

Science AMA Series: I'm Dr. Adam Greenbaum, co-director of the Center for Structural Heart Disease at Henry Ford Hospital in Detroit. I'm here today with Dr. Robert Lederman, an interventional cardiolo

Dr_{AdamGreenbaum}¹and_r/ScienceAMAs¹

¹Affiliation not available

April 17, 2023

Abstract

Edit: We are live! Please continue to submit your questions. Hi Reddit, Our team of cardiologists at Henry Ford Hospital specializes in working with the sickest of the sick, offering pioneering options to patients with hard-to-treat advanced heart disease. One of our focuses has been on finding new, novel ways to access the heart. The Henry Ford team was the first to successfully perform transcatheter aortic valve replacement (TAVR) using a novel way to access the heart, called a transcaval access route. This is done through moving a catheter through a vein up into the body, then bridging in the patient's abdomen into the aorta. I have had the pleasure of teaching this procedure to colleagues around the world, and the procedure has now been done in more than 125 patients at 18 centers throughout the world (16 in the U.S.). The Center for Structural Heart Disease cardiologists developed this procedure working closely with doctors at the National Heart, Lung and Blood Institute. We're now sharing this technique with others in an effort to save lives. The transcaval procedure is particularly effective in patients whose arteries are too small for traditional transcatheter routes to the heart, where scarring from previous procedures makes access difficult, or where multiple procedures require elaborate access. It has been very gratifying to say to our advanced heart disease patients and their families, "We have another option," when they've been told no option exists. EDIT: Thank you for tuning in! I'd be happy to speak with your doctor if you think this procedure might be a benefit to you or a loved one. For more information on our heart program: www.henryford.com/heart. Proof: https://twitter.com/HenryFordNews/status/657236352333946880?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Etweet Read more about transcaval heart procedure, here: <http://www.henryford.com/body>, <https://www.henryford.com/body.cfm?id=60737> <http://www.henryford.com/body.cfm?id=46335&action=detail&ref=2068> I also helped perform the first successful transcaval heart procedure in Europe. <http://www.henryford.com/body.cfm?id=46335&action=detail&ref=2166>

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DR_ADAM_GREENBAUM [R/SCIENCE](#)

ABSTRACT

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Hi Reddit,

Our team of cardiologists at Henry Ford Hospital specializes in working with the sickest of the sick, offering pioneering options to patients with hard-to-treat advanced heart disease.

One of our focuses has been on finding new, novel ways to access the heart. The Henry Ford team was the first to successfully perform transcatheter aortic valve replacement (TAVR) using a novel way to access the heart, called a transcaval access route. This is done through moving a catheter through a vein up into the body, then bridging in the patient's abdomen into the aorta. I have had the pleasure of teaching this procedure to colleagues around the world, and the procedure has now been done in more than 125 patients at 18 centers throughout the world (16 in the U.S.). The Center for Structural Heart Disease cardiologists developed this procedure working closely with doctors at the National Heart, Lung and Blood Institute. We're now sharing this technique with others in an effort to save lives.

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EDIT: Thank you for tuning in! I'd be happy to speak with your doctor if you think this procedure might be a benefit to you or a loved one. For more information on our heart program: www.henryford.com/heart.

Proof: [https://twitter.com/HenryFordNews/status/657236352333946880?](https://twitter.com/HenryFordNews/status/657236352333946880?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Etweet)

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Read more about transcaval heart procedure, here:

<http://www.henryford.com/body.cfm?id=46335&action=detail&ref=1943>

<https://www.henryford.com/body.cfm?id=60737>

<http://www.henryford.com/body.cfm?id=46335&action=detail&ref=2068>

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I am a radiology resident and our hospital does a fairly large volume of TAVR procedures, but I haven't heard of this.

