

Pediatric Intubation Practices: Insights from NEAR4KIDS

In this World Shared Practice Forum Podcast, Dr. Vinay Nadkarni discusses emergent tracheal intubation in pediatric critical care. Drawing from the NEAR4KIDS registry and comparing with recent adult-focused evidence, Dr. Nadkarni discusses the challenges of airway management in children, emphasizing the importance of patient specific physiology. He highlights how patient positioning and equipment choices can improve intubation outcomes. Additionally, the episode explores the benefits of video laryngoscopy and apneic oxygenation. This content is pertinent for healthcare professionals seeking to enhance their understanding of pediatric airway management, offering practical insights supported by recent research.

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Sarah Marcley 00:04

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Jeff Burns 00:19

Welcome to the OPENPediatrics podcast the World Shared Practice Forum. I'm Dr. Jeff Burns from the Division of Critical Care Medicine at Boston Children's Hospital and Harvard Medical School. We are very pleased to have with us today, Dr. Vinay Nadkarni. Dr. Nadkarni is a past president of the Society of Critical Care Medicine, and as many know, he's the Founding Director of the Center for Simulation, Advanced Education and Innovation and Academy for Resuscitation at the Children's Hospital of Philadelphia. He's also the co-principal investigator of the National Emergency Airway Registry for Children, NEAR4KIDS, a multi center prospective registry for advanced airway management in pediatric intensive care units. Finally, he's Professor of Anesthesia, Critical Care and Pediatrics at the Perelman School of Medicine at the University of Pennsylvania. Vinay, welcome.

Vinay Nadkarni 01:12

Hello, Jeff. Nice to see you and nice to be here to talk about this topic.

Jeff Burns 01:18

Vinay, thank you for doing this. As you know, you and I were talking, and we noted that in the July 2025, issue of the American Journal of Respiratory and Critical Care Medicine, volume 211 there is a concise clinical review on Evidence-based Emergency Tracheal Intubation in adult critical care by colleagues from Vanderbilt University. And it's an excellent overview of the evidence as it exists in adult critical care on optimal management practices and where the evidence is still lacking. And when I saw that article, I thought, I've got to get a hold of Vinay in your role as one of the co-leads of the NEAR4KIDS, again, the National Emergency Airway Registry for Children, known as NEAR4KIDS, to get your assessment of the issues that they examined, and ask, is there evidence in pediatrics for or against many of the categories that they've looked at. And so today, that's what we're going to do. And in particular, we're going to be looking at table one of that manuscript on page 1161, of this concise clinical review, again in the blue journal [American Journal of Respiratory and Critical Care Medicine] of issue of July 2025, volume, 211. So Vinay you know, before we begin, I guess I need to ask a fundamental question about really research in this area. You know, obviously every step can't be examined by randomized, controlled clinical trial. What has been the approach of the NEAR4KIDS registry, and what are your thoughts about really the optimal or really an acceptable, or maybe the only practical research methodology that one can utilize when examining airway practices on a critically ill child?

Vinay Nadkarni 03:18

Jeff, I think that's a really good question, because, as you know, we're going to be reviewing randomized control trials in adults, mostly in emergency departments, in anesthesia and in critical care units, large numbers of patients, diverse patients in pediatrics, of course, much smaller group. And as

usual, we lag behind in terms of the capability of looking at randomized control trials. So most of our information comes from registries and observational data like the NEAR4KIDS registry, and I should tip my hat to Akira Nishisaki, who's the real brains and brawn behind the NEAR4KIDS registry. But in that type of registry of prospectively collected data across multiple institutions, more than 60 institutions across the world, we're able to prospectively collect data and analyze it, but all of the analysis is really more or less like an observational trial, observational study. So we can find associations, but not causation, and we almost often, almost always, have confounding, because it's very difficult with the numbers of patients to account for the wide variability in patient practice, setting, experience, etc. Having said that, the data has set the stage, and there are a few randomized controlled trials like Annery Garcia-Marcinkiewicz, was able to do a study amongst anesthesiologists of video laryngoscopy, randomizing those children to either video laryngoscopy or direct laryngoscopy by anesthesiologists, and demonstrated that video laryngoscopy had a better first attempt success rate in a lower tracheal intubation associated event rate. And now in neonates, for instance, in the area of apneic oxygenation the POINT study has published their protocol and is doing a five center, multi-center trial, randomizing infants to six liters of high flow nasal cannula versus no apneic oxygenation, which is their current standard practice, and comparing the outcomes. But to come back to what you were talking about is are randomized clinical trials really what we should be basing this on. Because part of the problem is when we randomize to two groups, or even if we use a little more sophisticated methodologies, we're oftentimes including a lot of patients who are really intubate, easy to intubate, alongside those that are really difficult to intubate. And we're also not taking into account the experience level or the training of the intubator with the tool that they're being assigned to use. And so this, I think, is a type of confounding that hinders the ability of the RCT to give us the answers we need at the bedside. And sometimes it comes down to experience. And I think we're going to talk a little about this on the podcast about here's what the randomized trial say, here's the here's what the observational trial says. And then try to get an idea of what you and I do in real life, and how maybe we try to come to those decisions, given the evidence that exists and our experience.

