BBGuy Essentials 097CE:
Acute Normovolemic Hemodilution
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Guest: Hi, I'm Dr. Steve Frank from Johns Hopkins Hospital, and this is the Blood Bank Guy Essentials Podcast.

Joe: Hi, everybody. Welcome back to Blood Bank Guy Essentials, the podcast designed to help everyone learn the essentials of transfusion medicine. My name is Joe Chaffin, and I am your host. This is episode 097CE, and I'm very excited for you to hear it because it's a discussion about something that you may have heard of. In fact, if you're a longtime listener of this podcast, we've discussed it briefly before, but we're gonna have an extensive discussion on Acute Normovolemic Hemodilution. And if you don't know what that is, stay tuned.

But first, this IS a continuing education episode. The free continuing education credit is provided by TransfusionNews.com, and Transfusion News is brought to you by Bio-Rad, who has no editorial input into the podcast. This podcast offers a continuing education activity where you can earn two different types of credit: One AMA PRA Category 1 Credit™ or one contact hour of ASCLS P.A.C.E.® program credit. This activity also may be used to fulfill Lifelong Learning Continuing Certification requirements for the American Board of Pathology. To receive credit for this activity, to review the accreditation information and related disclosures, you just need to visit www.wileyhealthlearning.com/transfusionnews. Don't forget: The continuing education credit is no longer available two years after the date the episode was released; in other words, credit for this episode will expire on June 28, 2024.

All right. So, if you have been around blood banking for a while, if you've been around surgery for a while, you've probably heard at least a little bit of something about the mysterious entity known as "Acute Normovolemic Hemodilution" (we abbreviate it "ANH" for short). In fact, ANH has been around and has been discussed since the 1970s, which, as I am, is even before I started doing transfusion medicine.

The basic principle is, and Dr. Frank will discuss this in just a second, but the basic principle is that you remove blood from a patient immediately prior to surgery and replace that blood with volume, whatever the fluid you choose is to replace the volume. And then during the surgery, the patient bleeds more dilute blood. And then at the end, you give the patient their blood back. The idea is generally to save transfusion, to save allogeneic transfusion as much as possible.

Well, I know of no greater expert than Dr. Steve Frank from Johns Hopkins University to talk to us about Acute Normovolemic Hemodilution. Dr. Frank oversees the Bloodless Medicine Program at Johns Hopkins University and there are extensive details about Dr. Frank's bio on the show page for this episode, which you can find at BBGuy.org/097. I would strongly encourage that you go there and check this out. But in the meantime, I'm so excited for you to hear this episode.

So let's not wait any longer. Let's go ahead and talk to Dr. Steve Frank from Johns Hopkins University about Acute Normovolemic Hemodilution.

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Joe: Steve, welcome back to Blood Bank Guy Essentials.

Steve: Thank you. I'm privileged to be here. Thank you.

Joe: It's an honor to have you back. It really is. The last time we talked was way back, I looked it up, but I can't believe it. It was way back in 2018, four years ago, man. And you gave us a wonderful overview and, actually in places fairly detailed to look at your bloodless medicine program at Hopkins. Everyone listening, you can find that interview at BBGuy.org/048, and I really recommend that people check it out. We've got a lot of really great details in that.

I want to focus in on one specific aspect of that today, but before we do, Steve, I wonder if you'd just take a little time to walk us through what's been going on with your program in the last four years, both in bloodless medicine and in your overall patient blood management program there at Johns Hopkins.

Steve: Sure thing, Joe, we really run two programs side by side, and for about 10 years now, we've had both a patient blood management program as well as a bloodless medicine and surgery program. And they go hand in hand. Because in the first program, we aim to reduce unnecessary transfusions. And the second program, we specialize in treating patients who don't want transfusion for either religious or personal reasons.

We really use the same methods in both programs only to more of an extreme measure in patients who don't take blood.

Joe: So, let's see; you've done it ten years, and you were about six years into your program when last we talked. Have you seen any trends? Have you seen any increased or decreased use of your programs or increased emphasis in the hospital?

Steve: We started out in the PBM or patient blood management program, focusing on red cells like most programs do. For the first four or five years, we really focused on the hemoglobin trigger and then the "Why Give Two When One Will Do" campaign. That was probably the biggest impact of anything we've done. Also, the simplest measure that we launched; the "Why Give Two When One Will Do", based on the choosing wisely recommendation of single unit red cell transfusions. When that launched, we went from about 66% of our red cells being ordered as double unit transfusions. And now we're down to about 15%.

