Every Drop Counts, Preserving Blood in the NICU

Moderator: Dr. Jane Caldwell

Welcome to our webinar, "Every Drop Counts, Preserving Blood in the NICU" by Point of Care Testing University.

Preterm infants are subjected to frequent diagnostic blood sampling. In critically ill infants, blood loss due to blood sampling is considered the primary cause of iatrogenic anemia and anemia of prematurity.

Blood test ordering volume has risen in neonates, 5% annually in the past decade, even though there is a growing movement to preserve blood.

While neonatologists and NICU staff understand the objective need to reduce transfusions, few NICUs identify or subsequently modify factors associated with trauma and blood loss volume, such as test frequency, test volume, utilization of point of care or capillary testing, or tracking blood loss per patient.

Many of these factors necessitate input and workflow changes from other areas of the hospital, such as the laboratory, IT, and nursing and staff directors.

To address these issues, a small number of NICUs have developed and published quality improvement initiatives implemented within their own hospitals to reduce iatrogenic blood loss and transfusions in premature infants.

Their strategies consist of varying multifactorial approaches that have resulted in significant reductions in both blood loss and costs. While these initiatives have been successful, many NICU and laboratory staff are unaware of these findings. Awareness and implementation of such strategies and greater mindfulness regarding blood collection methods, amounts, and frequency of testing are needed.

Continuing education credits are offered for physicians, nurses, and laboratory professionals. This educational program was supported by Siemens Healthineers. This educational program was supported by Siemens Healthineers. Content was planned and developed by Medavera, Inc. There are no additional disclosures for this program.

After this webinar, participants will be able to identify evidence regarding the need to conserve pediatric blood in NICU patients, discuss implementation of quality improvement initiatives, and assess alternative strategies such as capillary draws to obtain critical blood results.

To obtain credit for this program, please listen to the webinar in full and click the button below the video for the CME/CE evaluation. Fill in your information on the evaluation page and answer the questions. Upon submission of your evaluation, an email will be sent with your certificate to the email address you provided.

If you do not receive your emailed certificate within a few minutes, please check your junk or spam folders for an email from **info@Medavera.com**. That's **info@Medavera.com**.

This presentation will be given by Dr. Eli Cahan of Stanford Center for Advanced Perinatal Education and Lucille Packard Children's Hospital and Bethany Lazzara of Northwestern Medicine, Central DuPage Hospital.

Dr. Cahan will discuss the current issues with blood draws in neonatal and pediatric intensive care settings. He will also provide information on the pediatric blood preservation movement and quality improvement initiatives that include recommendations for blood preservation in neonatal patients.

Ms. Lazzara will illustrate strategies to prevent blood loss with a case report of a micro preemie in the NICU.

Dr. Eli Cahan, MD, MS, is a neonatology fellow at the Lucille Packard Children's Hospital and a clinical researcher at the Stanford Center for Advanced Perinatal Education. He has published nearly two dozen studies and has been featured in NEJM, JAMA, PGM, PMJ, and Health Affairs. He is the co-director of the Health Equity Media Fellowship at Stanford University School of Medicine, a Health Communications Advisor for the National Academies of Sciences, Engineering, and Medicine, and an Executive Committee Member of the American Academy of Pediatrics.

Dr. Cahan is an award-winning investigative journalist covering the intersection of child welfare and social justice and is currently a contributor at *Rolling Stone*. His work has been featured in multiple national outlets and has won awards from the National Press Club and the News Leaders Association. He has also been a grantee of the Fund for Investigative Journalism and the Pulitzer Center.

Dr. Cahan, welcome to our webinar.

Dr. Eli Cahan

Thanks so much for having me, Jane.

I'm thrilled to join this amazing webinar today to talk about a topic that I'm very passionate about. And a topic that I think a lot of people listening to this webinar may be able to contribute to. And that's reducing unnecessary infant blood loss in the neonatal ICU, which is truly a team effort as we'll get into.

I have no disclosures for this program.

So as probably everybody here who has had the opportunity to care for term and preterm infants knows, know, circulating blood volume is important. We have to get oxygen everywhere that it needs to go. And the way that we do that is through the red blood cells. Everybody probably also knows that when we think about the amount of blood volume, in an infant of any size, there's not that much. Classically, the teaching that I've learned is 60 to 80 ccs per kilogram for sort of an average child, maybe 80 to 90 for an infant, and then up to sort of 80 to 120, 115 for a preterm neonate. So, for a three-kilo baby, obviously that's, you know, 350 ccs, which is less than a can of Coke.