Jeff Burns 06:37

Well Vinay, with that, let's get to the article. And again, for our listeners, we're referring to an article that appeared in the blue journal, the American Journal of Respiratory and Critical Care Medicine, volume 211, July 2025, and it's a concise clinical review entitled Evidence-based Emergency Tracheal Intubation by Semler and colleagues from Vanderbilt University. And it is, you know, it's a study of the evidence as it exists, as you just said, in adults, in adult critically ill patients. Nonetheless, I thought it would be a good springboard for us to discuss the evidence as it is, exists or does not in pediatrics, and to ask you, as someone who not only studies this, but has practiced for many decades how you approach these issues. They broke down table one on page 1161, into three categories, and they listed five areas where they felt there was evidence of benefit to support the practice. Two areas where they felt there was evidence of lack of benefit. And then finally, they listed a number of items that still need more investigation. So to begin with, evidence of benefit, again table one page 1161, blue journal, July 2025, Evidence-based Emergency Tracheal Intubation, evidence of benefit number one, pre-oxygenation with non-invasive ventilation decreases the incidence of hypoxemia during intubation compared with an oxygen mask. Has that been studied in the critically ill pediatric patient?

Vinay Nadkarni 08:20

To my knowledge, not. And one of the prefacing you added the point critically ill. And remember that this, the article that they're reporting on doesn't necessarily restrict themselves to critically ill patients. Now the issue in children, of course, we know for many years in the 1960s [Dr. Jonathan L.] Benumof and the anesthesiologists demonstrated that without apneic oxygenation, the reserve of the infant and the child was very different from the adult undergoing anesthesia. And that the duration of time before desaturation, eight minutes in the average adult, when you pre oxygenate them, is down to one, or at most two minutes in either the critically ill child or the non-critically ill infant. And some of that probably is based on the closing capacity of the lungs is much closer to FRC [functional residual capacity] in infants and children than it is in adults. But to my knowledge, pre-oxygenation has been demonstrated to decrease the desaturation to less than 90% and less than 80% during intubation. But the method of pre-oxygenation, to my knowledge, has not been studied intensively and well sort of and the difference between non-invasive and face mask pre-oxygenation has not been demonstrated. One last caveat is, remember, patients can start below, at, or above FRC. And so when we're talking about even critically ill patients, some are over expanded. Some are normally expanded. Some are most are under expanded at the time of intubation. And so what we may be seeing in the adults, particularly the critically ill adults, is that that non-invasive pre-oxygenation is actually a recruitment maneuver to give them more reserve and bring them up to FRC, as opposed to it being the tool. You'll see in all of these Jeff, the tool, whether it's a face mask or a non-invasive mask or a video laryngoscope or direct laryngoscope. It's not so much the tool. It's dependent on the patient and the provider on how they use it. And so my belief is that it's we tend to lump things into, is this tool better than that tool, rather than the real issue of whether we achieve FRC, whether we're moving to the patient's physiology. And when I intubate, when I personally at the bedside, intubate, without an without a randomized controlled trial, I'm trying to think of the physiology of the patient and whether perhaps non-invasive or positive pressure ventilation for pre-oxygenation, might recruit if that's what they need. But in somebody who's already over expanded, I might not want to add the positive pressure at that point. I might choose to use face mask oxygen.