Joe: Wow!

Steve: Doctors, they just want to give blood to the patient. If they give one unit, they feel just as good as if they give two. By the way, you know, everybody talks about the hemoglobin trigger, when you start giving blood, but not many people talk about the hemoglobin target when you stop giving blood. That's where the "why give two when one will do," comes in, is giving blood to the right target, not just the trigger.

Joe: I love that. And yeah, I can't help but just expand on that for just a second, Steve, because think it's fair to say that you and I didn't get out of residency yesterday. We've been practicing for a little while. So, I think we're both very well aware of the times, and this may feel alien to some of the people listening to this podcast that tend to be more “recently trained,” let's say, than you and I. But I'm sure you remember the days when blood bankers used to just beat up on people for transfusing one unit, right? It used to be a marker of quality. A point of pride in how you use two units rather than one; that's a “dose.” Do you remember those days, like me?

Steve: Yes. That's what I say in my lecture that we were trained, “the dose of blood is two units,” and then they changed the rules. ABB came out with their choosing wisely statement in 2014. That's when the experts in the field started recommending single-unit transfusions. It's about eight years now when that happened.

Joe: I'm hoping that the title of this episode actually attracts some people that may not normally listen to my podcast, perhaps some surgeons, perhaps some anesthesiologists.

So before we leave that why give two thing, I just have a curiosity question. People have asked me, "Do we have data that we're not doing harm by not giving two and giving one?" How do you respond when clinicians ask you that question about, is there data behind what you're suggesting?

Steve: Yes, there is data or yes, there are data. Because, in the now 12 landmarked randomized trials comparing restrictive to liberal hemoglobin triggers, all but one of them. All those randomized trials, except one, specified that they use single-unit transfusions when they talk about a trigger of 7 versus a trigger of 9, they were using single-unit transfusions. So, the data do support single units.

I've never finished answering your question. So, I told you we started with red cells. But then we branched out into the yellow products and that was like stage II of our PBM program. And now we've managed to reduce plasma and platelet utilization by a substantial amount by using best practice advisories to educate clinicians on the hospital guidelines for plasma and platelets, and also viscoelastic testing, and that's a whole other topic, but, you know, for trauma, transplant, cardiac surgery, we've really managed to reduce the overuse of the yellow products as well.

Joe: That's awesome. And it's not that you didn't finish your answer, Steve, It's that I didn't let you finish your answer. I got so excited about the two versus one thing that I couldn't help myself, but that's amazing. That's fantastic. And I want to give you the opportunity to address something that I know I've talked about on this podcast before, but I want to get your feelings on it.

Reducing the numbers is wonderful. Do you want to take just a second to talk to people about what the overall aim of patient blood management is and I'm sure, of your bloodless program as well? I mean, is it just reducing numbers?

Steve: No, not really, because it's really patient-centered and sometimes they say, "Oh, you just want to save blood and save money." But the truth is in those twelve randomized trials

comparing liberal versus restrictive transfusion, eight of them showed no benefit to giving extra blood and four of them showed harm or a worse outcome when giving extra blood.

And these are landmark trials in the New England Journal and JAMA. Not one of the 12 showed a benefit to giving extra blood. They do either the same or worse when you use a liberal transfusion strategy. And you mentioned the bloodless program. We really use the same methods only to a more extreme measure when we treat patients who don't accept transfusion. For example, we emphasize pre-op anemia treatment. We use the cell saver during surgery more consistently, tranexamic acid to reduce bleeding, smaller phlebotomy tubes, so we reduce blood loss from lab testing. We even use intravenous iron and erythropoietin, either before they come in or during the hospital stay. And then we tolerate lower hemoglobin levels for our Jehovah's Witness patients and, you know, no one's ever really tested the hemoglobin thresholds down to 6. For example, all those randomized trials I mentioned, they only went down to 7, and I can tell you that there's plenty of Jehovah's Witnesses that come in here and they leave with hemoglobins of 6 and they have nadir hemoglobins down to 5, and they do pretty darn well, especially if they're chronically anemic because we know that chronic anemia is much better tolerated than acute anemia.

Joe: Sure, absolutely. But have you seen any growth in your program in terms of more people being interested in it? Aside and we talked about this a little bit last time that you told me before that the majority of the people interested in bloodless, for obvious reasons, are people that are Jehovah's Witnesses. Have you seen increased interest in recent years from non-Jehovah's Witnesses?

