.

[00:59:13] Absolutely.

M.C. Elish: [00:59:15] Yeah, aw man, there's just so many great questions, but it is 2:59 and I want to be respectful of people's time.

M.C. Elish: [00:59:25] Thank you all so much for joining us. Any final words? Will, do you want to? What's with what's next? What words of wisdom do you have for people who are trying to go build a Sepsis Watch of their own?

William Ratliff: [00:59:45] I'll just say, to keep it short, I'll say listen to the experts and those caring for patients on the front line who have the expertise and feel the problem every day.

M.C. Elish: [01:00:02] So let's give the last word to Dina.

M.C. Elish: [01:00:06] What words of wisdom could you share?

Dina Sarro: [01:00:07] Words of wisdom would be, think of every possible person that integrating this type of tool might affect and get them involved on every level, from administrators to providers to nurses to data scientists, app developers, get everyone to the table and you'll get all the perspectives to be successful.

M.C. Elish: [01:00:33] Thank you both so much. This has been a wonderful conversation, I hope you all have enjoyed it and found it as informative as I have. There is actually a lot of documentation. So please go read more. And thank you all so much.

William Ratliff: [01:00:53] Thank you, Madeleine.