So, we really have to be vigilant and protective of the amount of blood volume that is circulating in an infant. And we have to be thoughtful about when we want to remove that blood for any reason. As we'll get into, when you think about preterm infants in particular, they are at risk of anemia and needing blood transfusion. studies have found that nearly 80% of preterm infants require blood transfusion at some point in the first month of life. That is just one. Obviously, many of these people who have cared for earlier neonates may know, some of them will need significantly more than one transfusion. And I think it's important to consider, especially as we move through this presentation, that anemia is a symptom, it's not a diagnosis, right? We will often write the reason for the transfusion in the chart being anemia, but anemia should trigger us to ask additional questions. It shouldn't leave us satisfied that we have an answer. And the question is, where's the anemia from? We know there are certain predictable reasons, physiologic reasons that infants and in particular preterm infants are at risk of anemia. Those include shortened red blood cell lifespans and low erythropoietin levels, both of which we expect. But again, I think we also should be thoughtful about, well, even as we expect, a neonate may be at risk for anemia and may require transfusions. Are there other causes?

And the big one that we will talk about is stuff that we do, not stuff that the infant can or can't do. I think it's important to keep in mind the refrain that many of us who have trained in pediatrics heard, which is that children are not just small adults, and apply that to neonates, which is that neonates are neither small adults nor children. Neonates have very unique physiologic parameters. Their body is obviously just learning how to do all the things it needs to do in order to support life and independence and the way that different organs talk to each other and their abilities to do functions that they'll need to do later in life, very significantly, especially during the transitional period and in the early days after life.

So, one of the areas that we should think about this, for purposes of this talk is with regards to how the newborn sort of manages the red blood cell capacity that it has in its body. And really the derivative of that is how it manages the fetal hemoglobin amount in the body. We know that infants are born with fetal hemoglobin is what babies produce in utero. And it takes a period of time, usually, you know, approximately call it four months, about 16 weeks, maybe a little bit longer, maybe a little bit less and to transition to a critical mass of the type of hemoglobin that we consider more, the sort of more mature type of hemoglobin. The reason that fetal hemoglobin exists is because as everybody knows, in utero, it is a very low oxygen environment. They're living in amniotic fluid. They are not breathing for themselves. Their access to oxygen is dictated by placental dissemination of oxygen in their bodies. And overall, as we would expect, they live in a lower oxygen environment, which means that you want a hemoglobin that can grab onto oxygen that's available and hang onto it for dear life, which is kind of what fetal hemoglobin does. As soon as you're in a place where, you know, there's more oxygen available, right? You're going from your aunt's house, who is a very good cook but always serves too few string beans, to the all-you-can-eat buffet. We shift the way that we think about getting oxygen in that environment. And in that environment, you want a type of hemoglobin that sure can get access to the oxygen that it needs, but also is effective at giving that oxygen away, at passing that oxygen off, because at the point that you have emerged into the world, your organs need to get all the oxygen that they need to have the energy to do the functions they need to do. And so, we want a different type of oxygen. However, it takes time to get there, right? And so the question is what happens to fetal red blood counts during the period of time that they're transitioning and what, based on what we understand about fetal hemoglobin, can we understand about sort of infants volume of red blood and the nature of how they're producing red blood in that period. studies postulate that the number of fetal red blood count or the number of fetal red blood cells may be lower due to the presence of red blood cells with higher hemoglobin content. There's a really interesting emerging realm of science, but basically it says that all your red blood cells don't look the same.

While the older you get, the more consistent you are, the better your factory, your bone marrow factories are at producing red blood cells that look like one another. When you're early in life, and especially for neonates who are just learning to do these things on their own, their ability to produce red blood cells that look consistent like each other is variable. So, what ends up happening is you get some red blood cells with very high amounts of hemoglobin within them and others with relatively modest amounts of hemoglobin. The thinking is also that the low oxygen environment increases the likelihood that you'll have very high hemoglobin counts in your red blood cells, especially for preterm infants. All of that to say, these studies say that because the body is saying, what matters is the overall ability to carry oxygen, not the number of red blood cells, because the red blood cells are just vehicles for carrying oxygen, that the body may say, I don't need as many red blood cells. And so that may set up neonates, and in particular preterm neonates, for having lower red blood counts, which means if they lose red blood or red blood is broken down for any reason, they're at higher risk of anemia. Okay?

There are lots of other things that we can think about what contributes to anemia. So, there's all the physiologic things we talked about, right? There's these red blood cells are less durable, so they tend to survive for less time. There's lower erythropoietin levels. Erythropoietin is one of the proteins in the body that tells the bone marrow to start producing red

blood and it derives from the kidneys, and the kidneys take time to wake up and so the sort of gasoline to drive your factories is lower. We also know that babies' bodies are rapidly expanding, meaning that the amount of blood they have per unit volume is lower, along with other factors.

That said, I think for the purpose of this webinar, one of the things we really should be interested in is what are all the things that we can think about outside of physiology that can affect anemia. One of those, first and foremost, which we will get into, is iatrogenic blood loss, blood loss that we in the health care system cause, namely through blood that we take away for diagnostic measurement. Other things that we can think about are nutrient deficiencies. We know that preterm infants in particular are at risk of deficiencies in lots of different nutrients, including sort of trace elements and vitamins and minerals and all of these things, which is why people, know, when I'm in the hospital, I spend a lot of time thinking about TPN (total parenteral nutrition) and spend a lot of time supervising residents writing TPN is because we want to make sure that babies get all the nutrition they need. Obviously, if for whatever reason your nutrition levels, overall levels are inadequate or the balance between different nutrients and minerals is off, that can also lead to insufficient production of red blood cells.