Steve: I'd say about 90% of patients who are requesting bloodless care are true Jehovah's Witnesses. The other 10% either, have personal reasons or a fear of infectious disease, or sometimes they have a family member who's a Jehovah's Witness. This is actually quite common, and that family member may be visiting in the hospital. Some of that goes on. And then we have patients with alloantibodies where, you know, we just can't find compatible blood easily or sometimes not at all. And we pull out all the stops for them.

Joe: I think that's one that isn't necessarily obvious to probably a lot of the people listening - the idea of someone with a large number of alloantibodies that you could potentially help obviously by going bloodless.

Well, there's obviously a lot more that we could talk about there, Steve, but I want to move into discussing one of the tools in your arsenal, in your bloodless medicine program, that I think is something that you have a great interest and a passion for, but it's something that's been around for a long time. Not necessarily used as widely, perhaps as it could have been, because there've been a lot of questions about it and that's Acute Normovolemic Hemodilution.

So before we get specifically to ANH, I wonder if just for people listening, when we talk about autologous transfusion during surgery, people have a tendency to focus in on one kind of traditional or maybe, or widely known method of donating your own blood. But I wonder if you could talk about it and I think you mentioned another one earlier, what are the options for you as an anesthesiologist, as someone coordinating a bloodless medicine

program or a patient blood management program, what are the options for a patient when they say, “I only want to get my blood during and after my surgery?”

Steve: So, there's really three kinds of autologous blood therapies. The first is pre-op autologous donation, that you mentioned, where say three, four, or five weeks before your surgery, you go and donate your own blood. They store it just like blood bank blood. That was really popular back in the HIV, hepatitis C days when our blood supply was very unsafe, like in the eighties. There are holdovers into the nineties when everybody wanted to give their pre-op autologous donation.

The problem was that you're just making the patient anemic before their surgery, without time to recover. Often, they would show up anemic for their surgery and their blood has been stored for four weeks. If they didn't need it, it would get thrown in the trash because you can't even use that blood for other patients.

In fact, that happened to me personally, when I had a lumbar fusion in 2006. I donated, the surgeon told me I should donate pre-op autologous, which I did twice, two units. Then I show up. I show up anemic for my surgery at 11.5.

I didn't need the blood cause they only lost 300 cc. They threw my blood in the trash. Then they billed me a thousand dollars. Because they said it wasn't covered by insurance.

Joe: Oh no, oh no!

Steve: I'm not making this up.

Joe: Wow. That's incredible!

Steve: This is a personal story.

Joe: Yeah.

Steve: And this was at the number one orthopedic hospital in the country. That's where I had my spine surgery. Now the good news is my spine surgery worked, and I did okay.

But the other autologous blood method is cell salvage or what some people call this, the cell saver. And that device is designed to return the blood patients lose during surgery to give them back their own blood that they lose.

And this cell saver was invented in the late 70's, conveniently, right before the HIV crisis in the blood supply in the early 80's. So, everybody wanted cell saver blood bags. Just like they wanted to do pre-op donation. Everybody wanted their own blood. Cause, I mean, you could die from a blood transfusion, 1984 was the most dangerous year to have a blood transfusion and the cell saver was really hot.

And it's still considered one of the number one blood conservation measures during surgery to give patients back their own red cells with the cell saver. But the problem with that is all you're giving back is red cells because the plasma and the clotting factors and the platelets, they all get washed out in the centrifuge.

So, if you give enough cell-saver blood, your patient will get coagulopathic for lack of clotting factors and platelets. It's good for patients who lose maybe, you know, a liter or two, but beyond that, you could have dilutional coagulopathy.

And then there's the third type of autologous blood use, which we're going to talk about next, which is Acute Normovolemic Hemodilution. We can go on and describe how that works and how we use the patient's own blood taken off before incision or before the bleeding occurs during the case, during the surgery, but before the bleeding and we bank the patient's own blood right there in the OR in a citrated [bag] And give it back to them when the bleeding is finished.

So, we'll talk about how that works.

Joe: Absolutely. One thing I wanted to just before we leave cell saver, intra-operative cell salvage, the whatever, the whatever proper term you want to apply to it. Historically, there have been some concerns. And I actually am asking this, not knowing the answer to this. I wonder if you could update us on the concerns in the past with using cell-saver. For example, in patients who are having surgeries for infections, or have an infection going on, or aseptic or cancer surgeries, have those issues been resolved, or are those still restrictions on using the cell saver?

