

**Vanderbilt Health DNA: Discoveries in Action**  
**Season 2, Episode 10**  
**Where Do Broken Hearts Go?**

**Dr. Ashish Shah:** The one thing that I get to do that no one gets to see is heart surgery and what the human heart looks like and all its various functions and dysfunctions. Some of these things are really, they're just miraculous and amazing. I mean I love heart surgery. I mean, I think everything about the heart is extraordinary and all the things that we're learning about is amazing.

**Dr. Kelly Schlendorf:** I think what the hep C story in heart transplantation has taught many of us, myself included, is the importance of capitalizing on advances across all disciplines of medicine, and really thinking outside the box about ways to expand the donor pool. So several years ago I don't think any of us would've thought that the development of newer and better drugs for treatment of hepatitis C, would've allowed us to think about ways to expand the donor pool.

**Dr. Lesley Omary:** I think many people have never seen a mental health provider of any sort before, and there is a definite stigma and people are worried like, oh my goodness, they're going to shrink my head or I'm going to be analyzed, or something like that. I actually think that many people are, by the end of the assessment during that pretransplant evaluation, are feeling much more comfortable about mental health. We try to break it down and let it be much more normalized so that people won't be anxious and nervous.

**Clark Buckner:** Where do broken hearts go? Whitney Houston famously sang about whether they can find their way home. And while modern medicine doesn't have a tonic for the lovesick, an astounding number of physically broken hearts go to a medical center in the heart of Nashville, Tennessee. There's a large team who work to get people living with hearts in despair back home to their life, with someone else's heart. Heart transplants, literally taking a heart from one person and surgically implanting it into someone else, are the result of various teams within multiple institutions working in tandem, under serious time pressure. The mission, to salvage a heart on the verge of not having a body in which to beat, and getting it safely to the body that needs a new engine.

In this episode, we'll hear from leaders of a groundbreaking heart transplant team at VUMC. They perform the most heart transplant surgeries of any medical center in the world. Yes, in the world. And yet many patients around the world spend weeks, months, even years on the transplant list, waiting for the perfect match, and for some, that heart never comes. For the transplant team at VUMC, that is a rallying cry for doing more, to find ways to get more people with broken hearts on the path to home. They do all that while pushing the boundaries of research with bioengineering teams and infectious disease specialists, and anyone else who has an expertise that sparks an idea on how to match more donor hearts to patients. Every day it's a sprint to match more donor hearts with patients.

You're listening to the final episode of season two of Vanderbilt Health DNA: Discoveries in Action. I'm your host, Clark Buckner. Discoveries in Action is about the big ideas and breakthroughs happening right here in Nashville, Tennessee, from Vanderbilt Health. Our drive to discover, care, learn and share, is in our DNA. It defines who we are, just as your DNA defines you. Dr. Ashish Shah is the surgical director of Vanderbilt's heart transplant program and he leads a team that is discovering innovative ways to advance heart transplant surgery.

**Dr. Ashish Shah:** In many respects, I think heart transplant... And transplantation in general is one of the great human achievements of the 20th century. I've been very, very public about this, I think it's amazing. If you think about what those teams did and those patients, at a time where the technology was... In fact the parallels to the space program are there.

You're doing something pretty gutsy with pretty limited technology, but there's this little bit of faith that the science will get us through, and with a little bit of courage, that's what we need to do. That's 20th century, so you finished the 20th century by saying you can do this, you can put an organ in and you can put the heart in, and it'll work. You can live your life. Now it's not going to be infinite life, but you can live it. The 21st century starts with, we're still stuck though with doing the same number of heart transplants. I mean, we keep nibbling around the edges here about how to make things better and get a few more donors. We try to have these organ donor cards and things, but nothing really moves the needle all that much.

Then we start with the hepatitis C story. I think that was the first... In my mind, and I think it's a little self-serving, but still think it's the first time that we saw something that's really going to move the needle on the number of donors. To take a step back, the hep C story really is these parallel social things going on. Number one, we've got this epidemic of IV drug use in this country, and the number of patients or people who die of drug overdoses, and they also have hepatitis C because along with intravenous drug use, comes infection with hepatitis C. So they have these folks who are donors, young, great hearts, garbage can, all of it's going in the garbage game because we can't intentionally infect somebody, which would happen if you use a hepatitis C infected organ, and expect good things to happen.