There are other things that we always have to keep in mind, of course, namely things that could lead to suppression of the bone marrow or premature breakdown of these more fragile red blood cells, of which infections and sepsis are one of the things that we think about first and foremost. So, all of this, the physiologic contributors, the non-physiologic contributors add up to the fact that about 80% of preterm infants receive blood transfusions within the first month, as we discussed, and a not small fraction of term infants also need transfusions, right? So, 0.5%, that's one in 200. You could hit that within a couple of weeks, depending on your unit census. And certainly, term infants are at risk of this as well. We know that of all of those non-physiologic factors, one of the top causes of iatrogenic anemia are blood draws, right? And so, if you look at studies, that review sort of overall blood volume removed. What you see is that in some of these studies, we can deplete overall blood volume in the first two weeks just by labs that we take by about 60%.

Right, so six out of every 10 or 5.8 out of every 10 red blood cell that exists at the time of birth or that we estimate for infants blood volume is removed in these studies for diagnostic assessment, which is about 40 ccs per kilo in aggregate blood loss over the first two weeks, right? So, 40 ccs per kilo. If you think about what we write in blood transfusions, usually we'll write in our unit, you know, between five and 10 ccs per kilo for a preterm infant and between 10 and 15 for a term infant. So that's, you know, between four and eight transfusions worth of blood that we're pulling off of preterm babies in their first two weeks and call it between two and four transfusions for a term infant if you apply those statistics to them. When you think about how the heck could we be taking so much blood off of these poor little babies, it all just adds up pretty quickly.

If you think about the way in which we write lab orders, often we will write standing lab orders for a certain period of time, ideally, but maybe you'll just write a standing order in the chart. You may be drawing off things every four to six hours, glucoses, blood gases, electrolytes, lactates, hemoglobin, right? So, you're pulling off blood to see how much blood you're pulling off. And then there are the other things that we may be doing every 24 hours, right? You may be tracking bilies (bilirubins) until they fall. You may be tracking electrolytes for an infant every day who's on starter, parent's hair, nutrition, things like that. All this to it all adds up very quickly. And as probably is evident from the way that we're talking about this, isogenic blood loss leads to all sorts of things that we don't like, right? So, whenever you're breaking the skin, you're at risk of increased infection among other morbidities. There's obviously if you're breaking into a line repeatedly, you're certainly at much higher risk of central line infections. I'm thinking about pulling off of umbilical lines or picks or those sorts of things. You're at higher risk of severe infections like bloodstream infections. Whenever you have infection circulating, you're at higher risk of clots because you may have disseminated intravascular coagulopathy.

And there are other things that we started downstream consequences that we should be aware of, right? So, when we're pulling off blood early on, and if we are contributing to anemia suffered by premature infants, there's emerging evidence that that anemia during prematurity puts you at risk of other things that we get very scared about, right? So bronchopulmonary dysplasia, certainly necrotizing enterocolitis, retinopathy of prematurity.

Then also if you're pulling off all this blood and you're giving it back, it means you're at risk of all the things that are associated with giving it back, all the associated transfusion reactions, right? Iron overload, potassium overload, and then the risk of needing blood from different donors, which, if you look at the evidence, exponentially increases your risk of transfusion reactions and all sorts of things as opposed to sticking with one donor.

Lots of morbidity and where morbidity goes, healthcare costs follow. Amid all of this badness and the recognition of this badness, increasingly there's a movement towards neonatal blood preservation. And the movement is about more than just reduction in blood draws, right? It's inspired in no small part from blood product shortages that have occurred and recurred numerous times in recent years, as we'll discuss. There is also a bigger conversation about the downstream consequences, not just the physical sort of consequences on the lung in terms of bronchopulmonary dysplasia, the consequences on the gut if you have necrotizing enterocolitis and you have to be NPO or God forbid you need surgery and you have a section of your gut that's taken out, but also the neurodevelopmental consequences of repeated blood draws and transfusions. And so, these are all things that are going into this conversation around neonatal blood preservation. As we alluded to in the previous slide, there have been significant concerns about blood availability throughout the United States for a very long time. Those concerns were really intensified during the COVID pandemic, during which the health care system faced very severe shortages.

And those shortages have not ended during COVID. They didn't stop when the pandemic was over. We've seen recurrent shortages since that time. These are just a subset of the shortages that have been declared, severe blood shortages by the Red Cross. And it's in the wake of those pandemic era shortages, these conversations that preceded the pandemic, but really the urgency around blood management, in particular around the pandemic, that got numerous different healthcare providers talking about how can we optimize and prevent as much blood loss as we can to preserve the blood supply as best we can. The NICU certainly has been perhaps a little bit of a later comer to this conversation than some of surgical fields, but now certainly is thinking about this pretty strongly. As we talked about, other drivers include neonatal pain exposure and all of the emerging research around neonatal pain, of which there is much. It is a very quickly developing field.