Steve: Sure thing. Infections and cancer during surgery are considered “relative contraindications,” because the blood is washed in the centrifuge. However, if you have frank pus in the wound, for example, that's a contraindication to the cell saver because even the washing process is not good enough to remove a hundred percent of bacteria.

Cancer is the same way. We don't have enough data yet. In fact, that study hasn't been done and there are no randomized trials showing whether there's increased cancer recurrence when you use cell saver during cancer surgery. What we do is we weigh the risk and benefits. Okay. Just like anything else in medicine.

Like if you're a Jehovah's Witness and you're having a Whipple surgery for pancreatic cancer, and you're going to lose two and a half liters of blood, we're probably gonna use the cell saver and we're going to give you back your own blood and we run it through a special filter.

It's actually a leukoreduction filter and Jonathan Waters in Pittsburgh at UPMC has shown that these filters that are designed to remove white blood cells actually are effective in removing bacteria for infected cases and also for reducing the number of cancer cells that are re transfused.

So, if we think the benefits outweigh the risk, like that Jehovah's Witness patient having a Whipple, then we'll use the cell saver with the special filter, but usually for infections and cancer, typically, if it's not a Jehovah's Witness, most places are not using the cell saver.

Joe: We'll circle back around to that issue in just a little bit. I feel like we've teased Acute Normovolemic Hemodilution enough, Steve. I was going to have you do this later, but I actually think now is a really good time for you to just walk us through the process. Walk us through the kind of the start to finish process so people can understand when you start

talking to people about ANH, how that process goes all the way through the surgery into the post-op period.

Steve: So, we call acute normovolemic hemodilution ANH. The idea is to bank the patient's own blood but between the time they go and the time they start bleeding. You have usually an hour in there between anesthesia start and bleeding begins to remove the patient's own blood, store that blood in citrated bags, and then we replace that phlebotomized blood with either crystalloid or colloid. You're hemodiluting the patient on purpose. When the bleeding begins, they're losing more liquid than cells. They're losing diluted blood rather than concentrated blood. So, they're losing less red cells. They're even losing less clotting factors and platelets because those are also diluted.

You want them to bleed a diluted blood. The idea is you give them back their own fresh whole blood when the bleeding stops. The thing that makes ANH blood better than cell-saver blood, or even pre-op autologous donated blood, is it is fresh whole blood. Cell saver lacks the clotting factors in platelets. Pre-op autologous has been stored for up to six weeks so whatever clouding factors and platelets are in there, probably not that functional but the ANH blood, it's only been outside the body for one, two, or three hours.

We're allowed to keep it at room temperature for eight hours, according to AABB guidelines. Even on a long surgery, you can still give it back when the bleeding stops. We think that the most common use for ANH now around the country and probably the world is really cardiac surgery. It works best for cardiac surgery and there's several reasons why.

Joe: Let's step back for a couple of seconds, because I definitely want to delve into that a little bit. I guess the question is, when do you make the decision that this person is a good candidate for ANH?

Is that immediately prior to the surgery? Before you put them to sleep? Or does that happen sooner? How does that evaluation occur?

Steve: There are several criteria where ANH is ideal and some criteria where it's contraindicated. You're basically gonna phlebotomize usually two or three units of whole blood off of the patient. They have to tolerate that 20 or 30% dilution. If they come in with a pre-op hemoglobin of 12 or less, they probably won't tolerate that much red cell loss or dilution because you want to keep the hemoglobin certainly above 7 maybe above 8 because there's going to be more bleeding during the surgery and they may drop to six before you give them back their own blood. I'd say you want a hemoglobin of 12 to be safe if you're going to do. You also want a decent size patient. If you have a 40-kilo adult, you know, their blood volume is half of what yours or mine may be.

So, they're not going to tolerate giving that much pre-op donated ANH blood.

Joe: You're being generous. Steven, putting, putting my blood volume as the same as yours, my guess is mine is more. Let's just leave it. That let's leave it there. You're very kind.

Steve: The typical adult, 70 Kg, has about five liters of blood, I like to remind all my medical students. If you're taking off two units, that's about one liter of blood cause 500 cc per whole blood unit. You're taking off 20% of their blood volume.