Jeff Burns 11:31

At our place I've noticed that, you know, over the decades, we certainly always whatever device the patient was on prior to intubation, we'd you know, turn it to 100% as soon as we made the decision. I think what I've noticed, however, regarding pre-oxygenation, that's different in our practice over the last four to five years, is that we more likely than not, are also going to set up a nasal cannula so that when the mask comes away and laryngoscopy is being performed. You still have high flow nasal cannula, or some flow, whether it's, you know, six to 10 liters or whatever, of some flow of oxygen going throughout that procedure, as opposed to prior to that time, I think we just took away the mask, and now laryngoscopy, et cetera. What is your practice in Children's Hospital of Philadelphia?

Vinay Nadkarni 12:18

Our practice has definitely changed. But what you've pointed out is the critical difference in nomenclature between pre-oxygenation and apneic oxygenation, presuming that we're using paralytic and that that patient will be apneic at the time we remove the face mask and start the direct laryngoscopy. But our practice has definitely changed that we went in 2014 in the national registry, 10% of patients, less than 10% of patients, were using apneic oxygenation. What you described the nasal cannula during the apneic period while laryngoscopy is going on. Now it's up to 64% in the registry are using this technique that you just described. And the evidence from our observational studies has suggested that it prolongs the duration of time before you desaturate to less than 90 and less than

80%. And those are outcome elements in the national registry that are considered tracheal intubation associated events. A desaturation is now considered part of the adverse airway outcome. Technically, just to clarify the nomenclature, tracheal intubation associated events exclude the desaturation portion and are just talking about lip trauma, esophageal intubation, cardiac arrest, etc. When you add that together with desaturation to less than 90% or less than 80% depending on your definition, now that becomes what we have a broader term, adverse airway outcomes related to tracheal intubation, and those are that occurs up to about 23% of time, on average across the registry, with a high variability between centers.

Jeff Burns 14:06

And could I ask in your practice at CHOP [Children's Hospital of Philadelphia]? You know, I did, I did slide from pre-oxygenation into apneic oxygenation. Do you also administer apneic oxygenation?

Vinay Nadkarni 14:19

We do. We do that now routinely. We had a period of time where we were in transition, where it was sort of optional. Now it is our standard practice, with exceptions made for either patients, obviously, who are already on non-invasive ventilation before going on, and then those where there is anticipated or experienced difficulty creating a seal with the extra tubing. We did do lab testing, and we also have surveyed the registry, and the incidence of not being able to make a good seal over the nasal cannula is very, very small. So we generally to answer your question more directly, yes, we're using it, and we're varying the amount the flow rate of the apneic oxygenation according to age, five liters, 10 liters and 15 liters based on infant, child and adolescent.

Jeff Burns 15:17

Back to our table now, area of evidence of benefit. The second area of benefit that they listed was that there is evidence that use of a video laryngoscope increases the incidence of successful intubation on the first attempt compared with direct laryngoscopy. Is there evidence for that in the pediatric literature?

Vinay Nadkarni 15:37

Well, Jeff, this is one of the few places I think that we can say that we actually do have some pretty good data. So in general, when we look at the NEAR4KIDS registry, so this is, again, across all kids, this is going to be over more than 10,000 children now intubated in critical care units, there is not evidence that across the board, video laryngoscopy either used as a video, as the video laryngoscope, an indirect laryngoscope, or as a coaching device that those across the board improve first pass success rate. However, in both circumstances, observationally, taking into account the factors that we can account for, it does appear that there is less tracheal intubation associated events, in other words, esophageal intubations, desaturations, et cetera. So there's maybe some advantage across the board, but it's not in first pass success as you might have imagined. However, Annery Garcia-Marcinkiewicz, who's one of the anesthesiologists, did a multi-center randomized controlled trial of this amongst anesthesiologists in the operating room for infants under the age of two. And they randomized children to video laryngoscopy or direct laryngoscopy. And they found that there was an improved first attempt success rate using the video laryngoscope compared to the direct laryngoscope, even in their experienced anesthesiologist hands. So again, it may or may not be the tool. There may be some component of training, but there is a suggestion that just like in adults, video laryngoscopy has some advantages. And then secondarily, I just want to mention that as a coaching device, there's observational evidence that the first attempt rate, success rate, is improved when you turn the video

laryngoscope towards the coach and not towards the intubator. That this actually can improve first attempt success rate and decrease tracheal intubation associated event rate. This is observational data, not randomized control data, so you know, recognize that perhaps there's a little bit of bias in who you turn the video laryngoscope view away from the intubator versus having them look at it. Always the caveats, Jeff, right.