Inevitably, at least prior to what I'm about to talk about, they all died. They didn't all die, but it was just bad and not certainly good enough, and not what you would want for your patients who are dying already. The last thing they want is, okay great, now my heart works, but now I have liver failure and I'm going to die. That's not what you want. Then these drugs came along, remarkable drug discovery of finding a medication that cures you of a viral infection. And a viral infection that's pretty endemic, I mean all over the world people have hepatitis and hepatitis C. A drug regimen that's curing people at over 90 plus percent, I mean this is unheard of. 12 weeks and you're done? It's amazing.

I don't know anything about this. I'm living my life, doing my heart surgery, sewing in a circle, that's all we do. And it was our hepatologist here that said, "You know there are these drugs, they're awesome.

They work. You could use them in your organ donors who have hepatitis C, because it works." Because they had been doing it in their liver transplant patients, and using hepatitis C infected livers, putting them into hepatitis C uninfected recipients, treating them, and then they were okay. So we have this problem. We have these donors, we've got patients who are desperate, desperate for a new heart because they feel terrible, they're staring at oblivion and/or they've got mechanical devices, left ventricular assist devices. These devices that are also phenomenal technology, but they're imperfect and they get infected and they break, and they leak, and the bearings wear out. I mean stuff that you can imagine where a heart transplant's really your only choice, and now you're up against the wall here.

So that's this sort of perfect storm of, hey wait a minute, let's put this to this and this, and all of a sudden we had courageous patients, a little bit like the genesis of transplant. We've got teams that are a little desperate, that's us. We've got to get these people help. And then you've got opportunity, and that is the sea of... It's terrible, people who have overdosed, have hepatitis C, but they're young and their hearts are great. All that comes together now, so it works. That's not the surprising part, but I think this notion that there's a rehabilitation of organs that can be used in transplant, that can restore things.

But then it makes you start thinking, well then we should really get back to fixing organs. Maybe not just replacing them, but why don't we start fixing these things? If curing you of your virus can help you, maybe these hearts are doable. First piece of our journey is using these hearts, and there're a lot. I mean changing the number of organ donors by hundreds and probably thousands is a big deal in heart transplantation, right? Where we've been flat about 3,500 heart transplants a year in the United States, flat, flat, flat, flat, no matter what we do. Facebook didn't do anything, nothing, but this stuff moves the needle.

**Clark Buckner:** There is a finite number of hearts available to transplant. It's a natural constraint stemming directly from the limited number of people who are willing to be, or can be donors. So there's organic demand way outpacing supply, and there's of course the constraint, rapid advancement in all sectors of medicine. Those dual realities put Dr. Kelly Schlendorf, the medical director of VUMC's heart transplant team, on the path to an inventive, collaborative method.

**Dr. Kelly Schlendorf:** I often joke saying that when I went into cardiology, I never thought I would realize or learn quite as much as I have about hepatology and hepatitis C, specifically. But it's a virus that infects the liver and about 15% to 20% of patients infected with hepatitis C will clear the virus spontaneously, and the other 75% or so will go on to develop chronic hepatitis C, and with time may develop liver failure. We usually start by talking a little bit about the opioid epidemic because really the opioid epidemic is the reason that so many of the deceased donors that come our way, have hepatitis C. Anybody who reads or watches the news is aware of the opioid crisis in this country, which is prevalent across the United States, but especially so in certain parts of the country like Tennessee, where we are now.

It's hard to think of anything positive that has come of the opioid epidemic but I often say that if there is a silver lining to that crisis, then perhaps it is that, as the number of overdose deaths has increased, so too has the number of overdose death donors, by about 17% per year, between 2000 and 2016. We know that when an individual dies due to a drug overdose, there's about a 25% chance that that person is going to be infected with hepatitis C. Until a few years ago, organs from those donors were routinely being discarded for fear of transmitting hepatitis C to the recipient. Then in 2014, the Food and Drug Administration approved the first of a handful of drugs for treatment of hepatitis C, that are called direct-acting antiviral therapies.

These are drugs that, unlike the drugs that preceded them, are highly effective at curing hepatitis C virus, and that are very well tolerated, even in heart transplant patients who are immunosuppressed. It's given the transplant community an opportunity to consider using organs from these donors as a way to increase the donor pool. We started the hep C effort in the heart transplant program in September of 2016, and since then about 80 patients have undergone heart transplants from donors who are infected with hepatitis C. To give you a sense of the magnitude to which that has expanded our heart transplant volumes, those 80 heart transplants account for about 35% to 40% of our volume over the past couple of years.