That's typically what we do in cardiac surgery - we take off two whole blood units. If you only take off one unit for ANH, you probably don't make any difference because the amount of dilution is so small that they're going to bleed close to the same number of red cells as they would if you hadn't diluted them.

Two to three units is ideal. In fact, the recent study, the University of Maryland folks showed that if you take off 1100 cc, you can make a difference. That's two whole blood units.

So there's three ways to make a difference with ANH. You can either reduce red cell transfusion. You can reduce the yellow product transfusions like plasma and platelets and cryo. Then there's a third outcome that people measure, which is post-op bleeding. So, the red, the yellow, and the bleeding.

If you look at the ANH studies, some of them show a reduction in red cell transfusion, if you do it well. Some of them show reduction in the yellow product transfusion, plasma, and platelets, and a few of the studies show a decrease in post-op bleeding.

If you summarize all of them, you will find some that show red, some that show yellow, and some that show bleeding improves. And it's not a huge difference. You're saving between half and one red cell unit. The percent of patients transfused might decrease from 55 to 40%, or something like that in cardiac surgery receiving red cells.

So, probably, the thing that makes it better than the cell saver, is you're getting clotting factors and platelets from this whole fresh blood.

I think that's why in cardiac surgery it's most popular now because especially the platelets are thought to be damaged and are dysfunctional after a bypass run on cardiopulmonary bypass. And when you can give two whole fresh blood units back to the patient with clotting factors and platelets, we think the hemostatic benefit is probably as great as the red cells themselves, which you could have done with the cell saver anyway.

Joe: Right. Well, I think that's such an important point, Steve, because in my experience, the tendency with ANH and deciding whether ANH is useful, quote, unquote or not, has in the past, at least the arguments have often revolved around just the red part of what you said. And as you mentioned, there are three different things we can look at.

The red part has been the focus. It seems to me. And as you said, when you look at the meta-analyses that have been done, and you were involved in writing an editorial about one that I think came out in a meta-analyses that came out in 2015? If I remember right, Steve? You wrote an editorial in response to that, and there've been at least one, I think a couple since then.

When you look at those numbers, it's not shocking. It's not like you're saving five units of red cells for every transfusion! I think it's important to understand that there's more than just the red value to that. There is more than just a decrease in the number of red cells. Sorry that there wasn't a question there, that was just more of an editorial statement.

But let me ask you this, Steve, because as I look through the data and I admit getting ready for this interview has forced me to look at some data that I haven't really considered before. And I looked at the literature in ways that I haven't done before.

One of the things that people have criticized the meta-analyses for, and I think you mentioned this in your editorial in 2015, is it's almost an apples to oranges thing. Some of the older studies in particular and some of their more recent meta-analyses have brought up the fact. You mentioned this in one particular study that if you're not taking a couple of units at least, you're not necessarily gonna expect much of an impact.

Could you talk about that and how that's maybe changed our look at ANH over the years?

Steve: Some of the limitations of meta-analyses we all know, are that you can't make data better than it was when it was collected. That's why there are three things that you really need to make ANH work. And make it worthwhile. You need a decent starting hemoglobin so you can take off enough blood, which is the number two factor. So decent starting hemoglobin, taking off enough blood to make a difference. And then you need a surgery that's going to lose enough blood, so it makes a difference. There's no point taking off a large amount of blood if they're not going to lose any blood. The goal is to have them bleed at a diluted hematocrit.

So those are the three things you need—a high starting hemoglobin, take off enough blood, and then hope they lose enough blood. But not too much blood because if they lose too much blood, you're going to have to give back your ANH blood before the bleeding stops.

That's the goal is they lose just the right amount of blood and then you can wait until the bleeding stops and give them back their own blood.

Joe: A little bit of an art to it, it seems like, Steve. Is that a fair way to put it?

Steve: I think it's also hard work. Let me tell you this. You need to find those citrated bags, which aren't always available. It's the same bags that the Red Cross uses, for example, when they collect your blood, the same, citrated solution, then you need a line that's gonna draw back at a high flow rate. I've tried to do this through peripheral IVs unless it's a really big, antecubital vein with a 16 or 14-gauge IV. You can't take an hour to do the phlebotomy because by then the surgeons are going to be underway and the bleeding's going to be underway. And the idea is to take this blood off them and dilute them before the bleeding starts.