CORRESPONDENCE:

I have several questions:

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- 1) In pre-operative imaging, in terms of the transcaval approach, what would you like your radiologist to look out for? I presume you would like to know of any aberrant vessels or unexpected masses, but is there anything else in particular that you wish, at some point, a radiologist might have looked out for and saved you from potential trouble?
- 2) At what level do you create the cavo-aortic fistula? Is there a predefined region or do you base it on the most feasible distal site? Also when you are making this pass, do you use any CT guidance, or is it a purely fluoroscopic procedure?
- 3) What size sheaths have you deployed through the transcaval approach? I imagine making a 24F fistula would be much less desirable than an 18F one, but different patients will need different sized valves and the delivery devices will need to accommodate.
- 4) How do you close your cavo-aortic fistula? Also do you have a cardiothoracic/vascular surgeon team on standby in the event that the fistula does not close? I imagine this would be a major point of discussion during the consent process with the patients.

Thank you in advance for your time Drs Greenbaum and Lederman!

[Ajenthavoc](#)

Hi!

First, we look for a part of the aorta that is relatively disease free, meaning there is less calcium deposits below the kidney arteries where there are no vessels or structures between the IVC and aorta.

Secondly, we usually tailor the target based on the individual patient needs based on prior CT scans. Usually, midway between the kidney arteries and where the aorta bifurcates to supply both legs.

Third, we think you're right - smaller tubes tend to be more desirable and appear to cause less bleeding. We have used anywhere between 14F - 24F size (tubes with an outer diameter of 6-9 millimeters) catheters; all with success.

Fourth, we close the fistula with commercially available self-expanding nitinol occluders, designed to close holes in the heart.

For more information: [see here](#).

Hi, I am a 20 year old male with aortic stenosis. It's a bi-cuspid and I've had it since birth. I had open heart surgery at 6 months old and had a valvuloplasty procedure done when I was twelve. Both of these surgeries were done in order to stretch and widen the valve, however the day will soon come when I will need a new aortic valve. My question to you is, considering the advancements of medical science, do you think I could have my aortic valve replaced without having to open up my chest? Also how common is it to have an aortic valve grown from the patient's own tissue? Is this something I can expect to have offered to me when the time comes? Thanks.

[DagothUr28](#)

First, great job on keeping up with minimally invasive treatments for your problem. There have been some patients with problems like yours who have been treated with currently available valves, but we can expect within the next 5 - 10 years valves will be developed to address your specific problem of leaky aortic valves and bicuspid aortic valves.

There have been exciting medical reports from other medical centers about growing valves, just as you mentioned. Although, to our knowledge, few of these are ready for testing in human patients.

It sounds like you are treating people 'so far gone' that drastic action is needed, but do you still advise people to change their diets as well? As far as I am aware it is pretty much undisputed that a good diet, low in animal products can slow and even reverse heart disease/plaque etc, but do you actively recommend this to your patients?

[puntloos](#)

We certainly recommend a healthy diet to everyone, but it's uncertain if a healthy diet truly prevents the development of calcific aortic stenosis, which affects a significant proportion of the elderly population. Our typical advice is "high quality foods = not too much, mostly plants."

I know sometimes the septum fails to close completely during development. How big of a hole can someone have without substantially affecting their performance, and how big of a hole can someone have and still survive to adulthood? (I understand "substantially affecting their performance" is vague, please interpret it however is convenient)

[TheBlackCat13](#)

It really depends on where the hole is located. In general, the larger the hole, the earlier it should be repaired.

Good morning, Doc! How do you see this procedure shaping the future of accessing the heart for fast, safe, easy ways to fix problems? If that's too complex of a question, here's a "fun" one. Any stories you can share from your experiences from traveling the world?

[imaginativedragons90](#)

Good afternoon! We feel that any time the procedure can be performed less invasively there's the potential for quicker recovery. It's been extremely gratifying traveling and teaching the procedure to others and helping patients who were felt to have no options. One of my favorite experiences (although locally) was the [very first procedure we performed](#).

