"Affairs of the Heart "
– SHOW 1104

Tease
Mending A Broken Heart
Robot Heart Surgeon
The Heart Factory
How's Your Heart?

TEASE

ALAN ALDA This simple little device is going to help save a toddler's life -- plugging a tiny hole left after the complete rebuilding of his heart.

ALAN ALDA (NARRATION) Zachary has only half a heart.

ROB BARTHOLET And this procedure's going to get him until he's an old man.

ALAN ALDA (NARRATION) A robot surgeon…

ALAN ALDA I made a stitch.

ALAN ALDA (NARRATION) …now fixes hearts. My heart gets put through its paces.

WARREN MANNING Squeezing, squeezing, squeezing.

ALAN ALDA (NARRATION) And I hold a heart in my hands.

ALAN ALDA I can really feel the beating. I'm Alan Alda. Join me as Scientific American Frontiers explores some Affairs of the Heart.

back to top

MENDING A BROKEN HEART

ALAN ALDA It was the first part of you that had to go to work. When your whole body was no bigger than this, and before your mother even realized she was pregnant, your heart began to beat -- even though it was no more than a tiny

crooked tube. With luck, and a little care and attention, it should beat two and a half billion times before it eventually gives out. For many of us though, just as the heart was the first organ to go to work, it is also the first to fail us. In the next hour, we're going to see some broken hearts get mended, and find out how to keep them from breaking too young. We're starting here, in Boston's Children's Hospital, with a heart that's still an infant's -- and that only a few years ago, might never have grown older.

ALAN ALDA (NARRATION) Zachary's heart problem was diagnosed before he was born.

KAREN BARTHOLET We first found out that he had some cardiac issues on a routine ultrasound. February 19th, 1998.

ROB BARTHOLET Basically, his heart looks like it was put together in a kindergarten art class.

ALAN ALDA (NARRATION) Zach's heart started to go wrong just a few weeks after he was conceived. Instead of forming two main pumping chambers -- one pushing blood to his body, the other to his lungs -- his heart formed only one. He's still alive today because of two operations that have replumbed his heart, allowing its single chamber to keep blood flowing throughout his body.

KAREN BARTHOLET Good, you got it in there!

ROB BARTHOLET The first surgery he had got him till he was 5 months old. At that point we had to have the next surgery or he wouldn't have lived much longer. And that surgery, which he's under right now, would probably allow him to live until he was 4 or 5, 6 or 7, years old, but not much longer than that because his body's going to outgrow this procedure. And this procedure's going to get him until he's an old man.

ALAN ALDA (NARRATION) So for the third time in his young life, Zach is prepared for open heart surgery. The operation he is about to have, here at Children's Hospital in Boston, is called a Fontan procedure. In a normal heart, blood that is pumped around the body by the left ventricle arrives back at the right ventricle to be pumped to the lungs. But in Zach's heart there is no right ventricle. So to get blood to the lungs a new route has to be built -- and that's what the Fontan does - it creates a tunnel for the returning blood that burrows straight through the heart. Now a single heartbeat can push blood around the body, through the tunnel and on to the lungs.

RICHARD JONAS You all set there Bob? Let's go on.

ALAN ALDA (NARRATION) The operation begins when a heart-lung machine takes over from Zach's own heart.

RICHARD JONAS Now the heart is stopped right now and is not getting any blood. So, that's why we need to move along at this part of the operation.

ALAN ALDA (NARRATION) Surgeon Richard Jonas has performed scores of Fontan procedures -- perfecting his tailoring as well as his surgical skills.

RICHARD JONAS Now we're gonna shape this Gortex patch.

ALAN ALDA (NARRATION) With Zach's heart cut open, Jonas starts to sew the patch of cloth along its inner wall.

RICHARD JONAS We've got to think about how this is going to be folded over in a minute.

ALAN ALDA When you fold it over, is that…

RICHARD JONAS It's going to make a tunnel, right.

ALAN ALDA That's how it becomes a tunnel. RICHARD JONAS Yeah, this is the bottom end of the tunnel starting to take shape now.

ALAN ALDA I can't quite tell why it isn't in the shape of a tunnel when you put it in. Why do you have to sew it into the shape of a tunnel?

RICHARD JONAS I guess it's not really possible for manufacturers to perform something. For instance, every child is a different shape and size so we really do have to custom build components to fit into an individual child. It really is sort of tailor made specifically for a child's situation. OK, well at this point we're going to make the fenestration.

ALAN ALDA (NARRATION) With the cloth sewn in place, Jonas uses a punch to makes a small hole -- called a fenestration -- in the side of the tunnel. Creating a deliberate leak like this seems strange right now -- but in the days to come, this little hole is to play a critical role in saving Zach's life. But for the moment, there's no hint of trouble. After being stilled for ninety minutes, Zach's heart is slowly stirring back to life.

RICHARD JONAS As the heart starts to get that warm blood, it will gradually start to beat. You can see the first blip. The top line there is the EKG. There's a beat there -- there's another one -- there's another one. Yup, there we go.