That's why in cardiac, they have a, usually eight and a half-French internal jugular catheter, which is about the diameter of a BIC pen, if you haven't seen them. You hook up the bag, you drop the bag on the floor, or put it on a scale- a lot of places weigh the blood. So, you end up with 500 cc in the bag. If you have an eight-and-a-half french line in the IJ, like they do in cardiac surgery, you can take off a unit in 10 minutes. And quickly replace that volume with crystalloid or colloid or both.

But if you're doing say a Whipple for pancreatic surgery and you don't have a big neck line, which we often don't have now, because Whipples are not as big as they used to be.

They don't even get central lines. Then you're trying to get a peripheral IV to draw back. I've tried to do ANH through an arterial line, a 20-gauge arterial line. It takes about a half-hour to get off one unit.

Joe: Wow.

Steve: Cause even though it's a higher pressure, it's a tiny little diameter.

That's what you need a big line. And that's why cardiac surgery is really the only place where ANH is consistently used now.

Joe: Just a quick aside, I haven't had many experiences with ANH personally, as a blood bank director, but I have had the experience of going into the OR when an anesthesiologist called me and said that something was wrong with the bag of blood that they had collected.

And I went in there to see this bag of blood. And, I'm not going to say which hospital it was, Steve, or what anesthesiologist was involved, because it would be a little scary, but on the bag was written "Fred's blood," which kind of concerned me, frankly, but further the bag was a football. It had to have at least a liter in the bag. So, thank you for making the point that it is a good idea to have at least some idea of how much blood is actually going into the bag. That's obviously very important. Those bags are attuned to specific collection volumes, right? And so, you said you actually have a scale in the OR?

Steve: Most places that do this routinely will have an electronic scale and they'll weigh it to 500 grams, right? That would be 500 cc of liquid.

Joe: Roughly. Yeah.

Steve: And that should be 450 of blood and 50 of citrated anticoagulant, I think.

Joe: Depends on the bag but yes, it's variable.

Steve: I think that's roughly the numbers. Half a kilogram, 500 grams is a whole blood unit.

And if you overfill the bag, which I've done one time, I have seen clots in the bag. So, you can overwhelm the amount of anticoagulant if you overfill the bag. And in fact, one of my colleagues said that as a precaution, they add a thousand units of heparin to each bag, just in case, because the worst thing is if you're trying to save blood and then it clots.

And then you've done the patient a disfavor because now you have to throw their blood in the trash. Some places even use a rocker to keep the blood agitated. We don't do that. In fact, I don't think you rock red cells or even whole blood in the blood bank.

Just platelets, right?

Joe: That's true. But generally, in blood centers, they will often have a rocker during the collection process. That's not uncommon in blood center world.

Steve: Oh, during collection to mix the citrate.

Joe: Exactly. Exactly.

Steve: So once the citrate is mixed into the whole blood, we just hang it on the IV pole and have it ready. Once in a while, we'll agitate it with our hands. But I, except that one time when I overfilled the bag, I have not seen any clots. And, you know, we run it back through filters anyway, that would catch clots.

But you don't want to do the patient a disservice and have their blood clot.

Joe: Let's move to the next step, replacing the blood that you've taken out. And obviously, as you said, you're taking out a substantial amount of blood. A couple units seems like kind of the minimum threshold for ANH. When you're deciding how much blood to give back, is there a formula? Are you giving mL for mL estimating that and you mentioned either crystalloids or colloids? How do you make those decisions?

Steve: First we have to replace the phlebotomized volume with crystalloid or colloid. And most people, if you're using say albumin for a colloid that they use a 1:1 replacement. Cause that's going to stay intravascular. If you're using crystalloid, I've read people that use a one and a half to one replacement. But these patients usually have central lines and you're measuring their central venous pressure. So, you can do it in a more physiologic fashion if you're going to maintain their CVP at baseline.

And then when the surgery is near the end and the bleedings finished, let's say in cardiac, you've reversed the heparin with protamine, you've come off a bypass, that's time to give the whole blood back to the patient. You definitely want to leave room in the intravascular space. That's an art by the way, that we practice in anesthesia. I like to say, our job is to keep that five-liter blood volume constant, and it's very easy to either under or over-transfuse a five-liter blood volume.

I have seen cases where the intravascular space is full, and here you are with a liter of whole blood to give back. And so, you might have to give a diuretic like furosemide, if the patient's volume overloaded. They often get a lot of blood out of the pump reservoir at the same time nowadays.

