OPEN PEDIATRICS™

Integrating Risk Analytics in Post-Cardiac Surgery Extubation Readiness

This podcast explores two multicenter studies on extubation outcomes in neonates and children following congenital cardiac surgery. These studies incorporate integration of machine learning and risk analytics for extubation decision-making and examine extubation readiness and extubation failure outcomes.

Speakers:

Daniel Hames, MD, MPH

Assistant Professor of Pediatrics,

Cardiac Care Unit

University of Nebraska Medical Center

Children's Nebraska

Jeffrey Burns, MD, MPH

Emeritus Chief

Division of Critical Care Medicine

Department of Anesthesiology, Critical Care and Pain Medicine

Boston Children's Hospital

Professor of Anesthesia

Harvard Medical School

Initial publication:

November 25, 2025

Sarah Marcley *00:04*
This podcast is a production of OPENPediatrics, an open access online community of healthcare professionals sharing best practices from around the world. Visit openpediatrics.org for more.

Jeff Burns *00:18*
Welcome to the OPENPediatrics World Shared Practice Forum Podcast. I'm Jeff Burns from Boston Children's Hospital, and it's a pleasure to have with us today Dr. Daniel Hames. Dr. Hames is Assistant Professor at the University of Nebraska Medical Center in the Division of Critical Care Medicine. He is also the Director of Quality and Safety for the Cardiac Intensive Care Unit at Nebraska Children's Hospital. Danny, welcome.

Daniel Hames *00:44*
Thanks so much for having me Dr. Burns, I appreciate it.

Jeff Burns *00:47*
Danny, we're here today because you have not one but two large studies that have been published now in Pediatric Critical Care Medicine. In the May issue of Pediatric Critical Care Medicine is your manuscript, you're the first author of a multicenter study looking at the outcomes of newborns following extubation in the context of congenital cardiac surgery. That article is entitled, Extubation Failure in Neonates Following Congenital Cardiac Surgery: A Multi Center Retrospective Cohort, 2017 - 2020. And again, that study is in the May 2025, issue of Pediatric Critical Care Medicine. In September's issue, September 25 of Pediatric Critical Care Medicine is not a follow up, but a corollary study, associated study that you ran, where you're looking at the outcome of extubation in children greater than one month again, following congenital cardiac surgery, again, an international multicenter, retrospective cohort study over the same period, 2017 -2020. And so we wanted to have you on today, because, you know, this is a very significant achievement. This is a international cohort of eight centers across the world, and you're reporting a large number of patients undergoing extubation first, as I discussed, neonates, and you report that outcome experience in the May 2025 issue of Pediatric Critical Care Medicine. And now you report the outcomes of children greater than one month in the setting of following congenital cardiac surgery in the same cohort over the same time period, 2017 - 2020. And so we wanted to get your report on what you did and what you found. But before we do that, I do have to acknowledge that the editorial committee selected both of your studies for a podcast, but your your study does entail the use of some variables that you will describe that are derived from what is called the T3 or the Etiometry platform. And for full disclosure to our audience, I have royalty interest in Etiometry, but I did not solely select your two studies for podcast today. I was not involved with your study in any way. And I should also add, and you may as well, you have no conflicts to report regarding Etiometry, no royalty interests, etc, correct?

Daniel Hames *03:27*
That is correct. No royalty interest from Etiometry.

Jeff Burns *03:29*
And as I understand it, as you wrote in both articles, you received no funding from Etiometry, and they had no editorial control over your manuscripts in any way. Is that correct?

Daniel Hames *03:41*
That is correct.

Jeff Burns *03:42*
Okay, I just wanted to get that out of the way for full transparency. So let's dive into it. What you did and what you found. And so of course, the first question is, what was your objective in developing these observational studies? What questions were you trying to answer, and what methodology or approach did you utilize to answer these questions?