We are very fortunate at Stanford to have some of the people who are leading this conversation, which also means that we think a lot about it, right? Because I can't escape some of my attendings who are thinking very, very hard about even the incremental impact of one blood draw. We know that obviously preterm infants, in particular moderately and extremely preterm infants, are already at risk for lots of cognitive and neurodevelopmental disorders than term infants as well as their late preterm colleagues. And emerging evidence suggests that each incremental painful experience may have really demonstrable impacts over the longer run on infants' development. And even says some studies have done imaging and scans and other assessments that have seen changes anatomically associated with those painful experiences and that trauma. So, a very interesting field to keep watching, but certainly one that is informing this conversation as well. The last thing that we should talk about is transfusions and transfusion reactions. Obviously, as everybody here knows, every intervention we make in a healthcare system is weighing risks and benefits. Transfusions are one of those. Certainly, they are not benign.

There are lots of things that we learn about in our training that occur associated with transfusions, including hemolytic

transfusion reactions, non-hemolytic transfusion reactions, organ-related like trolleys, or transfusion-related acute lung injury, graft-first host disease, as well as sort of reactions that occur not because of the immunological interaction between the donor blood and the host blood, but just because of the kinds of things that we're transfusing, right? So, when you think about transfusing platelets, there's lots of emerging science, including at our center, trying to understand, well, if we're infusing things that are very rich in cytokines, are those cytokines triggering reactions upon transfusion that we don't want? So increasing effort to lower platelet thresholds and try to transfuse kids less. The same goes for red blood in terms of thinking, what's all the proteinaceous, immunologic, and other stuff in this blood that potentially could be less than ideal for the babies we take care of, even as we're looking at that hematocrit or hemoglobin count and thinking, well, we're a little bit uncomfortable. lots of, again, developing science here, but certainly something that's informing the conversation around blood preservation as well.

In the wake of this conversation around blood preservation, we've had a lot of quality improvement initiatives start popping up all across the country. And these quality improvement initiatives have had frankly lots of imagination. They've been really creative. They've included partnerships, not just between the physician and treating team, but certainly involving nurses who any doctor who is not befriending their nurses, I think needs to go back to probably primary school, not medical school.

But nurses obviously know these babies, get to know these babies in a more intimate way than the healthcare, the sort of doctor healthcare team or the allied health profession, advanced practice practitioner healthcare team ever can just as a sheer number of hours. And so, these partnerships have relied on the expertise of nurses to help think about preserving blood.

Likewise with blood banks, who obviously we rely on very heavily at our institutions to get us products when we need products, but who in their own right are thinking very hard about how can they try to be effective stewards of the essential things that they maintain, is blood products.

There have been quality improvement initiatives that have gone beyond just the people involved, but obviously have looked at well, there innovations within the healthcare system that we can try to tap to improve or at least to make people think twice about whether or not we should be taking that blood off? Those include EHR record, column innovations, notifications, certainly things that I know we're all very familiar with but scientifically are shown to definitely make people think twice.

As well as some other strategies that are emerging that we'll talk about. And then certainly there's education, which of course we're doing today. And we try to do as much as we can to make as many people involved in any element and every element of NICU care aware of the importance of trying to preserve blood and the tools we might have to do so. So if we look at some of the partnerships that have evolved, again, blood banks have been, you know, pretty effective partners here, both in terms of, you know, thinking strategically about how to ensure within our institutions we can preserve blood, but also working more publicly, advocacy, public awareness building and innovations in collection and distribution of blood products in a way that they can help steward the blood product ecosystem. And then on the other side, just absolutely essential irreplaceable partners are of course the nurses. The nurses are the ones who, when we put in the order, do the blood draws, give the transfusions. They're the ones who are doing the thankless but absolutely critical work of charting, including ever more trying to chart the amount of blood that is coming out.

And so, any initiative that excludes nurses or doesn't think about, let's ask nurses ways in which we can do this initiative better. Maybe, you know, is probably doomed to fail, maybe could succeed, but certainly couldn't succeed to the level that you think about if we involved our colleagues in that way. And you've seen that in the literature. As we talked

about, the electronic health record is an amazing blessing and a curse. It has made some things very easy in terms of assimilating data and chart notes and those sorts of things. Obviously, I think a lot of us have spent wee hours of mornings and evenings with getting to know the EHR (electronic health record) in ways that are far more intimate than we ever hoped to get to know the EHR. But the EHR does, of course, have some advantages, including the ability to think about, hey, given this is a tool that we're all using every day, are there ways to, again, get people to think twice about whether that blood test, that draw is essential and or whether giving blood, giving a transfusion is essential. And some of those tools include collecting data daily as well as overall blood volume that is coming out of babies. This really great thing that some centers are now reporting every morning on rounds. And I encourage everybody on this call to advocate for this at your center because it's a really low hanging fruit to just say, hey, let's, let's just document how much blood is coming out from all these blood draws we did. Let's say it out loud with the rest of our numbers in the morning and in the evening when we're around. And that can keep us all aware of, do we really need, you know, another bilirubin today or can we get it tomorrow? Do we really need another metabolic panel today? Or did we leave the TPN composition the same and this baby is relatively stable, so we don't need another volume?