**Clark Buckner:** Transplanting these organs was definitely considered potentially risky at first, would the antivirals work to cure the diseased heart after transplant? Would patients be open to a heart impacted by disease? It turns out, when faced with a choice between a hep C heart or a potentially fatal wait, patients leaned into science.

**Dr. Kelly Schlendorf:** I think it's a few things. When we started the hepatitis C effort in the heart transplant program, we as a program made a conscious decision that we were only going to offer the opportunity to consider these donors to a select number of patients on our wait list. Specifically patients who we felt like had a high likelihood of potentially dying on the wait list if we couldn't get them to transplant quickly. Then about a year and a half into the program, we made the decision to offer this option to all active candidates on our wait list, and that decision was motivated in part by the fact that our early outcomes in using these donors were very promising. And in truth, it was motivated partly due to social media because many of our patients, both pre-transplant and post-transplant talk to one another via any number of social media platforms.

So interestingly enough, patients were coming to us and saying, "I understand so and so has been given this opportunity to consider a heart from a hepatitis C infected donor. Why haven't I been given that opportunity?" So as a program, we talked about this and ultimately decided that, so long as we educate patients and their caregivers about the potential risks and benefits of this option, about what we know and what we don't know about this option, that the decision really should be theirs and not ours. Amazingly since then, almost all patients who we've listed for transplant, have been very open to the opportunity to consider hepatitis C donors. To get to your question, I think that that speaks partly to their trust in us as providers, that we're only going to offer something that we think may be in their best

interests. And also really to the recognition that for some patients, the alternative to not getting to transplant in a timely fashion, is death.

**Clark Buckner:** Recovery from the transplant, an already difficult journey, is a little different for patients who receive a hep C infected heart. There is extra treatment, but Schlendorf and team found that patient outcomes were very good.

**Dr. Kelly Schlendorf:** Following a heart transplant from a donor who is actively infected with hepatitis C at the time that we recover the organ, the recipient is very likely to go on to develop hepatitis C. The way we know that is that we check their blood on a routine basis following transplant, and within usually several days or a week of transplant, the presence of hepatitis C virus is detectable in the recipient's bloodstream. We follow those patients closely during their inpatient stay, following heart transplantation. Then generally once those patients have been discharged from the hospital after their transplant, we get them started as quickly as we can on the hepatitis C treatment.

The treatments are pills, they're taken by mouth, generally for a duration of 12 weeks, and they tend to be very well tolerated by our patients. The most common side effects that patients tend to complain of are nausea and fatigue, and sometimes headache, but the therapies are well tolerated. And generally within several weeks of starting treatment with the hepatitis C drugs, the viral load within the patient's bloodstream becomes undetectable, so we can no longer detect the hepatitis C virus in their bloodstream. In the hepatitis C world, cure of hepatitis C is defined as an undetectable hepatitis C viral load 12 weeks after therapy has been completed, it's called SVR 12 or a sustained viral response at 12 weeks following the completion of therapy. And again, the drugs are highly efficacious and patients who go on to complete treatment for their hepatitis C, demonstrate cure.

**Clark Buckner:** As we talked about in the previous episode, Think Deeply, up close and personal interactions with healthcare can change a person. Confronting mortality raises all sorts of questions and patients grapple with what they're willing to do to live. The Vanderbilt Transplant Center team discovered that those personal reflections, coupled with the trust in their surgical team, meant patients were willing to take that calculated risk. Because of the enterprising efforts of Dr. Schlendorf and the Vanderbilt team, an entirely new set of donor organs expanded the donor pool. It's one of the most significant advances in transplants in the past decade, yet the fact that the donor pool expanded via this route, spotlights the scale of a social calamity that's taking place across America.

**Dr. Kelly Schlendorf:** I think first of all, we would all hope that the country finds a way to conquer the opioid epidemic so that not as many young people are dying from drug overdose. But I think in the meantime, so long as many of our donors die from drug overdose and are infected with hepatitis C, the goal would be to continue to really learn whether or not use of these donors makes sense. As we move forward, one can imagine that one of the things that would be ideal would be able to treat hepatitis C of the heart, the donor heart, before the heart is actually implanted into the potential recipient. So you can imagine where you take a heart that's being preserved during transport from the donor to the recipient

hospital, for example, and are there ways that we could treat the infection so that we don't end up transmitting hepatitis C to the potential recipient? I think a lot remains to be learned with regards to this field.