Daniel Hames *04:04*
Yeah, thank you. So this has been a question that has been bothering me for a little while now, and it really melded two particular interests that I have. One is trying to evaluate the non-respiratory organ support that children with congenital heart disease received from mechanical ventilation. So different from, you know, a patient with ARDS who is receiving mechanical ventilation for oxygenation and ventilation. Children recovering from cardiac surgery are receiving a number of different supports. So yes, they receive oxygenation and ventilation, but also some additional cardiac support via afterload reduction helping to balance the difference between pulmonary and systemic blood flow. And I have always been interested in how we assess how they're ready for extubation, using the tools that we have. And I've viewed it as a little bit of a gap in our knowledge base, and how we use our traditional assessments of spontaneous breathing trials and apply that to the cardiac population. The second piece of it is factors into the decision making and how we make decisions. And the way that I have explained this to some people in the past is that, you know, a lot of times, people will say that the decision of when to extubate a patient comes from clinical intuition. And I would agree with that. But your intuition at the bedside is different from my intuition. My clinical mentors, Peter Lawson and Ravi Thiagarajan have a different approach when they extubate someone. So is there a way that we can leverage the large amount of data that we have into a tool that can help us assess patient readiness for extubation. And so the primary question that I had were to use these two risk analytics tools, the IDO2 index and the IVCO2 index, and see if there is an association in those indices in predicting extubation failure. And so the IDO2 index, again, provided through Etiometry, synthesizes a number of different inputs, physiologic variables, lab variables, and then puts out a probability between zero and 100 that a patient has a low mixed venous oxygen saturation. You can set the threshold at 30, 40, or 50, and so it serves as a surrogate for delivery of oxygen. And the second variable is the inadequate ventilation of CO2 index the IVCO2. And that similarly uses physiologic variables, lab variables, but also ventilator measurements, and tries to predict the probability of inadequate ventilation of carbon dioxide, defined as an arterial carbon dioxide, above a threshold, usually 50 or 60. And so I wanted to evaluate various thresholds of these, because I see them at the bedside, but still, I think the clinical utility of them is being developed. And so wanted to evaluate thresholds and their association with extubation failure. But also in the context of some of the clinical variables that we use every day to try to predict extubation failure. And so a group of eight centers came together, including Boston [Children's], Children's

Nebraska, Toronto SickKids, Aga Khan in Pakistan, Dallas, Children's National, St Louis and University of Alabama to put some data together for a retrospective study. And we used multi variable logistic regression modeling to come up with our initial assessments using both clinical variables and then subsequently with the risk analytics variables. And then we also performed a net reclassification index to see when we added those risk indices to a clinical model, how much better was the model at predicting which patients were successfully extubated, and which patients suffered an extubation failure.

Jeff Burns *07:43*
We're here again with Dr. Danny Hames from the University of Nebraska, discussing his two large cohort studies that are published in the both in the May 2025 issue of Pediatric Critical Care Medicine and the September 2025 issue of Pediatric Critical Care Medicine. Danny what was the overall extubation failure rate for the neonates and then correspondingly for the children greater than one month, in the context of following congenital cardiac surgery?

Daniel Hames *08:14*
Sure. Thank you. So for the neonates, there were just over 100 patients who met the primary outcome criteria of re-intubation within 48 hours. So that was about a 14% rate. In comparison to the published literature of the extubation failure rates for neonates in this specific category, it actually tracks pretty well. We are again focusing specifically on patients who undergo high-risk procedures and who are receiving at least some period of mechanical ventilation in the post operative period. So the broader look at extubation failure rates of critically ill children or critically ill children with heart disease may be lower. But this is a specific high risk population that we're looking at and does track with the rest of the literature. And then, similarly, for the older children, we had the primary event rate of 79 out of the 922 patients who had met the criteria for reintubation within 48 hours, for a rate of around 8.5%. And similarly, when we hone in on this particular subset of population that tracks. But similarly, it is higher than the overall extubation failure rate of critically ill children recovering from congenital heart disease. And again, I think specifically because we're looking at those patients who needed some period of post operative mechanical ventilation out of the immediate operative period.

Jeff Burns *09:39*
So two follow up questions for you. And again, you're being very clear that the inclusion criteria here and the cohort under study here is following congenital cardiac surgery, and so these are quite ill patients, even for a pediatric cardiac intensive care unit. But my two follow up questions are, one is first, what is the message to your colleagues in the pediatric cardiac intensive care unit based on the findings of these two studies?

