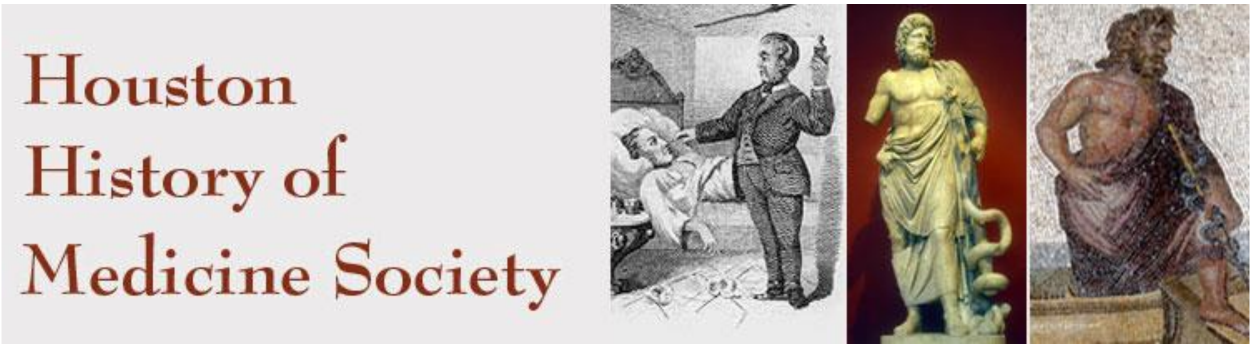

Heart Transplantation and the Artificial Heart at the TMC

Date: May 4, 2016

Speaker: Bud Frazier, MD

Abstract: Dr. Frazier is a pioneer in the treatment of severe heart failure and in the fields of heart transplantation and artificial devices and works with Texas Heart Institute

Mimi Swartz

0:00:20.0 I thought we might start by just telling people why there's a need for an artificial heart, if there is, if you think there is.

Bud Frazier

I'll see if I can talk again. Well, there are about 5,000 young adults dying for sure every year from total heart failure under the age of twenty. One of the myths, of course, is a heart transplant. I've done more heart transplants than anybody in the world. Why? Because nobody else would do them. Over at St. Luke's, they were all guys in private practice and they didn't want to fool with it. But we started in '82. And heart failure, I guess—I went over this—is still the leading cause of premature death in America. The transplants, this is about all the donors we're ever going to get. And the problem with heart transplants is they don't last. If you transplant a twenty-year-old, you pretty much condemned them to a premature death. When we started doing children at Texas Children's—I did I think forty-eight under the age of fourteen between '82 and '92. There's only one alive. In fact, it got so depressing for the pediatric cardiologists, they quit doing it for about five years.

0:02:11.6 Nonetheless, for certain individual patients, it can be very meaningful and lifesaving. So I don't want to denigrate it, but it's just we have to do better. This is, of course, my experience at St. Luke's, and I actually started in 1982. Nobody wanted to start because Dr. Cooley had done more heart transplants than anybody in the world in the early—in the late sixties, early seventies. Chris Barnard did the first one in South Africa. But Dr. Cooley did twenty-one, I think, or twenty-two. He didn't want to fool with them. The cardiologists didn't want to fool with them. It was serendipity, which all medicine is based on that I—since I trained with Dr. DeBakey, and I went over with Dr. Cooley, he wouldn't speak to me for ten years. So I couldn't go back to Baylor, so I had an appointment at UT. And there was a guy here named Barry Kahan, who was very important getting cyclosporine introduced because that was what made the whole field grow. It's a much better drug than the drugs we had before, and it also allowed us to transplant contaminated patients like patients with total artificial hearts.

But actually we started in '82. Dr. Cooley came in on July the fourth, 1982, showed me how to do one, but that was it. And he was a good Irishman. He'd been at a party, got a little tipsy, but still. It was the old joke, somebody used to say. Who's the best surgeon in Houston? Well, the best surgeon used to be Dr. Cooley when he was sober. And of course, well, they said we don't want to deal with anybody like that. Who's the next best surgeon in Houston. They said Dr. Cooley when he's drunk. I mean, he wasn't drunk, but he did come in. He didn't like to do it. And he started sewing the heart in, and he was sewing the right atrium to the left atrium. And I said, "Dr. Cooley, that's—I don't think that's going to work." And he looked at and he cut it all out and he said, "See how easy it is to make that mistake, Bud. I just wanted to show you how easy it was to make that mistake."

Anyway, so by 1987, we did more heart transplants than any place in the country, or the world actually, at St. Luke's. And since then, of course, other people have gotten in the act. But it will never meat the demands. So the artificial heart has to—mechanical hearts have always been a very important pursuit. But, as I said, this is in 1987. The only two people in here with heart transplants were myself and Dr. Cooley. It was the youngest heart transplant in the world, and this is the oldest in the world, that I'd done prior to '87. So it can be very rewarding, of course, but none of those people are alive now.

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So that's briefly why we need heart transplants. So you'll feel a little of this anyway. But we need heart transplants if we're going to be able to immediately impact premature death from heart failure. We need mechanical devices, something we can pull off the shelf anyway.

Mimi Swartz

0:06:37.3 Do you want to tell the story of when you were working with DeBakey and the kid you tried to save with your hands? Would you say that led to thinking about the mechanical heart?

Bud Frazier

No. I didn't—I actually wasn't too interested in medicine at all. And this is something else I hate to go into. It is—creativity is impossible looking backward. I had dinner with this Irish singer one time. And we spent the whole evening talking about that. And he said he was successful. I didn't know him. My daughter did, but he explained to me who he was on the way to this dinner. But he was very interested in heart surgery, so he pointed out that he'd never had any music lessons. And so he wrote all his own music, and he and his group did. And he thought that allowed him to be creative. And you hear a lot of this—and this is one of my pet peeves—if you're doing something that hasn't been done before, there's no evidence for it. So how are you going to have your evidence for something that there's no evidence. Anyway, you don't need to go through that.