And then there are obviously other innovations in the EHR that you can think about such as notifications, alerts, when you hit a certain amount of volume, notifying the providers that, we've now hit 10 ccs per kilo out from this baby over the course of their hospitalization. It's only been three days. We've hit 20 ccs per kilo out of this baby.

Or just when someone orders blood or when someone orders blood tests saying, you know, do you need 15 ccs per kilo? Can you transfuse 10 ccs per kilo? Do you really want to say we're going to do Q6 hour labs indefinitely or do you want to say we're going to do Q6 hour labs for the next 48 hours and reassess? So, lots of different ways that we can embed systematically ways of having people think twice, including people who, of course, we know are deeply well-educated, maybe over-educated, some of us compared to some of the other people who sit around our Thanksgiving table. But the question is, with everything everyone has going on, even if you take this course, which hopefully you'll remember, I don't know, you'll have to give us that feedback. There are ways we can make it more memorable for you. But even if you take this course, then you go back to your unit and your crazy and you got a sick baby, this sort of thing may not be top of mind and the EHR is potentially a tool to just trigger your memory about this webinar you took once upon a time or otherwise help educate people who have not had the opportunity to take a webinar like this. There are some other emerging initiatives and guidelines to try to, again, preserve the overall blood supply.

In October 2025, the American Academy of Pediatrics and the AHA (American Heart Association) updated neonatal resuscitation program, the NRP guidelines, including to think about, you know, really prioritizing deferred cord clamping whenever you can. We know that babies who are able to tolerate deferred cord clamping of 60 seconds or greater have lower rates of anemia, lower rates of transfusions. And now there's some recommendations around what's called umbilical cord milking for infants greater than 35 weeks who potentially are in a position where they could benefit from blood. I know a lot of centers are not accustomed to umbilical cord milking. This is also something we do not do routinely at our center, but there is emerging evidence that this could be really beneficial for babies at risk of anemia and maybe would need transfusions in the future.

We know that also, for example, deferred and delayed cord clamping is not just theoretically associated with these things, and you know, when you look at the numbers, it's not just associated in the short term with lower rates of anemia or lower need of transfusion. We also know it relates to all the things that we actually care about. For instance, decreasing rates of hypoxic ischemic encephalopathy and the need for therapeutic hypothermia. So real serious outcomes, really important things that we care about for all our babies. We're seeing that even, you know, relatively smaller techniques,

or just saying, can this baby tolerate 15 more seconds attached to the placenta on mom's chest, that can make a really meaningful difference in terms of the short and long-term trajectory of those infants. When we think about blood draws in particular, obviously we want to give everybody on this call the opportunity to advocate for these sorts of initiatives at their institution. And in particular, we want to give you a couple of tools that if you say, hey, I took this webinar, on blood loss and I think we should think about it that we give you sort of bullet points of things you could bring up. And as we think about blood draws, there are a number of different opportunities in terms of ways that you can try to save blood from blood draws. The first is obviously to reduce the overall number of tests, right? So, to the extent possible, trying to use tests that will assess numerous different types of markers that we're looking for rather than just one. I think a good example of this is whether you want to draw a blood gas and a metabolic panel, or if you can say, let's get a blood gas with lights on it. And maybe that's not going to be the full panel of lights and maybe it's not going to be the most accurate, but will it give you enough information, for example, to check a sodium on a child whose sodium has been a little bit labile or do you need more information? Same goes for lactates, right? Can you check a blood gas with lactate as opposed to drawing a separate lactate? And then obviously you may downstream need to draw a confirmatory blood, but you're already getting the blood gas as it is. So, the question is, can we sort of consolidate all these tests?

The second thing that you can do, and I find whenever I'm calling the resident service, this is something we're doing all the time, is reducing the frequency of tests. Right? So, as little as seems reasonable and safe for babies, trying not to have anyone have standing orders of recurrent tests. Right? So saying, hey, I'm going to ask you to put it in every, you know, six hours. That may be a tall task for your frontline team. And maybe for you, that's more pain than it's worth, but certainly for labs that we're getting a little bit less frequently, can we make sure that instead of having them standing where someone has to say, hey, let me discontinue this test, we're putting it in when we actually need it. Otherwise, can your Q4 test be Q6 test? Can your Q6 test be Q12 test? Can we think, hey, this baby who used to be significantly more sick and septic now is on the other side, is on antibiotics, is recovering pretty well.

Can we change the frequency of the CVCs from Q12 to Q24, things like that. Do we need to check every preemie twice weekly for their lights or can we check the lights once a week? Do we need to check every preemie once a week for their CVC to monitor their red blood counts or can we check them every other week? So, these are all things that you can think about. The third item is to reduce the amount of blood volume per test. This gets to kind of what we talking about earlier with consolidating the test, obviously anytime you can do a capillary blood test or a test that just requires less blood, we should endeavor to do that, right? If you're in a position where a cap gas is going to tell you as much as a venous gas, why not do the cap gas? And I think my understanding from nurses is that cap gas is sometimes easier to get, especially in a baby with outstanding access. And so that is a courtesy to your nursing colleagues as well often.