Daniel Hames *10:09*
So thank you. So I think that there can be a couple of messages. So one is you can look at the clinical piece that you know you have eight centers who pooled data to identify some clinical associations with extubation failure. I think that most folks would not be surprised to find that pre operative exposure to non-invasive respiratory support or preoperative mechanical ventilation puts patients at a greater risk for post-operative morbidity. What I would say that the way that I view that is that that may play a role in when you decide a patient may need to go to the operating room, especially for the neonates. Sometimes they may have a preoperative status that requires them to be intubated and mechanically ventilated ahead of time. Other times it's a delay in waiting for brain maturation and before going to

surgery. And so I think that the take home point for that is that you just have to weigh the risks and benefits of waiting for an ideal operative time and potential for accrued morbidity, the single ventricle association with extubation failures similarly, I think most people would agree that this is a very challenging cohort to manage. And so where I would push or challenge my colleagues in the cardiac critical care community to think through is, is that these tools, at least as we have defined them, with their thresholds, improved our clinical utility and predicting extubation failure again in a retrospective fashion. And at eight centers who have access to this, to this technology. So the way that I would think about it is in the subset that we know is high-risk, patients receiving pre operative mechanical ventilation, patients who are single ventricle anatomy, patients who have been intubated for a longer period of time. I think there is a utility and using these tools as an added feature, in addition to your clinical intuition and these clinical features and identifying patients who are at a higher risk of extubation failure.

Jeff Burns *12:11*
And of course, the corollary question that I wanted to ask and follow up is, what if one of our colleagues out there is practicing in a center that doesn't have the Etiometry platform. They can't assess the IDO2 or the IVCO2. What advice do you have for them?

Daniel Hames *12:33*
Yeah, so I think that the benefit of the tools, as sort of, I see it, is that, you know, continuous monitoring piece of it. And it is a limitation that it is not externally available. So what I would say for centers that don't have this, as I view it, is that we still have a lot of clinical data that has been pulled together from all of these centers. And there is still some strong take home messages and identifying patients who you may consider high or low risk for extubation failure. And may be able to still think through how you might approach their extubation timing and how you assess them. The tools are meant as probabilistic interpretations of data that we can get at the bedside. So there is the opportunity for checking mixed venous saturations. There is the opportunity to check arterial carbon dioxide. And so if you are able to check those, and they are below these thresholds of 30, 40, 50, or whatever clinician may deem clinically significant, as they're undergoing their spontaneous breathing trials or in preparation from extubation, then I would advise people to use that in their clinical decision making, when they're deciding about timing of extubation.

Jeff Burns *13:49*
And can I ask, did you find any association between dead space and extubation failure?

Daniel Hames *13:57*
Yeah, it's a good question. So we didn't look specifically at dead space. The theoretical rationale of the IVCO2 is that it is because it involves ventilator measurements end tidal CO2 measurements, and then PCO2 measurements when they feed into it. It is meant to overcome some of the limitations of dead space, but one of the things that we didn't do is individually look at some of the isolated components of each of these tools to be able to get a true assessment of the dead space fraction.

Jeff Burns *14:30*
Well, I didn't want to ask this without asking you, are you planning to do a follow up analysis of that data set to look at some of the more traditional measures, like dead space, to see if there is an [association]. In other words, doing an analysis based as if you didn't have Etiometry, but use the data set to look at

things like dead space or even assessing Adrienne [Randolph]'s, you know, spontaneous breathing trial from JAMA 20 years ago, and how closely does that correlate? But are you thinking about doing that, looking at non-Etiometry based variables as a re-analysis of this data set?

Daniel Hames *15:10*
So I've always sort of thought of, yes, doing that, and looking similarly at the, you know, originally, when we put this together, I had wanted the individual components of the algorithms too, you know, the heart rate, the blood pressure, like all of that. But it took so long to get the data that then it was, it was, you know, by the time everything came through, I was like, oh, it's already 20... I didn't get the data until the beginning of 2024, and so it was kind of a rush to get everything done because of that. So, so this is, yeah, short answer is, is nothing planned, but in an ideal world, we would.

Jeff Burns *15:47*
Well, Danny, what are the next steps here for you and your co-investigators?