But I got involved—this is interesting. This is the medical center. This is where we are right now. And this is 1941—I'm sorry—1949. Dr. DeBakey came here in '49, the year that Baylor was built and Hermann. And that was it. And he heard gun shots, and they were hunting out here, all this woods you know. It's really changed a bit. And here's Dr. DeBakey who was a very moving force in this field. And he looks a little like Groucho Marx, but believe me, he was not funny. And this is the Baylor that I went to, but Texas Medical Center—the medical students parked right here, and we just walked over here to Baylor. And of course, this is where we are now in this little—

All I did was play football growing up in Texas, you know. And I was interested in girls and football. And I got hurt when I was in spring training of '60 playing for Darrell Royal. And that ended my football career. So I decided to go to medical school really on a whim because I'd never taken a pre-med course. I was graduating, and I had to do something. My mother told that you could do anything I wanted as long as I didn't have to cheat, lie, or steal. But that sort of limits it, it turns out. And as a twenty-one-year-old, I couldn't think of anything. I thought of being a history teacher. I didn't want to be a teacher. That's what my parents were, and they were always grading papers. I didn't want to be a dentist. I thought about being a dentist, being in someone's mouth all my life. And Methodist minister, my uncle was a Methodist minister, but he was as mean as a snake, and I didn't want to deal with him.

And then I thought about physician. Well, I'd read a lot of Chekhov because I was a history major, history/English major and the doctor's stories. You should always—there's wonderful stories that Chekhov, who was a doctor, wrote. And that's what convinced me to go into medicine. I'd never taken a pre-med course. At UT, you could take them all in one year. And I took them all in one year and interviewed for medical school. I had a girl friend in Houston, so I wanted to go to Baylor. It had nothing to do with anything else. And in those days, there were no computers, so they asked you. You'd come to the interview, and they'd tell you in a couple, three days, whether you were going to be accepted or not. At that time, Baylor was one of the best medical schools in the South. There were more students from—there were only nineteen in my class that were from the state of Texas. The rest were from all over the country. They took seventy-five.

0:11:12.8 But I was interviewed on the weekend of July the fourth and Hebbel Hoff, it turned out, that was the chief of admissions committee then, a very prominent physiologist. I didn't know who the hell he was. And he asked me, "You know, since you're a history major, what other event happened on July 4 other than signing the declaration?" since we were celebrating the fourth. I said, "Well, Adams and Jefferson both died on July 4, 1826, fifty years after the signing of the declaration." I think that's what he wanted. But I also pointed out that the Battle of Gettysburg really was the last, which really spelled the end for the Confederacy, was on July 4 of 1863. Pickett's Charge was July 3. Lee didn't start retreating until July 4. And Vicksburg was surrendered by Pemberton on July 4, 1863 for the same reason, so he could get better conditions from Grant. And that's what really ended the Civil War. I always remember. Then there were grueling interviews. They usually asked you a lot of questions. He looked at my application for a while, then he slammed it to, and he said, "If you want to come here, you can. Let's go out and enjoy the fourth." So that's something a history major may help you with. I don't think he Pemberton or the Gettysburg.

At that time, DeBakey was everywhere. And he had his own press agent, his sisters. He got in all the media, and he really was never a very good heart surgeon. I hate to say this. If he was over at Methodist—I mean, he was better at it certainly than 90 percent of people in the country, but the people at Methodist said Cooley was the best one that ever lived. He was like Lindbergh. He did things nobody could do. But Dr. DeBakey got in with the media. He was very well known all over the world.

Here he is. This is in Life magazine. These are the first artificial hearts that they were working on. They were hand-made, hand-made, over in Baylor in the old lab. And you can imagine trying to get this today. This poor calf all wired up. But this is—the one thing Dr. DeBakey really did do is he got money for it. And that's what really started the field because the NIH had never funded a clinical program prior to the artificial heart program that Dr. DeBakey got. They studied the motion of mass cells and things like that, but they didn't study, they didn't fund, anything but basic science. But this was the first clinical effort that they made. And this is—oh no.

Male Speaker

"My main dilemma as far as my research work is concerned, is to perfect the artificial heart." So this was a real stimulus, but today, we have this anger management. I know somebody got fired over in our lab because he—he didn't really hit anybody. He just put his hands on one of the technicians that was supposed to have been watching an animal. And he got fired.

Female Speaker

[film footage] **0:15:13.5** "Back in the 1960s, Michael DeBakey was one of the handful of leading heart surgeons. He was known as the Texas Tornado."

Michael DeBakey

[film footage] "What do you mean, 'it's not flushing' Yeah, cut it off, it's damaged. We're running out of film, you see."

Bud Frazier

[film footage] "Dr. DeBakey was quite a task master. It was like working under a Marine drill sergeant. It's the patients' lives that you're concerned about. And I think Dr. DeBakey always emphasized that in a matter that was very forceful."

Michael DeBakey

[film footage] "No, no, no, no, no. Put your finger over that. You're not concentrating, you're watching me."

Bud Frazier

He never stopped. Never stopped. He'd just beat you up the whole operation.

Female Speaker

[film footage] "—Shah of Iran and the Duke of Windsor."

Male Speaker

[film footage] "We want a medical skill of yours at Baylor. Why did you come to Houston?"

Bud Frazier

Houston.

Male Speaker

[film footage] "Dr. DeBakey."