Jeff Burns 18:32

Well, Vinay, so now in your practice at the Children's Hospital of Philadelphia, what do you do in this regard?

Vinay Nadkarni 18:39

So we partly in the interest of training for the residents and fellows. We as a what I would say is a standard or a usual practice, perhaps a usual practice rather than standard, if you will. Our usual practice is to turn the video laryngoscope view away from the intubator and use it as a confirmation and coaching device for generally the attending, who's in the room, and looking at it. And under the circumstance that it's a difficult intubation, or the intubator is struggling, we would then turn it towards them to enable them to use that additional data to manipulate the tip of the tracheal tube, etc. In cases where it's a known difficult airway, and the plan the timeout before the intubation, the plan is to use it the video laryngoscope. There is a discussion as to whether it would be beneficial to use that as a video device, or as a coaching device, if you will. So in general, short answer, we use it as a coaching device. We turn it away from the intubator, mainly for training reasons, because we feel everybody should be able to learn and be proficient at direct laryngoscopy. And then, not and then we still allow the use of the video laryngoscope as a rescue device, if you will. Jeff, can I just add one more caveat to that, if the patient, and this is, turns out, is not evidence based, but if the patient has limited neck mobility, known to have limited neck mobility, let's say is in a neck collar, we oftentimes will use the video laryngoscope as a video device, as an indirect device. Truthfully, the study of this, the published data on this, is that there is no difference in success rate in the emergency department, and that comes from the NEAR, National Emergency Airway Registry, that is based in Boston. And that's generally an adult and pediatric registry in the emergency departments across many institutions. It's not the NEAR4KIDS registry. That registry had a report where they tried to look at this exact issue, and they found that there was not a difference.

Jeff Burns 21:02

Vinay, did that study look solely at standard C-MAC blades, or did they look at angulated blades, such as found in the so called GlideScope, or the D blade on the C-MAC device, etc?

Vinay Nadkarni 21:16

What a great question. So the first study I mentioned, which was Annery's study of infants in pediatric ERs by pediatric anesthesiologists, that studied the C-MAC, which is a non-angulated blade, compared to a direct laryngoscopy blade that, again was non-angulated. The latter study that we talked about, which was the emergency department study in the other national emergency airway registry for children in emergency departments did not differentiate between angulated and non-angulated blades. And as you and I both know, angulated blades may give you a really good view, but they may make it quite a bit more difficult to actually reach and get the tube into the right hole.

Jeff Burns 22:01

Well, we're back now with the third item that this article found a evidence for benefit based on evidence in the adult literature, and that is positive pressure ventilation, between induction of anesthesia and initiation of laryngoscopy prevents hypoxemia during intubation. Has that been studied in pediatric critically ill patients, to your knowledge, and regardless, what is your practice at Children's Hospital of Philadelphia, in this regard, in the intensive care unit?

Vinay Nadkarni 22:37

Well, I don't know that there are many practitioners that have equipoise and would be willing to randomize to no ventilation for critically ill children who who are being intubated under emergency circumstances. So to my knowledge, it has not been studied in a prospective or randomized fashion in children. And it's also interesting, I think, that the vast majority, in my practice, and in many of our practice, with truly critically ill children at high risk for desaturation, we only do what we would call sort of a modified rapid sequence intubation, where we would provide positive pressure ventilation after induction of paralysis, or induction with sedation and paralysis, I should say. So my practice would be to ventilate in between, unless, unless there is a constellation of factors, a very full stomach with a very distended abdomen, let's say that's full of gas, where the risk of forcing more air might further compromise ventilation, as opposed to improve it. Perhaps under circumstances where there are very healthy lungs that are well inflated, and where there might be anticipation that there would not be a rapid desaturation. So if they were critically ill for a reason other than lung injury or high risk for having a low oxygen reserve, those might be circumstances under which I would consider providing true apneic oxygen, true apnea and not providing positive pressure. I'm curious, in the adult studies, again, randomized control trials, oftentimes, a lot of healthy lungs get included in both groups, which perhaps dilute out benefit and harm. It's curious and in this case, there was a there was a benefit of providing the positive pressure which which actually supports my own bias, my own clinical bias, that it's helpful.