**Clark Buckner:** I'm as fascinated by the transplant process, as much as the next person. It is a captivating specialty and that's reflected in the dynamic interest in the recent three part documentary series on discovery+ all about VUMC's transplant team. It's called Last Chance Transplant. Did you know that the transplanting surgical team has to send people to get the donor organ? It's a real life version of the movie scenes when people drop what they're doing and meet at the tarmac. And until just recently, the journey had to be close enough for an organ to survive the trip. New technology may be changing the geography variable and the matching equation.

**Dr. Ashish Shah:** Part of our journey is how do we... If we're pretty aggressive here, why don't we start getting out there and using more organs and farther and further away? The next piece of technology then helps us, is machine perfusion. This is what we'll call it, ex vivo perfusion, machine perfusion, and this is the concept of rather than take the heart out, put it on ice and hope for the best, it's worked for 60 years, why change it? It's why don't you restore blood flow to this organ and keep it going? And if you can do that safely, man, time's gone. Time's off the charts. You can go anywhere, you can find the right recipient, you're not pressed for time. Because time has always been the challenge in heart transplantation. You probably have, realistically four to five hours to take a heart out from one person and stick it and reinfuse it in the other.

Although four hours seems like a long time, if you think about it between the traveling and the airplane and just physically going from the operating room to the ambulance, it's amazing, time just evaporates. It means that you don't have the luxury of saying, "This would be a better match for the person in Alaska, so why don't we just go there? Well, it's too far." The time means that a lot of organs weren't getting used. We can't get a team out here in time. Machine perfusion comes around, it's again, explored in your Europe, explored in Australia, explored here. And after a lot of work, it looks like it's doable, that you can keep this heart on this device.

We were involved in a number of trials that utilized these hearts that weren't conventionally utilized. They would be from far away. We even utilized it because a heart was available in Vanderbilt, but we didn't have a recipient, the guy was hours and hours away. So instead of throwing the heart in a garbage can, we just put it on the box. Let the guy come in. We all just sort of... I mean, it was nice. All the stress was gone, we just got a good night's rest, everybody's ready and then he came in. This introduces the idea now, if you take time out of it and now you can stare at this organ. Now transplantation's really interesting because now you take the time element out of it, but the next step is, wow we can just stare at this heart. Why can't we do stuff to it to make it better? That's the frontier and that's what's coming next.

**Clark Buckner:** At this point you might be wondering if there's a time when advancements will render transplant surgeons obsolete. I asked Dr. Shah if there's a point in the future when he thinks he and his proteges won't be employed as transplant surgeons.

**Dr. Ashish Shah:** People have been sounding the death knell of heart surgery for about 50 or 60 years. I think if we come to a world where we don't need to replace hearts, great. I hope I'm alive to see it. I feel however, the human condition is such that there's enough that goes on with the final end of an organ, we'll need heart surgeons to do that. But I think heart surgeons will lead the way in understanding how to get here because I think that this world of machine perfusion will allow us to take these hearts out, they'll allow us to understand the mechanisms for how a dysfunctional heart becomes functional. What's therapeutic, because if you take an organ out of the body, you can do whatever you want to it. You can give it toxic doses of something that may be good for the heart, but toxic to the brain, but the brain's disconnected so you don't care.

We can really do things that are really novel. I think there's going to be... And this is going to be led by honestly, heart surgeons, because we're able to get these organs out and physically have them out of the body. But also we know more about these hearts in isolation than almost anybody because we sit there and stare at it every day, coax it back to life every day, pray that it works every day. It's the heart surgeons lament, you sort of say, "Please God, make this thing work because there's a big hole here," so that's why, it's the long way of answering your question but I think that's why we'll always need heart surgeons, at least in this time period.

**Clark Buckner:** Vanderbilt has been one of the top transplant centers for years, but with recent discoveries and a crusade to reduce the number of patients who die while waiting on an organ, the program has soared. And as of 2020 surgeries, the VUMC performs the most heart transplants of any center on earth, it averages out to be one every three day days. In August, 2020, they performed four transplants in 48 hours.

**Dr. Ashish Shah:** Let's start with where the volume... What happened over here. I don't think any of it's intentional, other than we slowly but surely put together the right group of people. A very just synergistic group of people got together in the heart transplantation. Heart transplantation's been going on at Vanderbilt for a long time, had a long history of solid performance and innovation. Then we pivoted to these mechanical devices, LVADs, as did everybody and said, "Well the mechanical solution to heart failure is the answer because you can mass produce it. We're not limited by donors. There's no anti-rejection." Turns out that's an imperfect solution also because there's a power cord and there's some other hangups about these ventricular assist devices. You get the right group of people together.

