Announcer: Well, welcome again to another in our series of interview with the experts. I'm your studio host again, Malcolm Bell, and I'm delighted to have with me today one of my colleagues in cardiovascular surgery, Dr. PJ Spencer. We actually call you PJ, so I hope you don't mind me using that to throughout this PJ. And so, again, I'd, I'd really like to to welcome you. PJ's a very experienced cardiovascular surgeon, deals primarily with, you know, complex patients, but particularly transplantation VA patients and, and deals with a lot of patients receiving ECMO, which is gonna be a topic for today. So ECMO is, as I said, the topic of the day, and pj, as I said, welcome. But maybe you could just start off telling our viewers and listeners what ECMO means and what is the history of this and how have we got to, to this present day use?

Dr. PJ Spencer: Well, thanks so much, Malcolm. It's a real pleasure to be here and fun to be able to talk about this topic with you and, and the audience. What I love to tell is the initial story of, of ECMO, because it's birthplace a little bit, coincides with national hospital and the birth of, of chronic pulmonary bypass, which of course is part and parcel of my life. And it starts with a guy named John Gibbon, who was a resident at MGH back in the 1930s, taking care of a patient with severe pulmonary embolism that was hemodynamically significant. And he was charged with trying to keep this patient alive without any tools to do it. And the young woman did die. And he wrote in his diary, if only there were a way to take the blood from the venous side oxygenated and put it on the arterial side, maybe we could keep someone like this alive long enough that the blood thinner medicines anticoagulation would work, the clot would dissolve she wouldn't have to die. And this became his brainchild for the next number of years as he thought about cardiopulmonary bypass and would eventually give it up due to failures of the process and would've eventually be taken up by folks here in Minnesota. But that was the initial thought, and it was the type of patient that you would treat with ECMO. It wasn't cardiac surgery, that was his initial idea down this road. It led to the development of cardiac surgery until decades and decades later. In the 1970s, Robert Bartlett came up with the idea to use it as a mechanism of keeping the critically ill alive and started with babies in the 1970s. And we'll talk about the difference between VA and VV ECMO, but with VA ECMO to take care of respiratory illnesses such as meconium aspiration and congenital diaphragmatic hernia. And it worked in children but never really worked in adults. Adults could not tolerate the trauma to their blood with the technology they had available at the time they were hypercoagulable, they would clot the cannulas. And so adults universally did poorly with ECMO really until the two thousands and the development of the mag levitated pump that allowed minimal blood trauma so that adult patients could, could benefit from this technology.

Dr. Malcolm Bell: So, and maybe before go any further for, for those of listeners who are not familiar with what ECMO really stands for, it's extra corporeal membrane oxygenation. And, and maybe before we go any further, you, you talked about sort of in the early two thousands, but it does seem that in the last year or two to five years, it's really taken a big uptick. And what, do you have an explanation for that?

Dr. PJ Spencer: A few. I think we've gotten better as a community and taking care of these patients. We don't flood them with heparin as much as extracorporal membrane accusation. The blood has to leave the body in plastic tubing, go through an oxygenator in return. And in the early 2010s, we used an awful

lot of anticoagulation that was probably unnecessary and suffered a lot of complications. Certainly the pumps have gotten better and we've found new indications. You get a new technology and you start using it on folks that, well, maybe it'll work for this too. Yeah, maybe it's just not for ARDS. And then the world gets threatened with a disease of ARDS that's of pandemic proportions and it just explodes. And I certainly think since the 2020 era use of this technology has, has left solely the academic and large hospital arena out into the community.

Dr. Malcolm Bell: So, so of course you're, you're referring to the covid, you know, pandemic and it seemed to the point that we were just running out of ECMO machines on your, in so many places. So you talked about big plastic tubes, you know, taking blood away, returning blood. Maybe you can just tell us, tell us how big those plastic tubes are and at the same time, maybe you talk about what the differences are between venoarterial ECMO and, you know, venovenous ECMO. So the VA and VV maybe