Jeff Burns 25:11

Very interesting. Next item, use of a stylet increases the incidence of successful intubation on the first attempt compared with use of an endotracheal tube alone. Again, this was evidence for benefit in the adult literature on a critically ill adult patient. Is there evidence for this? Has this been studied in the pediatric critically ill patient? And regardless, once again, what is your practice?

Vinay Nadkarni 25:39

So this is actually, interestingly, been studied under selected circumstances of the newly born newborn resuscitation, particularly in the delivery room and in premature infants, and also in anesthesia. And in both cases there, the use of the stylet did not result in improved first pass success or less tracheal intubation associated events. In pediatrics, to my knowledge, it has not been specifically studied. But, I will say, both from my own personal experience and also from my experience in coaching a number of novice intubators that it really does seem to help with assisting the directionality of the tip of the tube. And so my if you separate the evidence, the published evidence, from my personal practice, I do use and recommend use of the stylet in my practice, yet I acknowledge that under the circumstances studied in the infants and in the operating theaters, that there doesn't seem to be an across the board benefit. Again, when you compare a tool, stylet, no stylet, with a procedure outcome, you have to take into account the experience, the training, etc. So, for instance, many of the neonatologists will cool down during the period that this was studied in the neonatal area, in the delivery rooms, many of the neonatologists were putting their endotracheal tubes on ice before they intubated, in order to keep them relatively stiff and not very floppy and mobile. And so the manipulatability and the tip of the tube being

manipulated was much easier with a stiffer tube, and that avoided the use of the stylet. So again, if you're trained using a stylet versus trained not using a stylet, that also plays a role, because you get very good with the tools that you are used to.

Jeff Burns 27:56

Finally, here's number five, evidence of benefit in the adult literature, laryngoscopy and intubation with the patient in the sniffing position may increase the incidence of successful intubation on the first attempt compared with the ramped position. And again, once again, this is adult literature finding support for that practice. Has this been studied in pediatrics, and what is your practice in this regard?

Vinay Nadkarni 28:22

So again, the specific study that you're referring to, I don't believe, has been done. There have been studies, particularly that have used radiology, radiographic images to look at the openness and the location and the anterior push of the airway with ramped versus sniffing position or extended position of the pediatric airway. All of which support the bias represented by the published that in adults and my own experience, which is that the sniffing position seems to work the alignment of the tip of the chin with the glabella of the nose, with making it a flat, extended, open neck, and having the tragus of the ear be at the same level as the sternal notch, are key kinds of targets that I think I in my practice, use as a practical kind of approach to trying to get positioning. I also noticed Jeff that the optimal positioning for intubation, for laryngoscopy, oftentimes turns out to be an optimal position for bag mask ventilation, and so one can almost use the manipulation one does to optimize ventilation with a bag mask before to find what appears to be a good open airway position for placing a tracheal tube. One caveat I would say, is that I think many of us, particularly those that are vertically challenged, tend to try to intubate with the bed being too high. That if we are standing at the head of the bed, lowering the bed down and then enabling us to elevate the head a bit, oftentimes allows us to get a broader view. Not have to lean down and get our face right next to the mouth, but rather, can stand back, stand tall, lift forward and intubate with a better view than if we crunch up and sort of choke up in order to try to intubate.

Jeff Burns 30:43

Well, Vinay, I must say, in my several three decades or so of practice, I think this is the number one area where practitioners could be more meticulous in preparing the patient for laryngoscopy. I'll often, you know, walk into the room and and, you know, say, you know, how are things that we set up? We ready? Yep, we've got, you know, the patient in the sniffing position. Which means they've thrown something under the occiput, but not actually taken the opportunity to actually look and say, is the is the external auditory meatus aligned with the sternal notch, and is the glabella and the chin, are they, you know, in parallel alignment. And that simple step, especially the external auditory meatus and the sternal notch got to be at least parallel, if not a little higher. And that simple step, I think, is often the difference between, is this difficult and this is not difficult. And so I'm a stickler for getting people to make sure that they've actually bend down, look at the alignment and make adjustments until it is where you want it to be. Okay, back to our table, they identified two areas of evidence of lack of benefit. The first was administration of an intravenous fluid bolus beginning before induction does not prevent hypotension or cardiac arrest during intubation. Has this been studied in pediatrics, to your knowledge, and regardless what is your practice?