And then the last thing is just as a general rule, point of care tests tend to require less blood than samples that we send to the lab. So again, if you're in a position to order a point of care test, I know point of care capabilities varied in different institutions, but again, if you can get your lights off a gas and you can do that gas as a cap gas, that is a great situation to be in in terms of preserving.

The other thing that we can think about is there's the volume of blood that we take, but then there's also the question of how can we reduce clotting, right? So often, you know, the way that I feel like throughout residency, I thought about clotting is like, this is something that happens sometimes, it's just kind of a cost of doing the business. But the evidence shows that there are lots of little things that we can do procedurally to try to reduce the risk that blood clots.

That includes ensuring we're drawing tests and sending them off as soon as possible, that we're handling the specimens in a way that reduces the risk that the blood is going to be static and at risk of clotting. And then obviously educating

all staff involved in the chain of delivery from the bedside to the analyzer in the lab that we want to try to get these tests done as soon as possible to reduce the risk that we'll draw off three ccs of gorgeous red blood that a nurse worked incredibly hard to get off a baby with very difficult veins and then that sample clots and then we need to redraw it. So obviously not a good situation for anybody, including related to trying to preserve blood. In fact, again, if you look at quality improvement initiatives across the country related to clotted samples, you will see that, you know, these QI initiatives can make a big difference. This one study that we cited, they literally halved the rate of clotting at their institution after implementation of a sort of multimodal pathway for addressing clotting. If we look at sort of other more comprehensive packages of quality improvement aimed at blood preservation, we see time and time again that it reduces all the things we wanted to reduce including the number of tests, the total amount of blood and costs. And again, these quality improvements have sort of tended to involve, they don't necessarily all involve the same measures, but it goes to show that even thinking about implementing any aspect of blood preservation can make a big difference, right?

So, in University of Arkansas for Medical Sciences, what they did was sort of change their transition thresholds and also reduce blood volumes, or lab volumes by doing as much cap testing as they can. And they saw pretty significant changes in all the things we measure. At Yale, they had a goal of reducing the rate of laboratory testing by 20% over two years. They implemented a variety of measures, included some changes in the electronic medical record, and they saw and they beat their goal. They saw a 27% decrease in lab tests, lots of savings, lots of new friends in the lab who didn't have to run tests as frequently, and also really important patient-centered outcomes, including family anxiety around test results as well as draws.

And if you look at the types of tests that they decrease, mean, there seem to be consistently a couple relatively easy wins, right? Like, do we need to take that extra glucose measurement? Do we need to, as a rule, be taking Q-shift glucoses on every baby? Or are there positions where we can sort of space that? Do we need to check with every feed for a period of time, or can we do every other feed? Can we do three times and then once they're good, they're good? Same thing for bilirubin. Again, this is something that I end up talking to the residents a lot when I'm supervising, but do you need Q24 hour glucose, or sorry, Q24 hour bilirubins for every baby until it's coming down or can we be more permissive? And do we need blood gases? This is a big one, especially for babies on respiratory support. Do we need blood gases at all for babies on non-invasive respiratory support, right? Like CPAP or PPV. And for babies on ventilators, do we need standing blood gases or can we watch the T-COM or the Entitle CO2 as well as the oxygen and the worker breathing. That tells us enough that we can do the management changes we need without consistent blood gases and then we can get intermittent blood gases when we have to.

Last example I'll give you, Duke also did a quality improvement initiative. had, again, changes in transfusion thresholds, used as much cap testing as they can, and also some changes around supplementation, including for iron and erythropoietin to try to maximize RBC production. And they saw pretty significant decreases in transfusion rates and improvements that were sustained over time.

I'll just note, know, there, think routine use of erythropoietin is something that is still emerging, lots of conversation, at least in the medical community about that. So, you know, that is not something that we know as much about, I think, yet to routinize it for every infant. I know it varies across centers. But one thing that, you know, I consistently see and I love our residents. They are absolutely amazing, but they have so much to do. They spend so little time in the NICU that it can be really hard for them to, you know, stay up to date with everything for every baby. But just making sure that every baby who's eligible for iron is on iron, making sure that a baby who's on a multivitamin, if they can be on a multivitamin

with iron, that kind of thing, dose adjusting the iron as babies grow, those sorts of things can, even though they seem small, can make quite a difference.

And then I think probably one of the most important points about all of this is, you know, the work we do starts and ends with our babies, starts and ends with our families. And so, there are real opportunities for partnership with families as another set of eyes. We think about partnering with nurses, we think about partnering with blood banks, but empowering parents at the bedside to let us know when they're concerned about anemia or alternatively when they wonder if we need to keep doing blood draws or if they wonder if we need to do a transfusion at a certain point in time. I know this can be an additional source of conversation for nurses and other members of the frontline team when they have lots of things on their plate, but the science shows that parental involvement improves lots of different infant outcomes in the short and long term.