Dr. PJ Spencer: Just absolutely,

Dr. Malcolm Bell: Maybe just start with the, the the VV

Dr. PJ Spencer: For sure. So I'll start with the cannulas. We have to get access to the vascular system to do this. ECMO by design really is cardiopulmonary bypass without a reservoir, that's what it is. What, no matter how you use it, the blood comes out, goes through an oxygenator, gets pressurized and is returned and it does it at high volumes and therefore you need rather large cannula depending upon the size of your patient. So in babies, the cannulas might be quite small, although the vascular system is as well. But in adults they tend to be quite large. And the larger the patient, the larger cannula you need, and on average our venous drainage cannulas are in the range of 23 to 25 French that's entering the vein. And the return cannulas are anywhere from the smallest adults to be about 15 French to the largest to be in the 19 to 21 French range. So rather large to to describe venovenous versus venoarterial, we'll start with venovenous and that's used to treat lung failure, whatever the cause a RDS of, of, of any, any type. And what you're doing is you're removing the blood from the venous system, oxygenating it, removing the carbon dioxide and returning it to the venous system. Ideally, we'd like to do this by removing it in large volumes from ideally below the heart. In adults, 70% of the venous return is gonna come from below the heart, and then we return it to above the heart or directly into the right atrium oxygenated it then passes through the lungs in a somewhat passive way, given their very disease returns to the left ventricle. And the left ventricle has to circulate that oxygenated blood through the body. So it does not provide any hemodynamic support at all. So if you code with venovenous ECMO, you have no blood pressure, which is a stark difference between venoarterial ECMO used for entirely different reasons. But it will provide you the mechanism of the lung and treat ARDS without the necessity of an arterial access. And therefore you can use less like anticoagulation of likely less vascular complications. Venial arterial extracorporeal membrane oxygenation is really cardiopulmonary bypass without a reservoir, 100% the same mechanism applies, but you need an arterial access. So you drain the venous blood from the body and bypass both the heart and the lungs. This arterial axis could be the ascending

aorta, it could be an axillary artery. Most commonly, however, it's a femoral artery given the, the, the qualities of the ICU setting. And so the blood is removed from the venous side, oxygenated, pressurized, and returned to the arterial side. And therefore it does provide hemodynamic support. And so if your blood, if your heart fibrillates or arrests, you will be able to provide that individual with blood pressure and circulation with venoarterial ECMO. And so it is an incredibly powerful tool for heart failure instability with arrhythmias, et cetera, where venovenous ECMO is completely contraindicated for those purposes.

Dr. Malcolm Bell: Now you mentioned the heart being in fibrillation, so ventricular fibrillation, how long could ECMO support someone who is in continuous ventricular fibrillation

Dr. PJ Spencer: With enough flow indefinitely, which is an issue, obviously, but the issue is, is while it can support all the other organs in the body, obviously if your heart is fibrillating, it will distend and it will not treat the heart, the heart will suffer a demise while you treat the rest of the body. And depending on what your, your goals are, that might be okay, but, but it, it will support the body but not necessarily the heart, if that makes sense.

Dr. Malcolm Bell: And then the typical patient that you're seeing you, that you are gonna be considering a VA ECMO, what, what would be the sort of top two or three that you would see

Dr. PJ Spencer: Largely these patients could have any diagnosis of heart failure? This could be probably more often than not because of the population of disease in our society is folks with coronary disease that have led to heart failure, that is either at stage or they've had an acute arrest and are unstable from that. But, you know, my practice and in our practice here at Mayo, all kinds of different cardiomyopathies end stage diseases from rheumatic disease, after multiple heart operations, et cetera. The key thing is can you use this tool to support the body while you find an answer in a treatment for their heart? Because ECMO is not an end stage, it is not a definitive treatment for the heart failure. It is to keep the patient alive and without multiorgan failure while you treat the inciting event while you treat the disease. Whether that's coronary disease, bridge the patient to a transplant or a more durable support like an LVAD, it's to get you to some destination. It is not the destination in and of itself. Yeah,

Dr. Malcolm Bell: That's an incredibly important point because you know, occasionally you're gonna see these patients, you're just not sure what's happening and you just, but you, you just can't continually, you know, do CPR and ECMO gives you that time to sort of keep the patients alive as you're working out, you know, what the cause of it is and how you're going to treat it. You, you started talking about your acute lung failure, A RDS we're talking about, let's say cardio shock out of possible cardiac arrest. Where does massive pulmonary embolism sit here? Is that VV or is it VA ECMO?