The first patient to undergo the procedure was quite sick with no other options. After explaining that I thought I had a solution to his/her problem but that it had only been tested in animals and yet to ever be done in a human and after explaining all of the potential benefits and risks, he/she consented to be the first patient in the world. He/she also felt that if by doing this, he/she could help other individuals in the future it was worth the risk. The first patient was extremely brave and his/her wish came true in that now > 150 patients throughout the world have been helped by her courage.

I also really enjoyed the [first procedure in Germany](#).

Was there consideration for a direct abdominal approach to descending aorta? My facility has a hybrid cath lab / OR we use for a few procedures (specifically a hybrid Norwood procedure) which allows a combination of fluoroscopy and open OR on the same table.

Would a laproscopic approach have a higher bleeding risk than the procedure described? How about an open abdominal approach?

The procedure seems like it would have a high bleeding risk so I am really asking why transcaval instead of a more traditional approach outside of standard vascular access techniques.

[RussNP](#)

There has been at least one case report of direct abdominal approach to the descending aorta to enable TAVR. From our perspective this approach is unattractive, because the patient undergoes major abdominal surgery, with all the risks and complications.

One of the reasons the transcaval approach seems to work is that there is NO surgical or laparoscopic opening into the body. The retroperitoneal space that surrounds the aorta and cava becomes "protective" as long as no surgeon pokes a hole in it. Without surgery, bleeding in the aorta drains immediately into the vein. If there were surgery enter the aorta through the retroperitoneal space, this bleeding would be catastrophic.

You are right that the procedure would "seem like it would have a high bleeding risk." It seems to work fairly well, and fewer and fewer patients have important bleeding complications.

To our knowledge the transcaval approach has not yet been applied in children.

How did you come up with the procedure? What is the process that takes it from a thought to a patient who needs it?

[svsilver](#)

I (Dr. Lederman) noticed something downright obvious about a common complication of heart catheterization. It is a little long-winded, so bear with me. Sometimes the hole in the femoral (leg) artery does not close immediately after the tubes are removed. As a result there is bleeding around the artery. This bleeding can be very severe and even life-threatening, because blood can track between tissues but inside the body. A lot of blood can be lost unless doctors recognize it and stop the internal bleeding. This is all obvious and well known. Now sometimes by coincidence, doctors poke holes in neighboring arteries and veins, whether intentionally or not. What is interesting is that sometimes the bleeding causes a connection between the artery and vein called an "arteriovenous fistula" or "AV fistula." So instead of continued internal bleeding that spreads inside the body, blood that escapes the artery immediately returns into the veins and continues to circulate through the body. This is all well-known. I also had read about a related problem in patients suffering from abdominal aortic aneurysm. Albert Einstein, among others, died when the balloon-like aneurysm in his abdominal aorta grew and grew and suddenly burst. He probably died because blood left the circulation and accumulated in the space surrounding the aorta. Rarely, patients with ruptured abdominal aorta are lucky enough that the bleeding finds its way into the inferior vena cava, in what is called an "aorto-caval fistula," which is just another form of AV fistula. These patients can be sick but are not dying within minutes. That difference was tantalizing to me.

I suspected that what was happening in these patients was that bleeding caused an increase in pressure in the space surrounding the aorta and vein. As a result, blood leaving the "spigot" of the hole in the aorta would be forced to reach the lowest-pressure "sump" created by the hole in the vein, rather than pooling elsewhere in the body. And that this was similar to the less frightening "AV fistula" that sometimes complicates heart catheterization. I realized these phenomena might be put to good use. So I asked a visiting cardiologist in my lab, Majdi Halabi from Haifa Israel, to test it in animals. In short order we worked out a simple technique to cross from the giant vein in the abdomen, the inferior vena cava, into the giant artery in the abdomen, the aorta in pigs. Just as we had hoped, we were able to cross easily from one to the other using X-ray fluoroscopy and standard catheter tools. More interesting, we were able to remove even a large tube crossing between the two, and the animals had no important bleeding or change in blood pressure. In fact the pigs had no symptoms or problems at all, and could be sent "back to work" eating walking immediately. We thought this might be a helpful alternative in patients who need transcatheter aortic valve implantation.