Daniel Hames *15:51*
So we obviously are trying to utilize this large data set kind of as maximally as we as we can. We do have some data points of risk analytics at other time points during the ventilator reading period, and so we're currently analyzing how that plays into it, as opposed to just the pre-extubation period. One of the challenges is that with eight centers and eight international centers, everyone has their different extubation readiness testing practices, and so some of the values and variables that we got during spontaneous breathing trials are on different levels of support. But we're thinking through how we might be able to analyze that and add to this story of how risk analytics may help inform or not inform ventilator weaning and readiness for that. We similarly are looking at those patients who extubated to non-invasive and were rescued with non-invasive and not reintubated versus those who required re intubation, to see if there's a signal that we can see in the IDO2 in addition to some of the clinical factors of patients who were rescued with non-invasive versus those who required reintubation. And then a few of the centers are individually, not necessarily collaboratively, but individually, looking at these in a prospective fashion. And so there is one study that I have ongoing in Boston Children's Hospital, where I was previously at, as you know, studying these in a clinical decision support tool that is implemented to try to target earlier ventilator weaning, but using the risk analytics tools to inform that decision making process. And also looking at some of the human factors that go into the decisions around extubation readiness testing and the level of support that patients are extubated to, and those associations with extubation failure as well. So that's in this realm. I think that this field of risk analytics and thinking through this is still new and growing. And so there's a lot of other studies that we're looking at and predicting other clinical outcomes, such as acute kidney injury. There's a group that's looking at delirium, and so I think this is really the start of something and thinking through how we can use these tools at the bedside. And then the last thing I'll say is that, you know, we looked at this in a binary fashion, looking at thresholds. I think that the next steps in trying to think through this in a very sophisticated way is really approaching it with machine learning to look for subtle trends that we might not be able to see, to be able to trigger alerts to clinicians at the bedside and help guide their decision making process as well.

Jeff Burns *18:32*
Well, we've been speaking with Dr. Danny Hames. Dr. Hames, as I said in the introduction, is an Assistant Professor in the division of Critical Care Medicine at the University of Nebraska Medical

School, Medical Center. And he is also the Director of Quality and Safety in the Cardiac Intensive Care Unit at Children's Nebraska. And we've been discussing his two recent publications in Pediatric Critical Care Medicine, and the citations are available in the link below to this podcast. Danny, thank you for this work. You know, knowing that your interest is in quality and safety, it's it's going to be fun watching your career evolve. And you know where you take this going forward, especially as machine learning and artificial intelligence helps you get there even faster. So thank you for being with us today, and Danny, you get the last word. And this is a this is not a medical question. This is a question that I've been asking people on the podcast, and that is, what was the last book, either nonfiction or fiction, that you read that you know moved you in some way, was memorable in some way.

Daniel Hames *19:41*
Thank you, and I appreciate that the time to speak about this. So I am a big reader. That's the only hobby I have, and I've read a lot of mediocre books lately, but the last one that stuck with me was called Tomorrow, and Tomorrow, and Tomorrow by Gabrielle Zevin. And it's a story of some college students who attend MIT, and they'd known each other for a while back when one of them had childhood leukemia, and one of their siblings was also in the hospital at the same time. And they met and they bonded over some video games at that time, and then when they got to college, they started to make video games, and it tells their story evolving over time as other people weave in and out of their lives, and as their lives take many different turns and chapters. And so it was a very realistic book with a lot of emotions, and one that I had to pause multiple times because I actually didn't want to, well, some people say they don't want to put a book down, but I didn't want to finish this book because I didn't want it to be over. So that was the last one that really stuck with me.

Jeff Burns *20:49*
Thank you for sharing that, Danny, and thanks for being with us today on OPENPediatrics podcast.

Daniel Hames *20:54*
Thank you, Dr. Burns, I appreciate it.

Jeff Burns *34:35*
Well Daniel Hames, with your expertise and as you know, one of the co-investigators on the NEAR4KIDS, it's been fascinating to hear, you know, where we have evidence in pediatrics and where we don't. And maybe not so surprising that, you know, we don't have the same degree of evidence as in the adult world. But I want to step back for a moment in our last question. And you are known throughout the world for your work in simulation, and how innovative you've been with simulation and just in time training and etc. And as you well know, a semi-elective intubation on a critically ill child is a resuscitation. And how do you think about it? You know, you're you're standing there in the room, you're the attending physician. You're in charge. You're orchestrating a team. What are the things you want to see from preparation all the way, you know, through confirmation and whether you're going to use, you know, recruitment maneuvers, etc, after the tube is in. How do you think about this?

Sarah Marcley *20:57*
This has been a production of OPENPediatrics. You can find the resources and journal articles referenced in this podcast in the description. We have more podcasts like this one available everywhere you get your podcasts, visit openpediatrics.org for more information.

Articles Referenced:

Hames DL, Burns JP. Integrating Risk Analytics in Post-Cardiac Surgery Extubation Readiness. 01/2026. OPENPediatrics. Online Podcast. Links: https://youtu.be/D6r8_1byo6c, https://soundcloud.com/openpediatrics/integrating-risk-analytics-in-post-cardiac-surgery-extubation-readiness-by-d-hames-openpediatrics.