Dr. PJ Spencer: That's a great question because again, it's, it's Dr. Gibbons brainchild and it is VA ECMO. So if you think of massive pulmonary embolism, it's right heart failure that will kill your patient. The the right ventricle fails as it's trying to pump against this large resistance. It's not usually hypoxia and hypercarbia that kills those patients. And so VV ECMO is of really no use for massive pulmonary embolism. VA ECMO was there to treat the right ventricle again, while you come up with a solution, be it just anticoagulation or more often than not, if the pulmonary embolism is that severe, some sort of embolectomy via transcatheter or surgical.

Dr. Malcolm Bell: Yeah, you, you've explained that very clearly. And then finally, as, as we see this being used more and more and it requires a lot of resources, it's presumably very expensive, you know, hospital stays, et cetera. Does it improve survival? I mean, in general, I mean, there's been some controversy about that. I obviously it depends on, you know, what the underlying cause is here, but where, where does that controversy come from and and do we think that ECMO does improve survival? And I I'm gonna follow up with another question just about a specific patient subgroup.

Dr. PJ Spencer: Absolutely. Well, I think the worst patient subgroup is the key. Last year a paper was published in circulation with 117 patients with cardiogenic shock from all kinds of different reasons. And they were randomized and 63% died, got ECMO and 72% died, did not get ECMO. And the conclusion of that trial was that ECMO maybe doesn't increased survival. And I think that demonstrates the, the challenge of demonstrating survival in very critically ill patients, very few PA papers prove to do it. And when they do, they become our, our dogma because it's so hard to demonstrate survival in the critically ill patient. But 117 patients is not that many. And when you bring all comers into a group, you, you lose I think the power to demonstrate whether or not your intervention is helpful. And as ECMO explodes into our care, who really does benefit is be going to, is gonna become increasingly more important. And, and, and patient selection will be the issue because as clinicians, we all know that there's that patient who arrested from A LED occlusion that we put on ECMO, treat that issue and the patient survives. And that would be an ideal patient for this therapy. But when a patient comes into the emergency department or the ICU, you have no idea why they're arresting and you put them on ECMO and then you find out later they have multiorgan failure, et cetera, of course they don't survive. And I think parsing that out will really be our challenge over the next decade so that we give appropriate care that's not overwhelmingly expensive or prolonged patient's life and suffering unnecessarily. And, and that's a hard thing to force out.

Dr. Malcolm Bell: So that really does seem to be that challenge. You're trying to work out the how, how you can identify, select that patient, you know, is going to have a better outcome. And, and I guess we're not quite there yet at the moment. You know, there's obviously patients are really probably not gonna survive regardless of what you do, but you're still using ECMO just in the last minute. And just very briefly, the, the, the other trial that I was thinking about was the ECLS shock trial. So this was an acute myocardial factor and a larger trial than the one you just described, also published last year, I think it was in the England Journal of Medicine showed no difference in survival, underlined the high mortality with cardio and shock about 50% in each group. You know, they were randomized to ECMO and no ECMO.

The controversy there though was the, the very infrequent use of venting of the, of the left heart. Maybe just in the last few 30 seconds or so, could you just tell us the importance of venting and how that's done?

Dr. PJ Spencer: Absolutely. So when we were discussing earlier, you can survive indefinitely with ECMO, but it massively increases the afterload to the heart. And, and if the heart is not ejecting, if it has really lost the ability to contract, you have to decrease the, the, the pressure within the left ventricle. And we have a number of techniques to do that. The most popularized one now is to use Impella device that kind of percutaneous left ventricular assist device to inject the blood out of the left ventricle. But you can use percutaneous PA events or if you're in the post cardiotomy state, you can use a classic surgical event in the left ventricle and bring that back to the venous side of the blood. And, and that remains controversial too. Does that really help? It certainly helps hemodynamically and it takes the, the wall stress away from the heart hoping that therefore we hope to maintain the myocardium so we can do whatever intervention we need and, and save the patient. But that's not been demonstrated to be true in a, in a scientific forum yet as well. But it is one of the critiques of that trial is that that has not been universally applied, even which patients you wanna vent will start an argument in a cardiovascular surgery meeting.

Dr. Malcolm Bell: So not so simple and, and so obviously another trial with venting, no venting probably it is gonna be a cold or Well, PJ has been an absolute pleasure having you on this podcast. You've explained a very complex procedure, you know, historically and technically and the challenges ahead of us very, very clearly. So thanks so much for being with us today and to our listeners and viewers and to our next podcast, it's goodbye from me and thank you for joining.

Dr. PJ Spencer: Thank you so much for having me.