The geography of Nashville, we're in the middle of the country and the right balance of population and geography so that the potential donor pool here is about right, and the demand is always there. People, when they're sick with heart failure, you need a heart, the demand is there. In fact the demand is much, much greater than the supply, even after we do all the checking of recipients and you cut through all the

red tape to get to being on the list. So there's an opportunity, you get the right people and for academic medical centers, heart transplantation hits all the things that we do really, really well. We do multidisciplinary care really well. We do complex patient care really, really well. We've got really great... I mean, it's not perfect, it's like a family, like anything else. Sometimes it's kind of ugly to watch, but the collective efforts between being in the operating room, the ICU, we get it right in academic medical centers, and so that's all the substrate.

I think once we started exploiting the donors that are out there and having a different threshold for it, and where a program like ours did 30 heart transplants a year, became 50, 60, and then 90, 100, I mean it just sort of built on itself. Then our first challenge became, okay wait a minute, do we have the right people? Do we have the right infrastructure? It is the relentless march to getting to this truth, that that's where things are going. So although it seems niche and just, "oh, it's only useful..." I see it as wow, there's a quarter of a million, probably more people that arrest outside the hospital a year in the United States, with 8%, 5% surviving, all that. So the teams in Minneapolis have constructed this concept of mobile ECMO. We have an ECMO team that can go to other hospitals, fly out, initiate extracorporeal circulation and bring them back, rather than the old concepts of, if you can make it to Vanderbilt, you're lucky, great. We'll get you on and you're going to save your life.

**Clark Buckner:** The path to transplantation and recovery is as much of an emotional rollercoaster as a test of physical and medicinal endurance. The psychological toll impacts a patient as well as their family and friends. It's fraught with emotion, burdens, fatigue, and often misalignment between reality and expectation. Dr. Lesley Omary is an assistant professor of clinical psychiatry and behavioral sciences. She works with patients undergoing this life changing procedure.

**Dr. Lesley Omary:** Transplant psychiatry is a new and growing field. Here at Vanderbilt, I would say we're ahead of the curve and I will tell you a little history about us here at Vanderbilt. 30 some years ago when the transplant center first got started, Dr. Wright Pinson was a huge proponent of psychological and psychiatric concerns. And so he brought in a psychiatric nurse practitioner, Karen Starr, some 30 years ago, who really pioneered this particular role here at Vanderbilt. She was the only person doing transplant psychiatry for almost 30 years, and then as things were growing, of course they needed more help so I was brought on to join her about eight years ago.

Well, we see them all during their pre-transplant evaluation and that is usually a multi-day event where patients are seen by a bunch of different people, surgeons, medical providers, nutritionist, social work, psychiatry, financial coordinator, the nurse coordinator, I'm sure I'm forgetting somebody. Then they have a lot of other testing such as blood work and imaging studies, cardiac testing, pulmonary function tests, it goes on and on. We're a part of that multidisciplinary evaluation, and so that's when we're identifying whatever issues they might have psychiatrically or psychosocially.

Some patients we start working with them right then and there, sometimes people are doing fine going into transplant, which has been a big surprise to me, that some people actually are coping fine. They



don't actually have significant problems with depression or anxiety, they're doing okay. Then we might see them after transplant and so after transplant, some people will have side effects from the immunosuppressant medicines and the steroids that you have to take to prevent rejection of your new organ. Those might include things like insomnia, anxiety, irritability, sometimes depression, or sometimes people aren't recovering as quickly as they would hope and we'd all hope, so then they start getting down and maybe depressed.

So sometimes we'll see them after transplant to help them with all those sorts of situations, to help manage those situations with medications or sometimes with supportive therapy or whatever it is they need. I would say a lot of our work post transplant is exactly that, helping patients to come back into their pre-illness life, if that makes sense? Most folks are doing pretty well for a while and then at some point they get say, for example, cirrhosis or heart failure, and then they're not doing well for a while. Then at some point they're doing poorly enough that they need a transplant, and then they probably have a pretty low quality of life at that time. So at some point an actual transplant, their quality of life is often quite low, so they've had to adjust to that.