Bud Frazier

0:16:17.8 The Duke of Windsor. There was artery you had to walk in this line here depending on where you were in the system. Now this is, you heard the whole time, these are just a few things you heard during the operation. "See if there's any sign of brain activity with the resident." You heard this all the time, "three hands and I wouldn't even need you at all." I went in to see one of the junior faculty one time, and they were all standing in the corner. And Dr. DeBakey was doing the case with just a nurse and yelling at them with this constant. And he just—he took all these men in their thirties, late thirties, and told them to stand in the corner just like you would a first grader. And they had to stand in the corner until the case was over. And he did it by himself. So this is probably something that wouldn't exist today. But he did teach you a lot. Nobody learned more.

This is one of his favorite mantras, and of course, he's certainly right about that. This is the meanest thing you ever heard him say to somebody. And I don't know how that would go over in anger management class today. But we heard that every now and then too. And we always call George Noon, God damn it, because he never even used his name without saying, "God damn it, George." And of course, it was George Noon who later saved his life.

But we did—we had to write a research paper. And just by serendipity, I got involved with a friend of mine, this guy, Frank Poke, who was a fraternity brother of mine at Texas. He was one of these guys that was always ahead of the game. He always did things, and he actually—we had to write a research paper every year. And it was October, but as freshmen we had to have a title by November the first. And it was October 30, and Frank came up to me. I was standing in front of the elevator. He said, "Bud, what are you going to do for your research paper?" And I sad, "I've got another day." I hadn't thought about it, you know. And he said, "I knew you wouldn't have done anything. I've already written a research paper. And we're going to do heart transplants and try to induce tolerance in heart transplants." And that's how I got into surgery.

0:19:04.5 And the next year, we did this artificial heart work with the Domingo Liotta. And this was the guy that made the first heart. And he did it over in the Baylor Labs. And it was a fascinating pump. He—I started working on this in 1965, of course. And I always remember Dr. DeBakey telling me this. He thought it would be pretty easy. We're going to the moon. We're going to do all this stuff, cure world hunger, etc., etc. And we did go to the moon, but we didn't have a hundred thousand patients with an artificial heart. And this was an NIH thing, just to show you how goofy it is. They thought by the early eighties, we would be in patients with an artificial heart. And they had the funding of it. But of course, that wasn't the case. Anyway. What was the question? I've forgotten that. How I got started?

Michael DeBakey

[video recording] "We were thinking of the heart as just a pump."

Bud Frazier

This is a good line.

Michael DeBakey

[video recording] "It seemed logical that if that's the main function, you ought to be able to duplicate that mechanically."

Bud Frazier

Well, it did seem logical, but it was a lot harder. Remember, your heart beats 100,000 times every twenty-four hours. So that meant if you're going to have a pump that would last ten years, fifteen years, beating 100,000 times every twenty-four hours, it was quite a mechanical challenge. And what else was it.

Mimi Swartz

0:20:44.5 Bud, wasn't there a story were you had a patient that was dying in the operating room and Dr. DeBakey—you were trying to keep him alive?

Bud Frazier

Well, we had—as medical students, we'd work up the patients. And it was, I was on Dr. DeBakey's service. And I was working up this young Italian boy, nineteen, eighteen-years-old. He spoke English. His mother didn't. He had severe rheumatic heart disease. A charming kid, looking forward to getting his heart fixed so he could go back to a normal life. They had a heart valve that worked reasonably well, and Dr. DeBakey was going to replace it. And his mother was with him. She couldn't speak English, but other than his mother, he was by himself. Anyway, we operated on him. He did well. And that night, he arrested. He had a cardiac arrest. So I was the youngest and strongest. In those days, you just opened the chest, and you started massaging the heart by hand. And I was massaging the heart by hand. And I always remember he looked up at me, and he reached up to try to grab me. And the nurse finally came and gave him some morphine. Dr. DeBakey came in. We couldn't get the heart started again. It was just a bad heart. So Dr. DeBakey told us to quit, but, of course, I wasn't going to quit. I was twenty-five and the kid was looking up at me. Then finally the resident who's a crazy guy, we call him Mad Dog Hoffman, actually hit me and knocked me off of him. But I thought if my hand can keep this kid alive, why couldn't we develop a pump of some sort to keep him alive, keep patients like this alive.

And I think that's one of the things that really stimulated me further to try to work on this technology. It is interesting that fifty years later, I guess, this girl that appeared on People magazine recently sometime in the last ten years with the pump that we developed. We were taking her to surgery. And she had a cardiac arrest. And we opened her chest, and I was massaging her heart just like I was doing this boy nearly fifty years earlier. And we just took a pump off the shelf, and she's alive and well today, five years later. So we did—I was fortunate enough to see that in my lifetime.

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Mimi Swartz

0:23:41.6 Do you want to talk a little bit about the kind of pump she has? When I started my research, Frank Michele said, "Well, you need to know about LVADs." And I immediately thought, "Why do I need to know about LVADs?" And talk about the development of that in terms of the artificial heart.

Bud Frazier

0:24:00.0 Well, first of all, that heart that we showed you—I mean, this really had a lot of impact on the development of this medical center. As Domingo Liotta figured out, at some point, that Dr. DeBakey was never going to put the heart in because he—Dr. DeBakey was fifty-two years old when he started doing heart surgery, and he never really got, as I said, slick at it. And Cooley was the slickest in the world and could do things that nobody could do. And he knew if anybody was going to put it in, it would be Cooley. So one time when Dr. DeBakey was out of town, Domingo Liotta took the heart over and they put it in at St. Luke's. And that, of course—Dr. DeBakey was very predictable. Dr. Cooley knew he'd get fired, but I think that's what he wanted. So he—anyway, so this is the first total artificial heart in a human to go in. This is September—I'm sorry—April of 1969. This is the first in the world. Dr. Cooley did it. He sewed it in in forty-five minutes. The patient actually did pretty well, but they way over immune-suppressed him, and he died of an infection. But the pump worked beautifully. And of course, Dr. DeBakey didn't take it very well. And he fired everybody in the lab.