So rather than immediately bleeding to death, the animals tolerated the procedure very well. Blood that

escaped from a hole we created in the aorta would immediately return to the vein as long as we created a hole in that too. This was a non-obvious inference we made from well-known clinical observations. Our approach completely challenged assumptions surgeons have made for decades. Every surgeon knows that when they open up a patient because of bleeding such as ruptured aortic aneurysm or gunshot wound to the inferior vena cava, it is literally bloody disaster that many patients do not survive. So almost every physician I shared our findings with thought our approach was wrong-headed and ridiculous, because it would cause almost instant death. But the key difference was that surgical wisdom came from observations in patients who were OPENED UP by surgery. Our thought was that the space surrounding the aorta and cava was confined enough that a little bleeding would make the local pressure rise. And that local pressure rise would be enough to channel blood that leaked out from the aorta to return to circulation in the vena cava. This would only work as long as a surgeon (or gunshot) did not open up the space surrounding the aorta and vena cava. We showed this work at some medical conferences, and published a paper describing it in a good medical journal, Journal of the American College of Cardiology in 2013. But there wasn't too much interest. Until Adam Greenbaum called.

Oh. Just about the procedure? I wanted to ask you what your thoughts are on Vaping and it's effects on cardiovascular health. Would you be willing to elaborate on Vaping otherwise known as electronic cigarettes and it's effect on cardiovascular health?

[economicalspence](#)

We strongly advise against vaping and the use of all nicotine and tobacco products. Our blog, Henry Ford Live, recently wrote [an article](#)

During these procedures (like TAVR) how often are you unable to place the valve and need back up CT surgery? Follow-up question: Given that interventional Cardiology is taking an ever increasing number of procedures from the CT surgeons. Will they be able to stay competent to perform very difficult invasive heart procedures?

[liberty4u2](#)

Fortunately no patient has needed emergency surgery rescue due to transcaval access. Currently, catheter based valve replacement is performed by a team of docs with different backgrounds including cardiologists, cardiac surgeons and others who work together. I would not be concerned that cardiac surgeons will not remain competent, and we enjoy working with them every day on these procedures.

What is the biggest misconception about heart disease that people should be aware of? And what made you decide to specialize in cardiovascular vs other fields when you were in med school?

[mav194](#)

The biggest misconception is that you can't prevent it or minimize your chance of getting it. Eating well, exercising, staying away from tobacco products, monitoring blood pressure and preventing diabetes is crucial. Did we mention not smoking is important?

Great question. Dr. Robert Lederman watched a cardiologist instantly save the life of a patient who was dying before his eyes. I (Dr. Greenbaum), quickly became attracted to cardiology once I learned about all of the ways we can easily help save patients' lives and improve their quality of life.

Hi and thanks for taking the time for an AMA. I am a field service engineer and work on angiography imaging equipment. I have a couple questions. How important is a low dose procedure versus image quality? Do you use 3D imaging obtained by the angiography equipment and if so does it help with the angle position of the new valve with this type of procedure?

[Yardgator](#)

We feel that the lower the dose of xray fluoroscopy, the better. Medical imaging (like life) is full of compromises. In order to minimize the radiation exposure of angiography, we will reduce image quality as much as we can tolerate. Combining angiography with 3D imaging, we may be able to make these procedures safer or faster, or even better. We routinely combine info from a prior CT with our angiography procedures but we haven't yet used 3D angiography (Cone Beam CT) for these procedures.

Hello,

Will there eventually be an equally successful procedure for the mitral valve? If so, are there the ramifications for CT surgeons?

[Charladam](#)

The mitral valve is a little more complicated than the aortic valve with respect to transcatheter approaches. However, there are equivalent procedures being tested and I'm confident that in the future there will be a similar solution. As surgeons remain intimately involved in these procedures, I don't see any major ramifications for them.

Since this process is designed for small arteries, has there been any interest in using it on babies or the very young to treat various congenital issues?