You definitely want to hold back on any banked blood and leave room for the ANH blood and any pumped reservoir blood that they're going to hand to you when they come off a bypass.

Joe: I can see how that is an art. You're juggling a lot of things and I know you guys are anesthesiologists, you do that all the time, dealing with 20 different things at once. You're good multitaskers, but it's a more complex process, I think than many blood bankers realize in terms of you having to figure out, this has to go in here, this has to go in here both mechanically and just in terms of the overall, big picture for the patient. And as you said, leaving the space to put in what could be a substantial amount of fluid, right?

Steve: The way I describe it to my residents is five liters is just over a gallon. If you think of a gallon milk jug, and that's roughly how much blood you have, if you're a small patient, trying to keep that gallon constant while the surgeons are losing blood and we're giving blood is really tricky, really tricky because if you're 20% down or 20% up, you could be entering hemorrhagic shock, or a transfusion-associated circulatory overload if that gallon isn't constant.

We like to follow, of course, heart rate and blood pressure, but CBP is helpful. And nowadays in cardiac, they have the transesophageal echo so they can look at the left ventricular diameter and the left ventricular end-diastolic volume. We can get pretty scientific about keeping intravascular volume normal.

Joe: I think that you've given us a really great overview with some practical steps, Steve. I'm going to ask you one more question in just a second, about where a hospital, a facility that was looking to start an ANH program should go. But before we get to that, I mentioned that you wrote a wonderful editorial in 2015, that will be linked on the show page, by the way, for this episode, everyone.

Since that time, Steve, so, we're seven years out from that editorial. I think that, or at least it's my impression based on what I have, you know, like I said, in preparation for this interview, I feel like I'm seeing more attention to ANH. I wonder if that's your impression as well. And I wonder if you have any thoughts on what you've seen in the literature since you published that editorial in 2015.

Steve: I think you're right, Joe. and they're focusing on what they call “large volume ANH.” That means two whole units of whole blood or a liter of phlebotomy blood. That's the study that came out of the University of Maryland that was retrospective, but there's a study coming out soon from a group in China, that looks at high volume ANH. Again, two full units of whole blood and they're going to show a decrease in red cell requirements, as well as a decreased postoperative bleeding. They monitor chest tube bleeding very carefully after cardiac surgery every hour on the hour. It's the best patient population to measure bleeding. And they're going to show a decrease in bleeding.

There is more attention. One unit is probably not enough. Two or three units is ideal. And I think it's the yellow products, the plasma and the platelets that make all the difference because otherwise we could just use the cell saver and give them back the red cells that they're losing.

Joe: That makes total sense. I think there are other things we could probably talk about with this, but I do want to get to something that, again, sometimes people that are listening to this podcast are in various stages in their career, in various positions.

One of the groups of people that I want to help with this discussion is someone who's listening to this who let's just say works at a small hospital somewhere in the middle of the country that does not have an ANH program. Maybe they're a cardiac surgeon. Maybe they're an anesthesiologist. Maybe they're a blood banker. And they're thinking, “this seems like something that at our facility, we might want to consider.”

If that's the case, if someone finds themselves in that situation, how would you recommend that they get going? Who do they need to have at the table? Who needs to be involved in this discussion and the planning before they start implementing it?

Steve: If it is cardiac surgery, then the perfusionist team should be involved and, they're the ones that run the heart-lung machine and they basically take care of intravascular volume during bypass, as well as the anesthetic and the vasopressors. They run the show during bypass, so the perfusionist should be on board and they can be very helpful in all kinds of

blood conservation measures, including ANH. The surgeons and the anesthesiologist and the blood bankers, of course. There are times when, if you don't use that blood within eight hours, the AABB allows you to put it in a cold environment. And you can give it, I'd have to look up the exact number of hours, I think I read 24 hours after.

Joe: That's correct.

Steve: After it's removed for the patient. Blood bankers are definitely going to want to be aware of what's going on, but outside of cardiac surgery, I just don't see it being used that much.

The one time where it might be useful is in a cancer surgery, like a Whipple, because you don't want to use the cell saver, on a cancer case. It's relatively contraindicated if you're going to suck cancer cells into this cell saver. ANH is another way to use the patient's own blood when the cell saver is not an option.

We have done this for Whipple surgery if you have decent IV access, either a large peripheral vein that draws back, then you can... I actually took four units off of a Whipple once for a Jehovah's witness, who had some vascular involvement with the portal vein. We think it played a major part in getting this patient through without allogeneic blood.