Michael DeBakey

[video recording] "Now, Dr. Cooley had no experience with the artificial heart program at all. He didn't do laboratory work. He's a good surgeon, but that's all."

Bud Frazier

But that's all. I always loved that. And then there was some truth to that. He didn't do any lab work. And they didn't do—it was a real limitation. I was in Vietnam at this time. I was in conflict out there and shot down twice. And it—but I said it was probably a safer place than being in Houston. But I came back, and we started working. I finished at Baylor, and then I came over with Dr. Cooley because by then, the lab at Baylor was dissolved. So the only lab was at St. Luke's. So I basically stayed there. We were working, by then, on the LVAD, the left heart replacement, not the total heart because the total heart, by the early seventies, seemed to complicated and didn't seem like we could do it. We had a project with the total heart, but we didn't think we could do it. So this was a partial heart replacement. We put it underneath the diaphragm here to take over the failing heart. And this was actually very successful, and it was—I'm trying to limit—I came over to Baylor because I thought I'd come back to Baylor. And Dr. Crawford, who's the guy I'd worked with the most at Baylor told me to not even come over there unless I wore a fake beard or something because he didn't want Dr. DeBakey to see him talking to me. It wasn't quite that bad, but I certainly wasn't going to go back to Baylor. So I was the first chief of cardiac surgery here at UT.

0:27:43.3 This is just something. Nobody believes any other place, but this is one day at St. Luke's. We did more heart surgery there than any place in the world. And this is just one day. This is one day of Dr. Cooley's schedule. But the LVADs were funded by NIH. They did what they call an RFP. That's the way we do everything. You want to make a plane, you want to do anything, the government doesn't make anything. That's one good thing about our system. They give the RFP, request for proposal. And they decide from the experts what they want their proposal to be. They want a plane that will fly around the world in two hours, whatever. And companies propose what they're going to do. And they have to put a huge outlay for whatever it is. And they may or may not get it. And this is the way this field started. It really couldn't have started anywhere else but the U.S., and it couldn't have started if Dr. DeBakey hadn't gotten the money in '64 because once the government starts something, it can't stop it. So they developed a device and technology division of the NIH. And they always had to have a project.

And so that's how this sort of propagated itself. And one of the parts of the RFP was supposed to last two years. And this was a limitation. This was the first pump we did. And this was the first LVAD. And we put it in calves. The calves are the best animal for this. This inlet cannula was a problem because blood never stops moving in your heart. It's always moving, but in this pump, it would stop in this inlet cannula while the pump was pumping. It would stop. Briefly, but it would stop. And blood doesn't stop moving. And this is an example of why early pumps—and this is what would happen to it in the calf. We could never overcome this. And it was a real barrier to the whole development of the pump. I was working with the chief of the lab then; it was a wonderful man who was a summa cum laude at Harvard. He was the AOA at Harvard Medical School, smartest guy I've ever known and a very sweet, nice guy. And he was brilliant. And he was stumped by this, and he was going to give up. We were actually going to quit the pump. And we stopped it, and there are still a few people around that remember that that there was this inlet obstruction that was going to cause us to quit.

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Now, how did I happen to know that that was a problem? Well, I happened to know, and I often think about this, as I said we didn't have attention deficient syndrome when I was growing up because we had mean people teaching us like Ms. Murray. If you even—I get nervous. I don't even like to look at that picture, and she's been dead forever. But if you even moved in her class and if you even spoke without your hands, then that ruler came down. Nobody spoke, and you memorize the whole Lang's book of English grammar. Everybody did it. And there was no out. And of course, Dr. DeBakey was the same way.

0:31:45.0 We had a patient named Caplan that kept occluding his Fem-Pop. Five times in a row, he occluded, but he finally got up on the floor. The nurse calls me in the middle of the night, tells me it's occluded. So I go back down. I go up to see him, and it is occluded. His leg is cold. Now, Dr. DeBakey never carried a beeper, so you had to know where he was. But you pretty well knew where he was at any given time. So I knew he was in his office after midnight. He never slept because he was a mutant of some sort. He never slept. And I went down there. And I knew if I hadn't been at Baylor and hadn't known him—I was a DeBakey scholar in my class, which was bad because it meant he remembered you more.

I said, "Dr. DeBakey, I wish you would look at Mr. Caplan. I'm worried about his leg." Now, if I'd gone in and said, "Dr. DeBakey, Mr. Caplan's graft is clotted off again," he would have fired me. You didn't say things like that to him. But he just grumbled and grumbled, and he went up to see him. And you never ask him a question. That was the other thing you knew. Never ask him a question because he doesn't want to hear your questions. You just learned on your own. But I was so sleepy, and I'd been up all night. And I just said, under my breath, I said, "I wonder why the graft keeps clotting?" And he immediately took me outside. And he said—I remember him just so clearly—said, "You know, when blood stops moving, it clots. Is that too hard for your pea-sized brain?" And then he hit me right in the chest. And I said, "No sir. I understand." Then he went through Virchow's triad. Then he said, "Repeat after me: when blood stops moving, it clots." So I said, "Well, when blood stops moving, it clots. He hit me again. "That's right. Never forget it."

Well, I never forgot it because that was what was wrong with his pump because the blood stopped moving throughout the duration of systole. While the pump was pumping, the blood was stopped in there. And that's what stopped it. And that's why it was building up this obstruction. And all we did was remove the inlet cannula. It worked beautifully. And this was the first pump to be approved by the FDA

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as a left ventricular assist device. And I always reflect that I don't know if I would have removed it quite as well if I hadn't had that poke in my chest at the same time. His teaching method stuck with you.