[fullofbones](#)

As transcatheter heart valves evolve and become smaller, the need for this access method may decrease. However, there will always be patients without other access options who could benefit from the procedure. And, there are other procedures where the size of the delivery catheter is still very large such as endovascular procedures for thoracic aneurysms where this access method has and can be used. Transcaval access to the aorta has now also been used for placement of temporary heart pumps during high risk coronary interventions where, again, other access options were not available, could have a role during interventions for children where, certainly, arterial vessel size is a limitation and may have a role in yet to be developed procedures that might require large catheter access to the arterial system. Who knows...

I am curious about how another hospital would go about doing training to adopt a new procedure like this one into their repertoire?

When would you expect this procedure to be prominent at least nationally?

Thank you.

[Kalivice](#)

The procedure has now been performed in greater than 150 patients at greater than 20 centers throughout the world all taught by either me or Dr. Lederman. While it is safe and teachable, it should

not be attempted without training and proctoring. This is a subject of an ongoing FDA regulated clinical trial. Our expectation that after completion of the trial, it will become more widespread; assuming it continues to work as well as it has thus far.

Hi Dr. Greenbaum, I'm not really in the medical field but I'm interested in your procedure and I was wondering why people don't bleed to death internally if you poke through the vein into the artery. And how are you able to go "upstream" in a vein vs "downstream" in an artery?

[tankmelon](#)

Hi there, we think it works because we take advantage of a great opportunity, a great coincidence created by normal anatomy and physiology.

In the abdomen, the two largest blood vessels are the giant vein called the inferior vena cava and the giant artery called the aorta. These two blood vessels course through a compartment in the torso called the "retroperitoneal space." Picture this as two pipes that pass through a relatively empty balloon. Blood pressure in the aorta is high in order to pump blood through the body. Blood pressure in the inferior vena cava is low to allow blood to return to the heart. This is simple plumbing. The pressure of the retroperitoneal space, the "balloon" surrounding the vena cava and aorta, is approximately the same as pressure in the veins.

So what happens if we poke holes in the two pipes passing through the empty balloon, one pipe having blood under high pressure and the other under lower pressure? Does the balloon fill with blood? Well, yes, just a little, until the pressure in the balloon rises above pressure in the vein. And then blood leaving the high pressure aortic pipe just returns to the lower pressure venous pipe. And in this scenario, the retroperitoneal space is modeled by the balloon. What we think happens is that after a little bit of bleeding, blood stops accumulating in the retroperitoneal space and returns to the vein.

And we have some more evidence that this is the case. First, we have actually measured the pressure inside the retroperitoneal space while we are closing the hole in patients. The retroperitoneal pressure is higher than the vein but lower than the aorta, just as we would predict

Second, there have been cases when, by accident, we partially pulled back the tube otherwise making a leak-free connection between vein and artery in patients. When we accidentally unblocked the hole in the aorta but kept the tube blocking the hole in the vein, there was bleeding and a drop in blood pressure. But when we pulled the tube back further, to unblock the hole in the vein, the bleeding stopped and the blood pressure returned to normal.

So we learned that you can have a big hole poked in the aorta, and the patient usually tolerates it well, as long as there is simultaneously a big hole poked in the vena cava to allow blood to return. After the main event of the treatment, which is transcatheter aortic valve replacement. We have to close the big hole we created. And we close the hole using a device to plug it. There are a family of devices made of a wonderful material called nitinol. The mesh devices can be compressed like springs to fit through a tiny tube. But when they are released, they self-expand into very large mesh discs that are used to close holes in the heart of patients with congenital heart disease. In transcaval access, we implant these leaky nitinol mesh devices to close the hole we create. And even though the devices leave a residual leak in most patients, the leak is tolerated very well. As far as we can tell, most of these leaks close up over days or weeks.

Greetings! I am studying BioMedical Engineering at the moment, and in one of my lectures we had a guest speaker who talked to us about the future of heart transplants. Where are we today, or how soon might it be until a fully successful heart transplant becomes reality?