We'll add that their families and friends have had to adjust to that too, because now the patient, for example, is no longer able to work, somebody else maybe has to get a second job. Or for example, the patient's no longer able to mow the lawn or do the cooking, or the shopping, or help with the children, or whatever the issues might be, so other people around them have had to pick up the slack, so to speak, and help the patient with their illness, but also help manage the household. Then post transplant, we see all sorts of interesting dynamics and changes in the dynamic because maybe for several years, there's been this one way and now the patient's feeling better and able to get back to some of those activities.

There's this balance between what can the patient now do? How can they improve their quality of life? How can they contribute to the family, whether it's going back to work or whether it's helping with the chores or whatever it might be? We do see actually some interesting conflict sometimes in how this gets managed in people's families. We try to help people navigate that because sometimes a patient, yeah, they've had their transplant and they're doing well, but they're not a hundred percent back to normal, right? They still may need some assistance at home, but the family member is exhausted. Caregivers are exhausted and they're like, "I can't do any more. You've had your transplant, it's time for you to get back to helping out," but maybe they're not there yet in their recovery. There's a lot of back and forth, there's a lot of negotiating and we do help with that sort of issue.

I think it's important to note that a transplant, people think of it as being a surgery, but there's all this other stuff that goes on that contributes to the success of not just the transplant itself, but getting a patient back to a good quality of life so that the whole thing will have been worth it. That's all these folks that are on these multidisciplinary teams, that get a lot of recognition. The social workers, the financial coordinators, the nurse practitioners, the nutritionists, all these people who really play vital

roles in the success of the surgery itself, and then also the success of the patient living a longer, better life.

**Clark Buckner:** Transplant surgeons along with biomedical engineering colleagues and many others, are constantly flexing the boundaries of what's possible. Dr. Shah likes to wax philosophic about the heart and how the wondrous capabilities of science intersect with this fragile thing called life. It's not lost on Dr. Shah and his contemporaries that, for a time, their patients embody the Canadian rock band, the Sheepdogs's jam, "I've got a hole where my heart should be." Dr. Shah is quick to tell you that, although the heart has been long thought of as a seat to our soul, the mechanism by which we love are inseparable to who we are as people, it's not. It's not mystical. It's not the core of what makes us us, it's the engine, complete with valves, that keeps us alive. And questions about how to fix broken hearts range from replacing or repairing parts, to putting in a whole new proverbial engine.

**Dr. Ashish Shah:** I am really focused on how do you resuscitate these hearts and recondition them? How do you get a heart that's dysfunctional and make it better? What are the therapeutics out there? What are the maneuvers that control the perfusion? How do I operationalize what I know from a basic science standpoint works, how do we do that clinically? Whether it's people who have a cardiac arrest in the street, whether it's coaxing that heart transplant I did last night to work, to the everyday heart operations that we do. I think about that a lot. And I think about that a lot, because I think that there are lessons and secrets that's going to help us in the future. That ultimately will obviate the need for transplantation.

When I was first starting out, I'd say it's me against death, like I'm going to prevent my patient from dying. Then as you get older, you realize that you don't really have control all the time. You do what you can, you do the best you can. You solve the problems that you can. There's a biologic law that you're never going to overcome. At any rate, it's a long way of saying that it all swirls together and depends on what you're working on and what drives you, really is E, all the above. You want all that because you want a sense of purpose and autonomy and respect, and I get that in ways that I sometimes don't think I deserve.

I'll just leave you with this, that the ultimate driver is that desperation on the part of these patients. They feel that bad. They need that much hope, that they're willing to let you try in ways that are like those astronauts. Like sure, I'm going to the moon. I don't know what's behind that panel, but let's do this thing.

**Clark Buckner:** That's a wrap for season two of Vanderbilt Health DNA: Discoveries in Action. We have loved taking you on this adventure. It's been a powerful and energetic look at how science is working to prevent future pandemics, the inextricable ties of healthcare to climate change. We've looked at why we need to get loud about what we're flushing from the toilet bowl, and explored why now is the time to make sure research is intentionally inclusive with everything from pronouns to clinical trials, to

thinking about where people get care. The journey will continue in other ways and we look forward to continuing this path with you to new Discoveries in Action.

In the meantime, you can learn more about the show, check out episode extras at [listendna.com](http://listendna.com). You can also find us on Twitter @VUMC\_Insights and on all of your favorite platforms at Vanderbilt Health. Of course don't forget to follow, rate and review the show anywhere and everywhere you get your podcasts, like Apple Podcasts, Google, and Spotify, we're there. Until next time, Vanderbilt Health, making healthcare personal.

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