We diluted them down from like a starting of 13 hemoglobin down to about 8 during the bleeding part of the surgery. And then when we gave the blood back at the end, the patient ended up pretty close to 11. So, I think it really helped.

How do you get started though? I think you really just need the citrated bags.

Joe: That's the key, right?

Steve: Then you need the right tubing that will allow reverse flow into the bag.

I don't know if you know this, I found out the hard way, the new IV tubing, won't flow backward because they have a little disc in the tubing to prevent a reverse flow. You need an IV tubing that will flow backward into the bag.

Joe: Very interesting. I don't think I knew that. I really don't think I did. That's fascinating. It's the little stuff that trips you up. Right. But would have thought that would be the one of the kickers?

Steve: Other than that, maybe an electronic scale, and then you're good to go.

Joe: This has been, again, just a great look and more than just an overview. You've taken us into the details of ANH in ways that I think are going to be really, really helpful for people to understand and to understand how this has been something that we've talked about for a number of years, and maybe there's more of a future for it than we might've thought. I do want to close though, by asking you one specific thing and you're welcome to interject anything else, of course.

But, in terms of what we've seen recently with the COVID-19 pandemic related, I'll just call it “blood crisis,” because that appears to me to what it's been. I've personally, in my career, have never seen a longer lasting or deeper blood shortage in places where I've worked. I don't know what your experience has been with that, but it's definitely been that for me.

Has that, in your opinion, driven any increased interest in ANH? Have people started talking about it more because blood might not be as available as it has been?

Steve: I think there's no doubt that patient blood management is more important now than ever. Ever since the pandemic hit and the blood supply hit record low levels, I think back in December of 2021, with the Omicron variant, we were hurting bad across the U.S. I think platelets were really hard to get. Type O blood was really hard to get. We canceled one cardiac surgery for lack of Type O back in like November. And it was rescheduled. I mean, it was just postponed rather than canceled.

I think platelets are so hard to get that like I said, the ANH blood being whole fresh blood, it's got to be good to give back patient's platelets that haven't been exposed to the heart-lung machine. There's some evidence for a hemostatic benefit. I think now more than ever all the blood conservation methods we use are just gaining in popularity.

Joe: For good reason. So, Steve, thank you so much for your time. I really appreciate you hanging out with me.

Steve: Thank you, Joe. I'll come back anytime. Thanks for having me.

Joe: Hi, everybody. I hope you enjoyed that interview just as much as I did. Just a couple of quick thoughts before I let you go, please be sure to visit BBGuy.org/097. There are a couple of things there, one in particular that I'd really like you to see. There's a link to an editorial that Dr. Frank and his group did back in 2015 on the efficacy and utility of Acute Normovolemic Hemodilution. It's really a great summary of some of the things that we talked about today. If you're someone that keeps articles in your file, that is definitely something to have on hand.

Also, just to be sure that if you're a physician or a laboratorian, don't forget to go to WileyHealthLearning.com/transfusionnews. There, you can get an hour of completely and totally free continuing education. You can also click the link on the show page that I just mentioned at BBGuy.org/097. As always, thanks for the continuing education sponsorship to Transfusion News, to Bio-Rad who brings you Transfusion News, as well as of course, to Wiley Health Learning.

I also need to thank a couple of people first. The Blood Bank Guy managing editor, Dr. Daniella Hermelin, who just has contributed in enormous ways, including helping me write the continuing education materials. Also, to my assistant, Naomi, thank you so very much to both of you for your help.

So, I really hope you'll take just a few minutes to go to Apple Podcasts and give this podcast a rating and a review and to subscribe to it just so that you'll be aware when new episodes are coming out and new episodes are coming out. I promise you that you'll see that in the coming weeks.

The next episode will be a discussion with Dr. Cassandra Josephson and Dr. Steve Kleinman, two giants in the transfusion medicine field, and we're gonna be discussing the

very interesting and massive new study that's going on and project that's going on called “REDS-IV-P.” More on that very, very soon. You'll hear about that shortly. In addition, I have my 100th episode coming up in just a few episodes. I can't wait to share what I have very specially planned for you with episode 100 coming up. So, all that is coming soon.

But until that time, my friends, I hope that you smile, have fun, tell the ones that you love just how much you do, and above all, never, ever stop learning. Thank you so much for listening, and I'll catch you next time on the Blood Bank Guy Essentials Podcast.