Anyway, this was the first pump that patients left the hospital with. They could go back to work, but it was a problem in its durability. It didn't last. It only lasted about two years, the membrane. You know, fatigue. So that's the first LVAD that we used. And we started working on—and this is one of the things I think is also important. I knew Norman Shumway very well because Shumway started his medical training in my hometown in west Texas. I always sort of had a good relationship with him. But he had a debate with Jarvik in the early eighties on national television on an artificial heart heart transplant. This was very hot on the news all the time. Jarvik was on the news all the time. And I remember Shumway saying, "Well, the problem with," and Jarvik was a very slick, good looking guy and Shumway was this staid, sort of middle-aged, Midwestern guy. He wasn't very lively. And Jarvik, of course, won the debate. Here he was about that time. He was sort of crazy. This was when he was in Playboy. So here is Jarvik, and he's debating against Shumway, a standard physician. But Shuymway made a very good point. He said, "Look, this pump's a nightmare. It's not good for the field because they can only live two years. You can't change it out every two years. All it will do is prolong the transplant list."

0:36:38.4 And he was right. If you're not going to be able—you save individual lives, but you're not going to address the problem. So that's when I started working on the—this is the pump. The main problem not only was durability but the size of them. These were big pumps. They were life saving and they let people go back to work, but you can't expect these things to last forever, not forever. But Shumway told me, he said, "You know, you need one at least ten years. You've got to have another approach to it." And the only other approach I could think of was a non-pulsatile pump. At the capillary level, there's no pulse. The only organ that actually needs a pulse is the heart itself. So I started working on continuous flow pumps.

Now, success has many fathers. Failure is always a bastard. We always know that. But nobody's ever challenged me on this because nobody was interested in continuous flow pumps. All I could hear was all the negativity. "You had to have a pulse. La de da de da." But I couldn't see any way we could have a long-term pump if we didn't have a non-pulsatile pump. And these two guys, this guy showed me the first one to work. And it's interesting. Wampler made this first continuous flow pump. And he showed it to me at a meeting in Louisville. It's an Archimedes screw pump, 2,000 years ago. Archimedes screw. And they still use it. He was on a missionary travel. He still goes on the missionary travel. And he made this little pump the size of an eraser on a number two lead pencil. And showed it to me and he said, "You know, we could put this in the heart and it will take over for the heart." And I said, "It's going to hemolyze. It's going to be like a whirring blender." But again, that's why we did the animal experiment. It didn't hemolyze. And I asked him, "Why'd you know it wouldn't hemolyze?" And he said, "I didn't." So again, you have to do the experiment and let nature give you the answer.

0:39:15.3 We began putting these in, in 1988. And this is the first patient to have a continuous flow pump. Now as I said, none of this was funded. We had no NIH funding at all. And I had some internal funding, Dunn Foundation. Houston's always had these wonderful foundations that we can get the money from. And I could squeeze some money out of them. Jarvik didn't have any money, and Wampler had some from his company.

Here's a young boy that had nothing. He had no heart function at all. All he had was that little pump. And here he is awake and eating a popsicle. So I knew you didn't have to have a pulse. Nobody else did, but I did that. I guess Wampler and I did. And Jarvik and I started working a long-term pump at the same time as I started working on this. This was everywhere. Everyone was very excited about this, Wall Street Journal, The London Times, everything because nobody believed this. Again, it just shows you, you have to do the experiment and let the experiment show you which way to go. And that sort of was the Kitty Hawk of the field.

0:40:41.9 Now with Jarvik, we also developed the blood washed bearings. Nobody else believed those were possible. And we developed those by—Jarvik would make these pumps in New York. He lived in Lincoln Center. He was married to Ask Marilyn, the world's most intelligent woman. She does have the highest IQ in the world. They tested her three times. She's never gone to college. She noticed that George Washington was the first president. She won't know who the second president was, but she's a lot of fun. She can beat you on Rubik's Cube, I can guarantee you. Something about her brain. But we did all these experiments, and then we also showed after five years, five years, that you could have a blood washed bearing because you had to have bearings in this pump. And that opened up the field further to an implantable continuous flow pump, but our poor calves—the national—the animal Texas—the poor things, we do have to have them in order to do this experiment. So this is how the continuous flow LVADs were developed.

0:42:03.7 Again, nobody thought that—it was absolutely impossible to have something that would spin at 25,000 RPM and—something that you—a bearing that wasn't lubricated. You have oil in your car for your bearings, you know. You can't have a non-lubricated bearing. It's impossible. That's what everybody said. And, of course, it wasn't. So we started using these pumps. I put the first long-term one—we put the first bridge to transplant in at St. Luke's, but the first long-term pump we put in this man who was a hospice counselor in England. And he was dying of heart failure. And he decided he didn't want to die of heart failure. So he called me and asked me if he could put one of these pumps in. I went to Oxford. I put this in at Oxford. And he wrote two books after he had the pump in place. Wonderful guy. Went everywhere, did everything, but he was over anti-coagulated. He was in the British Health System, which you can think on paper is a good idea, but isn't in reality. It's good if you don't get sick. If you get sick, that's the last place you want to be. But he was over anti-coagulated, and he died of nosebleeds.

He went into the hospital in Manchester. He died of nosebleeds and poor judgment of women because, for some reason, he got involved with two different women. And they both came, and one of them was his wife, of course he was sort of involved with her automatically. But there was another one involved. They come to the hospital. He's passed out. He's bleeding. He needs a blood transfusion. The British don't like to do anything. They won't give them permission to transfuse him, neither of the women. They fought with them. So there's a lesson in that two. But I think if they would have transfused him, he'd still be alive because these bearings showed no wear at all. There was no wear. So that was the start of the field of continuous flow LVADS. All right. What's your next question?