Vinay Nadkarni 32:27

Again, this may be one of the things that if you take the variety of patients that we need to intubate who might be hypovolemic, normovolemic or hypervolemic, and you give all of them in one group or another, a fluid bolus, there's going to be perhaps help and harm. I think the findings of that adult study are reflected in our NEAR4KIDS registry, where, when we looked at the incidence of hypotension, which is hypotension that required treatment, which is one of the tracheal intubation associated events that we do track that there was not a difference in those patients who received fluid bolus or not. However, I have to say it wasn't a randomized control trial. It's just observational. So it was sort of personal choice whether they got the bolus. My personal practice is again, to try to sort that out physiologically. Now we have a little better tools than we used to have. You have maybe POCUS ultrasound to help you out a little bit as to whether you whether your beliefs of whether the child is hypovolemic, normovolemic or hypervolemic might be supported by some other evidence. But generally, there are two things that I like to take into account. One is the underlying fluid status of the child to the best of our knowledge. And the second is, what drug are we what medication are we planning to use to intubate with? Obviously, with something like propofol or a vasodilating drug, I'm much more likely to want to prophylactically give a fluid bolus to sort of ward off the expected hypotension. That same patient I would be ready to give a vasoactive or I might even preemptively give a small hypotensive epinephrine dose prior to intubation, with the expectation that their blood pressure is going to drop and they're going to vasodilate. I think it's this kind of stratification that's needed in our studies to help differentiate which patients would benefit from or not benefit from, perhaps harm from fluid boluses. But I do think that a one size fits all of always giving a fluid bolus or never giving a fluid bolus is not the right approach.

Jeff Burns 34:35

Well Vinay Nadkarni, 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?

Vinay Nadkarni 35:38

Well, Jeff, I think just like a resuscitation, there's sort of standard tools. You know, the first three or five minutes of every resuscitation is very similar and uses the same tools, and that we have few evidence-based things that are easy to implement, but difficult when you have a large, sort of disorganized team. So team roles, clearly positioning of the patient, and then, sort of that SOAP ME, kind of mnemonic, you know, suction. Do I have a large Yankauer? Do I have something that will go through the tube? What oxygen differentiate and sort of identifying we're going to pre-oxygenate this patient, and then we're going to use apneic oxygenation with this tool. And once intubated, you know, these are the settings that we are expecting to evolve through. For the airway, selection of the airway, having an a laryngeal mask airway, and we are going, we are moving more towards using it as an adjunctive device and not so much as a rescue device only. So getting that early intervention, early access to the to the laryngeal mask airway, if we're having any difficulty with bag mask ventilation. Identifying the depth of