[SixFeetDeepPete](#)

Totally artificial heart transplants are now a reality. While they're not common, they are being performed in patients for the first time ever. It will be interesting to see how this progresses with time.

Dr. Adam Greenbaum,

Feel free to answer only your favorite questions. :)

- Were you aware your name means green tree? If so, has this had any impact on your life?
- What **would** you attribute to your success?
- Why have only 18 centers throughout the world been able to utilize your methods?
- If 16 centers in the US have used this procedure and at least 1 in Germany, where is the other center?
- Would you say that US is ahead of other nations in the development of innovative healthcare practices and procedures (like your own)? Why or why not?
- My father survived an aortic dissection. How scared should I be of living my life? Scuba diving, rock climbing, having babies, living in foreign countries where 0/18 of your fancy heart disease centers are located, etc...
- Lastly, I teach high school math. If you had one sentence of advice for my students, what would it be?

[DeltaSigma91](#)

Hello! Oddly enough, I am aware of what my name means. Sadly, it's not impacted my life. I recently learned that average person only has 28,470 days to live. Crazy, huh? Make each one count. I guess that's what I would tell your math students.

As for your questions about the number of centers... initially, most if not all doctors thought the idea was crazy and unsafe. Now that it has been safely performed in >150 patients in > 20 centers throughout the world, many have changed their opinion. However, there are still some physicians who think it is too scary.

What are ways to keep our hearts healthy at a young age to avoid future risks of heart disease?

[Mlogan26](#)

Don't smoke :)

Hello Dr. Greenbaum, I was wondering what type of health conditions you look for when choosing a treatment for a given patient? When would you use this procedure instead of more traditional approaches? Is it always superior or is it only preferred in certain cases?

[scott_swarthout](#)

Hi Scott, this procedure was initially intended for those who have no other options, but we are learning that the least invasive way of performing this procedure may be better in the future. I could see this access method being used even in those with other more conventional options.

How did your first patient feel about being the first?

[3dogdoc](#)

I have to say - it was one of the strangest consent I ever had to obtain. How do you ask someone to perform a procedure that's never been done before...ever?!

I shared with her that I might be able to offer her an option for a life-saving procedure that had never been done here, or anywhere for that matter. I explained to her that it had been done in pigs before, but never in humans, but that the researcher was a personal friend of mine, and he would come out and do the procedure with me and that I knew that he leaves no stone unturned. I believe her husband's words were, "Are you going to learn something from this procedure?" I responded that regardless of the outcome, we would learn whether or not this technique could help save many people. From there, they decided to go for it.

How did your first patient feel about being the first?

[3dogdoc](#)

I can tell you how I felt too..

With both excitement and trepidation, Dr. Lederman and I performed the procedure. We mentally and physically prepared for every possibility of which we could think but also knew something could occur that we could not have anticipated as this procedure had never been done anywhere in the world. We had vascular and cardiac surgical colleagues, Doctors Loay Kabbani, M.D. and Gaetano Paone, M.D. perform the procedure, both of whom, despite their skepticism, stood by willing to help. Dr. Paone continues to support the technique and has lectured about it to other surgical colleagues to help to ease their skepticism.

How did you think of it?

[anotherheartdoctor](#)

Dr. William O'Neill from Henry Ford Hospital came across an article printed in a medical journal authored by Dr. Lederman at the NIH in Bethesda, MD introducing the concept and explaining the animal data surrounding the procedure. I contacted Dr. Lederman inquiring as to more details about the method believing that one day, it might be needed and beneficial. Interestingly, less than 1 month later, a patient arrived on my ICU service quite ill with no other options. The rest is history.

Can the procedure be used for anything else?

[ShayEmSol](#)

There's been a few doctors who have used this technique to repair an aneurism in the chest using a technique called TEVAR. We've also used it to implant a large temporary heart pump (Impella) for patients who didn't have good access options.

Hello. My name is Dr. Greenbaum.

[JordashOran](#)

Well that's weird... Small world. Maybe we're related.