And similarly, we can think about how and whether they can play a role in trying to preserve blood for their babies. So just to sum it all up, there are lots of different things that we can do to reduce blood loss and preserve blood in the NICU. There are the things we can do more of, more capillary and point-of-care tests, more partnerships internally and externally, the use of institutional guidelines and EHR alerts and education for providers and families. And there are the things we can do less of, like reducing the amount of blood we're taking where we don't have to take such large samples, reducing the frequency of blood that we're sampling, reduce the burden on the lab and requisite costs associated with that and reducing transfusions. And that's all I got. So, thank you so much for tuning in and obviously.

Hope to hear from you in terms of what we can do better next time around in this webinar. Thank you.

Dr. Jane Caldwell

I'd like to introduce our webinar speaker. Bethany Lazzara is a registered nurse and clinical shift coordinator specializing in Level 3 Neonatal Intensive Care at Northwestern Medicine Central DuPage Hospital. She currently holds her certification in Neonatal Intensive Care and is a member of the leadership team for the 22 plus bed unit. She is also a permanent charge nurse of the NICU with responsibilities in day-to-day maintenance of the unit and the entire women's and children's division.

In addition to her leadership in the NICU, Ms. Lazzara has been a transport nurse for over eight years, ensuring safe transfer of patients ages 24 weeks to six months. Welcome, Ms. Lazzara.

Bethany Lazzara, BSN, RNC-NIC

Thank you so much for having me. I really appreciate this opportunity to talk with everyone.

Today I'm presenting a case of a micro-preemie born in our unit. This young lady was born at 26 weeks gestation. She was 720 grams at birth, which is about one pound, nine ounces. I've always found in my practice that it helps to figure out real world equivalents to our NICU terms and sizes and things like that. So, you'll find that throughout my slides as well.

When she was born, she was in need of full respiratory support. She was unable to breathe for herself. We administered surfactant through her ET tube, and she remained on mechanical ventilation. Umbilical catheters were placed of venous as well as an arterial and those remained in place for several days to maintain her electrolyte levels and glucose levels and all the other things.

On day one of life, she was born at 26 weeks gestation, three days, which is approximately six months pregnancy.

Her weight was equivalent to a large grapefruit, small pineapple, somewhere in that, again, day-to-day life kind of things to give you an idea of her size. She had approximately 65 to 75 mLs of blood in her entire body. Less than three ounces total, quite a bit less than three ounces total. And that comes into play with blood preservation through labs and through all of her blood gases that she is in need of throughout her stay.

So, when she was born, her first blood gas was done immediately after she arrived in the unit and she had just been intubated within 20 minutes prior to this blood gas. The levels of the gas were clearly not very good, which showed that she was needing to remain on the ventilation to sustain her breathing.

The blood gases that we do for these babies, we pull off of the umbilical arterial line to begin with when we have that line available to us. This is done for multiple reasons, but mostly to save the babies from extra pricks and painful procedures because they already have enough things going on for them.

The blood gases help us to determine the ventilation that the babies are in need of and any kind of adjustments that they are needing and requiring changes as they progress through their stay.

In her first day of life, she required five blood gas samples. As you can see, when you take samples from an arterial line, it does require a little bit more blood. And this does not take into consideration the amount of blood that has to be wasted as well, which is minimal, but still there. So, for her five blood gases that first day at 0.4 mLs each, her first day was 3% of her blood volume, approximately.

That is only for her blood gas levels. She was also requiring CBCs. She was also requiring chemistry levels in addition to all of that. We are able to get some of those levels off of the blood gases, but confirmation is needed in a regular lab specimen as well.

This slide kind of demonstrates very well how much blood these babies are actually using throughout their time in the NICU. As you can see, day one was a significant amount of blood loss for her as we were trying to stabilize her ventilation, stabilize her electrolytes, her glucose levels, and in general, just taking care of her. As you can see, over the course of the 28 days, she lost about 28.5% of her blood volume. There are more blood draws in premature babies than term infants in NICUs as a general rule just because of the sensitivity they have to any adjustments that we make in their electrolytes, their ventilation, and we have to constantly monitor those situations.

Unfortunately for this little person on day 10 of life, she developed a pulmonary hemorrhage. So, her umbilical arterial line came out around day six and we found on day 10, she started having blood tinge sputum when she was being suctioned and it continued to develop and she lost a significant amount of blood through the pulmonary hemorrhage. It's very scary for these little people and is actually very dangerous for these little people as they are bleeding internally and we don't have a set way to help them through it. Just manage their symptoms and work with them to get through this very dangerous situation. And she did that, which was great. Her blood gas is listed there for what the first one was after we developed.

Her first blood gas after the pulmonary hemorrhage was discovered is listed here and as you can see it was a significant change from the gases that we had been receiving previously. Since we did not have the arterial line anymore, we were doing all of these blood gases off of her capillary which means a heel stick. So, each time we needed to do a blood gas she was getting poked. The best part of this though is that it is using a significant amount less of her blood for capillary sticks.