Mimi Swartz

0:44:32.1 Do you want to talk about the guy that you implanted in March 2012 and what happened, or 2011, Mr. Lewis?

Bud Frazier

Yeah, that's a big chunk. As we implanted more and more of these, I became—of course, we need a total artificial heart. There's a number of patients—I've had two die this last month over at St. Luke's. We need a total heart replacement. We can't just do transplants. They don't come out of the air. So we still really need a total heart. And I began working in 2005 to—I'm going to skip through all this—to make a total artificial, completely implantable, heart without a pulse. I will say, here's a twenty-five-year-old-boy with the LVAD. That's what we called the HeartMate II, which is identical to the Jarvik. It's just put in a little differently. And he was twenty-five-years-old. He came in dying of heart failure. And here he is about twenty-eight, and his heart finally recovered enough that we could take the pump out. So if I'd transplanted him—he's a smart kid. He was an engineer. And he knew that he wouldn't live to be fifty if he was going to have a heart transplant. He'd just had a kid. So he didn't want a heart transplant. And I don't like to transplant young patients like I told you. But you see, his heart is that little pump, and that's what's doing all the work. I took it out, but I told him he could play six sets of tennis without getting into trouble with this thing, but he can't do it anymore. Yeah, anyway.

0:46:42.1 I recently went to Kazakhstan. They put in over 300—they put in over 450 pumps now—in Kazakhstan, these small continuous flow pumps. And more than 35,000 have been implanted worldwide. So we got around the nightmare because now these pumps, we've had over a hundred patients that have had pumps in, single pumps, for over ten years. So we've solved the durability problem. So we then began working on a total heart replacement because, as I said, sometimes you need the total heart replaced. And one of the ways I—this is another whole subject—my daughter doesn't believe that's me. She says, "Who is that guy? That's not you. You were never that thin."

Anyway, I'm sorry. I wasn't actually planning on using this. A number of these patients, like that boy I showed you, we've removed the pump from because I think a lot of the hearts will recover if you rest them properly. But the total heart replacement, this is the last thing we'll touch on, again, we go back to man's best friend in the calf. And this animal, we removed the total heart. This was 19—I'm sorry—this was 2005, and replaced it with two continuous flow pumps, two small pumps. So there's no pulse at all, and yet the animal was awake and eating. And we put it on a treadmill. We had the treadmill. They can walk. They can exercise. And this was the first demonstration that you could do this in a patient. And we did it in an animal. Then we did it in a patient in 2011. This patient was dying of heart failure. We took him to the OR. He had a small heart. An LVAD wouldn't work in him because the LVAD, as I said, doesn't work in a lot of these patients. We totally replaced the pump. He'd been in the ICU for two weeks, intubated, and dying. And here he is just two continuous flow pumps and his heart gone. He woke up, worked on his computer. Sadly, he had a disease called amyloidosis that we found out later was involving the liver and the kidney. So he and his family decided to cut the pumps off. But it works beautifully in the patient.

Because of this—this is the last thing I want to touch on—we now, going from the pump that didn't work in the sixties—we now have a pump. This young engineer that came to me a few years ago, and his father had died of heart failure. Serendipity again, evidence-based medicine. He was a brilliant engineer, and he began working on a total artificial heart. It's powered with a continuous flow. And that's this pump. It was another earlier total artificial heart. You can see the difference in size. And this works. It has only one moving part. And the moving part is pumping to both the lungs and the body, and,

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incredibly, it has a Starling's response. That means as you need more blood, you walk up a flight of stairs, it will pump more just like a natural heart does. And that has to do with the position of this pump, of the spinning the part, the one moving part. And this, of course, is the last thing I would like to see while still vertical since I started working on it so long ago.

I will say, in 2005, I went over to see Dr. DeBakey. He was, I guess, ninety-six at that time, and showed him that we could totally replace the heart with these continuous flow pumps. And he said, "Bud, it's a wonderful idea. It's a wonderful idea. I think I did some research on this in the sixties." He didn't, but he'd been in academics enough, he's always going to hedge his bets, just a reflex in academia. You always, if you can't do anything else, lie. But he said, "Work on this, Bud. In five years, we'll have this in patients." Well, in five years, he would have been 101. And I didn't say anything. I knew what he was thinking. He knew what I was thinking. And he said, "Of course, Bud, we all hope you'll still be around by then." Sadly, he didn't make it, but I think we will see it.

0:52:16.7 See, it's this one moving part. One moving part. It's spinning by magnets, and the magnets tell it where to get, to be, according to the inflow. So if it moves just a little bit one way or the other, it flows more. And that's an incredible technology, and it works. We've already had it in animals. We have it in an animal over there now. We've gone on the treadmill. We've had it on twice. So we'll have this in patients within two years. And it will be a long-term pump that will work. Pulsatile pumps will never work. They'll never—you never say never in anything, but right now, it's just 100,000 motions every twenty-four hours is a bit, a little much. Plus, you don't need a pulse. I will say, also, this pump, this engineer, by changing the speed of the pump, he can create a blood pressure curve just like a normal 120/80. He can put it anywhere you want.

And I guess the last story, I always remember my—the Fraziers are redneck, Scotch-Irish, mean people. And I was named after a gun fighter who was killed in a gunfight in 1896 in Fort Stockon. You can look it up in the Texas history if you have any interest in it at all. But my mother's family was a little better. My grandfather, my mother's father, was the first organic chemistry teacher at A&M. In 1900, he started teaching. He taught there for forty years. Brilliant guy, lived forever. And I came back from Vietnam. I went to see him in 1970. And I said, "Granddaddy, what do you think about landing on the moon?" And he said—he's a wonderful guy, so he knew everything. And he said, "I don't think he landed on the moon." I said, "Come on, Granddaddy. Of course they landed on the moon." He said, "No, they faked it somehow. I don' t know how they did it, but they faked it." I said, "I don't want to even hear you say that. It's just embarrassing. You're an intelligent man." And said, "Okay, maybe they did land on the moon, but remember, I drove mules to Oklahoma in the land rush which was in 1889. I volunteered for World War I, but I was two old for World War I. And I can't describe to you my astonishment when I saw the first plant fly over. So coming from that to going to the moon was too much." He said, "Maybe they did go to the moon, but I just don't want to think about it."