the tube. This is a really simple thing, Jeff, but just sort of saying out loud, you know, three times the size of the tube is where I expect. You know, if it's a 4.0 tube I expect it to be at 12 centimeters at the lip. Just saying that out loud, so that you know, we have an estimation of where and where we're going to end up. Positioning, as you mentioned, careful and attentive positioning to optimize bag mask ventilation and intubation. The P of SOAP ME, I use for positioning, for people, identifying roles and rescues, and also PPE, not forgetting about the face mask, not forgetting about the eye protection, etcetera. And then when we get to medications, really thinking about the physiology of the patients. First of all, do I have access and a push pull? Do I have the ability to give rapid fluid? Is it drawn up? Do I know where it is and what IV will be used and it's working? And then the medications selected based on the patient's physiology? Are they hypertensive? Are they hypotensive? Are they septic or not? We know that ketamine has become kind of our universal kind of medication. But there are certain patients who might have exhausted their catechols, that I really want to make sure that I have some hypotensive epi or an epi infusion running and going, trying to make sure that I have it in line and ready to roll, not just in the room, theoretically ready to go. Monitoring, one of the key things I try to do, Jeff is it always seems to happen that the pulse ox is below the blood pressure cuff. Halfway through the intubation, somebody inflates the blood pressure cuff and the pulse ox sound or waveform goes away. So I always make sure that they're on different extremities, and usually want to check that the non-invasive blood pressure cuff has been checked in two different locations, so that if it fails or I can't pick up a blood pressure where it's sitting, I know exactly, or the nurse knows exactly where they're going to double check and where they were able to get a good blood pressure prior to the intubation. Then the extras end-tidal CO2, not just after intubation to confirm, but also during bag mask ventilation, so we know that we have an open airway, good movement, and we're observing the chest rise. And then finally, after intubation, confirming tracheal tube placement with end-tidal CO2 chest rise, etc, and then deciding whether this patient, were they a patient who had a pneumonia? Were hypoinflated? Was it a long pre-oxygenation time period where I may want to use some recruitment maneuvers, some sustained inflations and slightly higher pressures and PEEP to try to re-recruit the lung? There are demonstrations with EIT [Electrical Impedance Tomography], you know, where we're actually looking at and seeing that during a period of pre-oxygenation, lungs become atelectatic, especially if no bag mask ventilation is provided. And so this might be an opportunity with a freshly intubated patient to recruit the lungs. Now I have to say this last part of it, Jeff, is personal practice and is not really evidence based, but again, sort of a combination of sort of good sense physiology and some preliminary studies in adults that suggest that there's a lot of atelectasis going on during the process of intubation. I'm curious, Jeff, if you have the same approach, or if you have some key pearls that you want to pass along as well.

Jeff Burns 40:25

You and I discussed this a little bit earlier. I think I have the same approach. I do get concerned when we don't meticulously set up a tray with everything we're going to need, as you just outlined, and you find something's on or on the bed, and something's, you know, someone's holding something else. And so I think it needs meticulous preparation, as you've said, before you start. I really like the idea of calling out, all right, we know where the tube should be. Let's all speak about it before it goes in. And then finally, all the way to the other end. We're not done once the tube goes in, that's often when you know the difficulties are still present. And I too, agree with the notion of a recruitment maneuver, especially for our patients who were intubating acute hypoxemic or respiratory failure, poorly compliant lungs. There's no way phasic ventilation after you confirm that the tube is in, is going to recruit that lung, and so I too also will have a low threshold to give a recruitment maneuver at that point after

confirmation, okay, let's give 20, 25, centimeters of water for 20, 25, seconds, and recruit this lung to FRC before we expect the sats to come up, etc. But enough of that, Vinay, we're at time, and this has just been terrific. Dr. Vinay Nadkarni, principal investigator of the National Emergency Airway Registry for children, NEAR4KIDS. You know we thank you as on behalf of our community for having the insight you and Akira to start this registry and allow us to gather more evidence on our practice around you know, a very high-risk procedure on a critically ill child. So we thank you for your leadership and helping us be better in this area. And hearing how you practice has been fascinating. The mixture between, you know, the art and science of medicine and so this has been wonderful.

Vinay Nadkarni 42:25

Well, thanks. And also, Jeff, we should give credit to Adrienne Randolph and PALISI because when Akira had finished his fellowship and we were attending PALISI. Adrienne put out the challenge for us to develop QI programs within PALISI. And this was one of the first brainstorming sessions we had, was that we needed a national emergency airway registry for quality improvement purposes. And then Akira sort of evolved that on to be much more research oriented. So you know what comes around, goes around. It's a continuous spiral there.

Jeff Burns 42:59

That's wonderful. Vinay, any final thoughts?

Vinay Nadkarni 43:03

Well, Jeff, just one final thought that when an airway seems to be more difficult than you expected, when you've tried an approach with either a direct or an indirect laryngoscopy, suction, etc, trying the same exact thing with a patient in the same position without making any other changes of personnel or procedure or equipment, doesn't make any sense to me. I see it happen all the time, and I think what it should prompt us to do is to say what was unsuccessful, and do I need to reposition this patient? Do I need to use a different tool? Is it a different provider? Is there something that I can do to improve the chance of getting a successful intubation and then do that. But just going in with the same tool, the same approach is very unlikely, and that is borne out by evidence in the NEAR4KIDS registry.

Jeff Burns 44:03

Okay, thank you, Vinay.

Vinay Nadkarni 44:04

Take care.

Sarah Marcley 44:06

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