So, with this pulmonary hemorrhage treatment for that, she went on a high frequency oscillation, which is a higher level of ventilatory support. And we were giving her multiple blood transfusions and blood product transfusions.

She received platelets, she received FFP, and she received packed red blood cells. So, for that day alone, she received eight blood gases, simply because we were trying to manage her ventilatory support.

The oscillator is an extremely sensitive machine and works very well in these situations. However, lots of tweaking is needed throughout her time on that to make sure that we aren't giving her too much support or too little support. So that requires a whole lot of blood gases. And so, she received eight blood gases that day.

Capillary blood gases utilize a significant less amount of blood for the baby from an umbilical arterial line. The differences between the two are quite significant in the volumes that they use.

Throughout her stay and throughout the time with the pulmonary hemorrhage, there was a significant amount of blood loss just through the gases that we were needing to draw. As you can see through here, once we switched over to capillary gases, the volume of blood that was used to gain the gases was significantly less, but the day of the pulmonary hemorrhage, popped back up again and then went down as she was recovering from that. So over the course of 13 days, she lost a total of 7 mLs of blood for blood gases alone which is a pretty significant amount 10%, almost 10% I should say, for the blood gases.

This slide demonstrates in a really easy way to see the difference between an arterial blood draw and a capillary blood draw for blood gas testing. If she were to be receiving only arterial blood gases throughout this entire time, she would have lost a total of 17% of her blood volume. Instead, by changing from arterial blood gases to capillary blood gases, the volume of blood was significantly decreased. The other bonus to that is the umbilical arterial line was removed, which also significantly decreases her potential for infections by having an open site.

So, the overall outcome for her was actually pretty positive. The pulmonary hemorrhage was a very difficult time for her. It was quite a bump in the road, and it did have long-term effects for her in her stay in the NICU. She was weaned from all of her ventilation down to a low flow nasal cannula and was able to start taking bottles and breastfeeding. She did very well with those. It was slow going at first as it is with most of our preemies, but that's okay.

She continued on her low flow cannula because she demonstrated that she really, really wanted it, even though we tried to convince her otherwise. And she was actually able to discharge home with her mom and dad on a low flow cannula. So, they had to learn how to use oxygen at home, which was wonderful. And she continued her oral feedings and was growing just like a normal baby should be. We are hopeful that her oxygen need won't be an extended period that eventually she will figure out that she's good to go and she can make it on her own.

In the NICU, blood gas analysis is extremely important in helping us to determine the needs of each individual baby while they are on ventilatory support. We don't want to give them too much support. We don't want to give them too little support. Both extremes are very, very dangerous for them and can cause lifetime effects. We want to make sure that we are adjusting their support as they need it. Neonatal infants with ventilatory support, their needs change hour by hour, day by day versus adults who can typically change over days and weeks and months. So, we have to have a more constant way to monitor them and ensure that we are doing what they need.

The smaller the blood volume needed for these labs, the better because these babies just don't have the blood to give us in the first place and we just keep taking and there's risks involved with blood transfusions as well, even though that is the best way to help them through these situations.

Dr. Jane Caldwell

So, Ms. Lazzara, do you think there's more awareness in your NICU of blood loss in neonates?

Bethany Lazzara
I absolutely do. We are very conscientious of any blood loss for any baby, but especially our micro-preemies and anyone born basically under 32 weeks gestation. We actually keep track of our blood loss of our babies. Every single blood draw is documented so that we are able to visualize a total volume of blood loss. If the babies do need to be transfused, then their blood loss levels go back to zero because we have replenished what we have taken, but it is a very, very important part of our world and there is a huge focus on it for us.

Dr. Jane Caldwell
Are there any other measures that are planned to prevent unnecessary draws?

Bethany Lazzara
There are always new inventive ideas in place. Our medical team recently has shifted to trying to minimize our blood draws and to condense our blood draws. If we are able to get the same results off of two separate blood draws, we will do one or the other and not both.

Another thing that has been helpful is we have started doing external CO2 monitoring, which has decreased our need for blood gas draws as quite as frequently. They are still incredibly necessary though, because they give us a lot more information than just the CO2 levels, but it has helped to decrease the amount of blood gases that we've had to draw.

Dr. Jane Caldwell
Dr. Cahan, a question for you. Where do you see the blood preservation movement headed?

Dr. Eli Cahan
I think it's only going to grow. I think we're still in the very early days in thinking long and hard about blood. I think I've seen so much variability in the institutions that I've had the opportunity to work at. I've worked at over a dozen healthcare systems now throughout my training and everyone has a different approach to the different ingredients here. And so I think there's lots of opportunity for implementation of things that we're not implementing right now and potentially in the future there's an opportunity for some standardization around guidelines and expectations for how NICUs are managing.

Dr. Jane Caldwell
Thank you so much for sharing that information with us.

Bethany Lazzara
Thank you so much for having me.

Dr. Eli Cahan
Thank you so much for having me.