0:55:11.2 And I asked this young engineer, "How did does it know? How do you do it and position that?" And he said, "Well, we have these data points that tells it exactly where it needs to be according to the pressure on the inflow side. And it's going—we have 20,000 data points a second and that tells it where to be." I said, "Wait a minute, 20,000 data points a second? You mean 20,000 data points a day or an hour?" He said, "No, doctor, it's right here. Twenty thousand data points a second." And I immediately thought of my grandfather who's line was, "Maybe they did go to the moon, but I just don't want to think about it." I said, "Maybe it is 20,000 data points, but I just don't want to think about it." So I think that's what you will all see in your lifetimes, this technology if we don't blow ourselves up somehow. We'll finally solve it. And it was all done in this medical center. I think that's one of the things you should know, something about this history of our medical center is very unique and dependent upon very few people and, as I said, to come from a forest sixty years ago to what it is today, I think, is remarkable. And I think we've all been beneficiaries of it.

Okay, you got any other questions. I think you people—

Male Speaker

Questions for Dr. Frazier?

Bud Frazier

—are ready to get out of here.

Female Speaker

Is your funding being researched? I mean, is your research being funded now?

Bud Frazier

Pardon me?

Female Speaker

Is your research being funded?

Bud Frazier

Well, it is now, but that's one of the big problems with the LVADs. The first pulsatile pump, we had a lot of NIH funding, again, with Dr. DeBakey. But when I started this continuous flow pump, I did it with just local money that I could scrounge up. And it was all internal. And we didn't have the funding to develop it properly. So there are a lot of complications, not a lot, but there are complications with that implantable LVAD that are solvable. The Catholics, I always love the Catholics. I'm not a Catholic, but they have these mortal sins and venial sins. As I said, the problem with the pulsatile pump, to me, was a mortal, 100,000 every twenty-four hours was too much. But all the problems with the implantable, continuous flow LVADs are being used here and Methodist and St. Luke's, everywhere. And all of them are solvable, but the companies won't solve them. That's the only thing I've learned. It doesn't matter how easy it is to solve them because we can power these through the skin, for example. We could do that in the seventies. Because we didn't have any funding, it was cheaper to do the first work going what we called percutaneously, through the skin. And about over 20 percent of those get infected. Well, there's no reason to even have one. But you tell the companies that, they're not going to change it because they don't have to. They're still making a lot of money. And there's about three things that they need to do. If we'd had government funding, we would have solved it before it went into the patients. But we didn't. All this was developed without any government funding. And that's because when we started, nobody believed in it.

Mimi Swartz

0:59:10.3 You want to talk about who some of your funders are now, or is that a secret?

Bud Frazier

What?

Mimi Swartz

You want to talk about one of your major, local funders on the BiVACOR or is that a secret?

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Bud Frazier

It's not a secret. It's the mattress guy.

Mimi Swartz

Mattress Mac.

Male Speaker

He need a heart?

Bud Frazier

What?

Male Speaker

Does he need new heart?

Bud Frazier

0:59:29.1 Well, I don't know. He just coughed up the money for some reason. There's a lot of money in mattresses I guess. But he gave us five million dollars, but it's much better. I mean, NIH funding is a pain. The system is a pain. I've been on the NIH Advisor Council. I've spent a lot of time in Washington. And the system is a little flawed, but once you get it, it's wonderful because you can do the work. And if you can do the work, that—see, the problem with private funding, investors, they want to make money. And if they're not making money in two or three years, they'll back out on it. That's what happened to that hemo pump. That little pump the size of an eraser? That was a wonderful idea, but it was all funded by venture capitalists in San Francisco. They didn't want to fool with the FDA, and they got involved in some land deal in Seattle. They don't care. It is, I think, one of our big limitations. And so far, our local funding for this has been understanding. But I keep reminding the engineers and the people involved that these people, didn't invest the money just because they love mankind, and they want to help everybody. They want to make money. And the beautiful thing about the NIH funding is once you get the grant, then you can do the work. The private funding, you get the money, and then you have to—unless it's a pure philanthropy, right, say the Dunn Foundation. We've been so fortunate with the Cullens and Jesse Jones and all these foundations. That's really the best way to fund it.

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Mimi Swartz

1:01:46.4 Any other questions?

Male Speaker

Anyone else?

Mimi Swartz

You understand all of that? It took me about ten seconds to get it, but it's my third year of working on the book.

Bud Frazier

It's easy. Yeah.

Male Speaker

If you would suggest to people to live more healthy, for heart health, what one suggestion would you make?

Bud Frazier

For heart health? [laughter] I don't know. I always remember I was in San Diego. Mehmet Oz, who was another Frankenstein sort of thing, but I got Mehmet Oz involved in these pumps. And he's a very good surgeon, I'll tell you. He was one of the best ones at Columbia. And he did all the work up there. That's how he got his name. And he got on a national TV on the LVADs, which I showed him how to do, and I sort of created him. But I don't know, it's crazy. I've only seen five minutes of his show. I sat down, wrote him a letter, and said, "Look, Mehmet, don't give up your day job," but somehow or another, he's still on. It was 2000. We were out in San Diego, and Dr. DeBakey came out there. In 2000 he would have been ninety-two, and he flew out by himself. He had his slides. He gave a beautiful talk. And Oz was very fanatic about exercise and diet and everything. And Dr. DeBakey, after he gave him his talk, he went up to him and says, "Dr. DeBakey," —he didn't like people asking him questions, and he really didn't like Oz."