ALAN ALDA (NARRATION) Twenty minutes later, Zach's rebuilt heart is beating vigorously.

RICHARD JONAS We're going to be off the heart-lung machine in about a minute.

ALAN ALDA (NARRATION) Zach's single ventricle is now able to pump blood around his body and through his lungs almost like a normal heart. But right now it's facing perhaps its greatest challenge -- getting Zach through the critical few days following surgery. As it turns out, his rebuilt heart comes close to being overwhelmed -- by a simple cold.

ALAN ALDA How is Zach doing now?

PETER LANG He's had one complication following the surgery, which is that he developed a lung infection.

ALAN ALDA And that made it hard for the heart, if he hadn't had the fenestration?

PETER LANG It makes it hard for blood to go through the lungs, and in this adjustment period after the Fontan, without the fenestration he could have gotten very sick. He could have been, oh, stuck on a ventilator for a long time, and we've had children who've had a Fontan operation and this kind of lung infection who have died. So the fenestration…

ALAN ALDA So the fenestration was vital.

PETER LANG I think so.

ALAN ALDA (NARRATION) Zach's cold lingers for days, but never becomes life threatening -- thanks to the fenestration. Here's why. His infection is making it hard for blood to flow through his lungs -- so hard that his heart may simply have been forced to a halt. But by allowing the backed-up blood to spill out into the heart's main chamber, the fenestration is relieving the pressure, and allowing his heart to keep pumping. Of course, not all his blood is now going through his lungs, so it has a little less oxygen than it should-- it's a little bluer. But right now, that's a small price to pay.

JIM LOCK This infection is exactly the kind of situation, if he didn't have a Fontan fenestration, would have resulted in a very high mortality rate. It's not unlikely he wouldn't have made it if he didn't have a Fontan fenestration.

ALAN ALDA So the fenestration probably saved his life. Now he's lived through this cold, which could have been fatal, possibly. Now there comes a point where you want to close that hole eventually, right? Why do you want to close the hole?

JIM LOCK Because children can tolerate being blue pretty well for a period of time. But it's not well tolerated life-long. And so if we left that hole open, eventually he would suffer complications from being blue.

ALAN ALDA So that's why you've got to close it and that's why you invented this?

ALAN ALDA (NARRATION) "This" is a deceptively simple little device that closes holes in hearts without surgery.

JIM LOCK And the whole thing now folds up into something quite small.

ALAN ALDA When I was a kid I used to do amateur magic, and that's how you fold flowers that appear out of nowhere.

JIM LOCK You're kidding!

ALAN ALDA Yeah, a whole bouquet. You just fold it up like that and you could get it into a small space like this.

ALAN ALDA (NARRATION) The small space in this case is the tip of a catheter.

JIM LOCK That's what goes inside the body. And we thread it up through a vein in the leg and up into the heart, and we watch it under an X-ray fluoroscopic machine and we know where the hole is. And let's pretend that this is the hole here.

ALAN ALDA (NARRATION) Like my magic flowers -- or a tiny umbrella -- the device springs open.

JIM LOCK See it snap? Then I pull it back like this, pushing it back like that.

ALAN ALDA Wow.

ALAN ALDA (NARRATION) This is nine year old Josh. He's lived with a fenestration for six years now -- and it's time to close it.

JOSH'S DAD The doctor was telling us it's kind of like a fine-tuning. They have to tune him up before they send him out.

ALAN ALDA (NARRATION) Josh's blueness is visible in his lips and fingernails.

JIM LOCK The drill with a patient with a Fontan circulation is to give them the best possible circulation for the rest of their life. Because it's a little bit tenuous. They only have one ventricle, and what we need to do is to optimize that circulation so that they can be pretty asymptotic and be very productive citizens into their 40s and 50s and pay taxes.

ALAN ALDA (NARRATION) Josh's tune-up will all be done through a tiny hole in his groin.

JIM LOCK OK, let's take this picture just like this, guys. Inject.

ALAN ALDA (NARRATION) Injecting a liquid that shows up black on the fluoroscope reveals Josh's blood vessels -- including the pulmonary artery taking blood to his lungs.

JIM LOCK So you notice the diameter here is probably 7mm, and it drops to 4mm and then it goes to 9mm. That's not a very severe obstruction, it's really only mild, and if he had a normal circulation we'd ignore it.

ALAN ALDA (NARRATION) But since Josh's heart already has a hard enough time pumping blood to his lungs, Jim Lock plans to use this metal coil -- called a stent -- to open up the constriction.

JIM LOCK He's going to hold this with his beefy fist so that it don't move. And with my thin delicate fingers I'm going to push it up. See it there? Coming in, coming in, coming in. OK. Blow the little balloon up for me. Right now, slowly.

ALAN ALDA (NARRATION) A balloon inflated within the stent expands it to permanently hold open the route from the heart to the lungs.

JIM LOCK OK, so this should be very close to perfect.

ALAN ALDA (NARRATION) Now it's time to close the fenestration. The twin umbrellas are loaded into their catheter and threaded up into Josh's heart. The tunnel and its hole are invisible in this picture, but the first umbrella's arms are unfolding on the outside of the hole.