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And he said, "Dr. DeBakey, it's just wonderful. How do you do this? What is your exercise regimen." And Dr. DeBakey said, "Well, I used to walk up stairs, but I don't anymore. I just take the elevator." That was it. "Well, what about your diet? What about your diet?" And Dr. DeBakey told him the truth because I'd seen him. He said, "You know what I really like are these—I like these tamales. We have tamales down in Texas. They're really good and these Snickers bars. You know, these Snickers bars are really good, and they're very nutritious." And of course, Oz was—and the last thing he said, and I'm standing behind him telling him to, "Stop it Oz. Stop it." And he said, "Well, what about your religious? Do you ever pray? Do you pray before you go into surgery?" He asked Dr. DeBakey that, show you how dorky he is. Do you pray before. And Dr. DeBakey looked at him and said, "No, I don't pray before I go into surgery. I would be mistrustful of any surgeon who felt he needed divine intervention to perform the surgery."

1:04:51.0 He did say one of few funny things I ever heard him say after he followed me. "I must confess though, sometimes I pray after the surgery." So anybody that's been in a bad jam in surgery can understand that. But the only two things I've known that are helpful, I do think are helpful, are regular exercise if you can do it. Swimming I think is probably the best thing you can do. I think that diet makes no sense at all. All you have to do is follow the history of diets in America. We didn't have any heart disease until the twenties and thirties or coronary disease of any consequence. All we ate was butter and fats and all the things you're not supposed to eat. But I think regular exercise is good—swimming is the best if you can do it—and aspirin. And you should take as much aspirin as you can tolerate. I take it till my ears ring. And I take six a day, 350 mg aspirin, every day. I do think that helps. It's a very good anti-inflammatory. It has something to do with the platelets. This organic chemist grandfather I told you, that's what he did. He took eight a day, but for arthritis. He took it for arthritis because as an organic chemist, he knew that acetylsalicylic acid changes the solubility coefficient of calcium. And I don't know if that's true or not, but I assume it is true. He never had any arthritis. But I wish I could give you some magic formula. I'm just sick of these people that seem to continue to come up with the diets.

And that's a metaphysical problem too. When I was in medical school, they absolutely knew that low cholesterol—they'd done the studies at Framingham—absolutely diet would control coronary heart disease. We have just as much as we ever had, in fact, probably more than we had in the sixties. We just can do more for it. So we know that. We were going to cure cancer. We had 5 FU was going to cure cancer. And all infectious diseases were going to be cured when I was medical student. And of course, we're still in struggle, but a lot of advances. But I do think regular exercise and sensible eating, sensible. Considering all I learned when I grew up in Texas, in the fifth grade we took health. And they told you to eat a balanced diet, pictures of different colored foods on your plate. Get a good night's sleep and to exercise. And that's about it. You don't need these diet books or anything. Take fifth grade health.

Male Speaker

Why Kazakhstan? What's the connection?

Bud Frazier

1:08:22.9 Well, it's strange. Kazakhstan is a strange country. They're very prosperous. And they've got one guy—the best form of government was a benevolent dictator. And so how or another, they got this guy with an unpronounceable name who's in with the Communists. And once they started breaking up, he got Kazakhstan, which is nearly an empty country. It's all desert. A lot of the gulags were there. Stalin used to send them out there to die. But they also have a lot of oil. And they built this beautiful city, Astana, which is absolutely the most modern city I've ever been in I think. Everything's new there. There was a beautiful medical school. Everything's taught in English there. All the courses are in English. They speak perfect English. I was the oldest person I saw in this whole city. And they have a heart center there. They have a very, very good technical surgeon that came over here over a decade ago or more and trained. They can't do transplants. They don't have a system for getting donors. So these put these pumps in. And some of the longest lived patients with these pumps are in Kazakhstan. So it's just like everything else. They had the money. And if you know the history, you would know who the guy's name is, but I think he's still alive. He was able to isolate Kazakhstan from Russia and control their own finances.

Male Speaker

Anyone else?

Female Speaker

Why do you use a calf? Why is that the particular lab you used?

Bud Frazier

What?

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Female Speaker

Why calves?

Bud Frazier

1:10:26.1 They live. They survive. We tried the sheep over at VeriSuite II, but they don't live. They're very sheepish of course. The one thing about a sheep is they have to be with other sheep. Literally, if you just do one sheep, you got to put other sheep around them because they'll die if they're alone. They don't like to be alone. But the calf is very durable. The bad thing about the calf is they out grow the technology. They grow so rapidly. Now, they're the standard animal. Pigs, of course, are pigs. That's why they call them pigs. They're awful. They'll bit you. They're mean. And they're very smart, unfortunately. But we don't use the pigs. We use them from some of our coronary artery stem cell work, and we have used sheep occasionally for minature pumps. But the calf became the standard, really in the sixties, for doing all this work. Here Dr. DeBakey started using the calves. And if we had a better animal, it wouldn't be—it was sad, these animals. I don't like it. I never liked to hunt. I never liked to kill things. And I'll be glad if we see a day that we don't even have to use them. But if we don't, nearly every device that we've developed we found something to change in the calf. In this pump, nothing about the pump, this continuous flow pump, nothing about the pump—that's an engineering marvel—but about the connectors, the interface between the blood and the pump. We've gone through several iterations of that. And we learned that from our calf experiments.

Male Speaker

You have now just heard one of the most incredible stories of the most incredible person in the Texas Medical Center. We are very grateful.

Bud Frazier

Thank you.

[Transcribed by Adept Word Management, Inc.]

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