JIM LOCK It's fully open.

ALAN ALDA (NARRATION) Then the second umbrella is released.

JIM LOCK We're going to take a picture now with all eight arms open, one on the left side and one on the right side and make sure it's in the right place. Ready guys? Inject.

ALAN ALDA (NARRATION) Now the tunnel is visible on the left side of the picture. Some blood is leaking past the umbrellas, but that's because their cloth mesh is still porous. In the coming months, Josh's cells will grow into the mesh, sealing the hole tight. The final act is to release the catheter, leaving the umbrellas behind.

JIM LOCK And there it is.

NURSE It's all done, okay? You're in the recovery room. It's all over. Alright?

ALAN ALDA (NARRATION) Josh's blood oxygen, which for years as been at 70 percent, has jumped to the mid nineties.

DAD Hey big guy, how'd you do?

ALAN ALDA (NARRATION) Just minutes after the procedure, and already Josh's lips and nails are pinker.

MOM He's pink! DAD He's pink. For the first time.

MOM Look's good. Little dirty, but good.

ALAN ALDA (NARRATION) For Josh and his parents, nine years of living with his broken heart are almost over. The odds are good that his rebuilt heart will now allow him a normal life. Meanwhile, Zachary is home in Texas, having fun. One day, his fenestration will also need closing. The fact that it can be now done with Jim Lock's little folding umbrellas means that, like Josh, a tune-up is all he'll need for his heart to take him into ripe old age.

back to top

ROBOT HEART SURGEON

ALAN ALDA (NARRATION) Jim Wenzell flies planes for a living…. NURSE What airline?

JIM WENZELL Southwest.

ALAN ALDA (NARRATION) Or at least, he used to, before his airline grounded him when he was diagnosed with a dangerously narrowed coronary artery. Today he's at the Ohio State University Medical Center, where he's about to be operated on by a robot. Jim Wenzell is one of the first patients in the United States to benefit from a technology that promises to revolutionize surgery -- yet whose origins can be traced back to a now distant war. It was a war that also formed the background for a television series. MASH was set in a Mobile Army Surgical Hospital during the conflict in Korea. The real MASH units represented a major breakthrough in battlefield medicine. Before the early 1950's - and the helicopter - many soldiers wounded in battle didn't survive simply because they couldn't be treated by a trained surgeon quickly enough. Fast forward to the 21st century, as viewed through a promotional video made for the Pentagon's Advanced Research Projects Agency. In the mid 1990s, the goal of a research program aimed at bringing new technology to battlefield medicine was to shorten still further the time between a soldier's being wounded and getting expert medical attention.

ALAN ALDA So you drive this out…

ALAN ALDA (NARRATION) Five years ago, we visited a mobile surgical unit parked in peaceful Palo Alto, California.

ALAN ALDA If this person had been wounded in the battlefield and he happened to be lucky enough to have a surgeon here, what's wrong with him?

ALAN ALDA (NARRATION) Jon Bowersox, himself a surgeon, was working with a team of scientists and engineers on a way to project his expertise into the battlezone while he remains miles away.

JON BOWERSOX What it looks like is there is about an inch long hole in the small intestine. If we didn't treat that, what would happen is the casualty would develop a severe infection and die in a relatively short period of time. So what's needed to take care of this is emergency repair of the intestinal injury.

ALAN ALDA (NARRATION) These were actually pig intestines from a local butcher's shop. Poised above them was a pair of mechanical hands.

ALAN ALDA What do these things do? They get right down in the wound? This is the machinery?

JON BOWERSOX As you see, why don't we move them into position here if you just move our position control.

ALAN ALDA That's this red button?

JON BOWERSOX It is. Stop please. Good, Good. So as you can see, just like the surgeon's hands, they're placed right over the site of the wounding and these are instruments the surgeon normally uses.

ALAN ALDA (NARRATION) The armored operating room was connected to this tent by a cable. But the plan was for a wireless link so that OR and surgeon could be many miles apart.

JON BOWERSOX So this is a surgeon's workstation, instead of being at the patient's side in the normal operating room. I put on these polarized glasses that give me 3-D vision. Instead of talking directly to my assistant, I put on a pair of stereo headphones, and instead of picking up the actual surgical instrument handles, I put my hands, into the halves of the instruments that are attached to the console. And now, it's like being at the patient's side.

ALAN ALDA (NARRATION) Jon was seeing a 3-D version of theimage shown in the monitor that I was watching.

ALAN ALDA How much like the real experience is it when you were over there?

JON BOWERSOX Well, I think the most telling thing is that every surgeon that has used the system, after working with it for about 15 or 20 minutes, will move their hand out of the instrument handles and try to push bowel out of the way, it's getting in the way.

ALAN ALDA (NARRATION) Jon appeared to be as dexterous with the remote instruments as he was with the normal ones, aided - as he would be in a regular operation - by a skilled assistant. Jon could see Michelle in a small monitor in his workstation, and together they speedily repaired the wound.

JON BOWERSOX As you can see now, I am able to tie the knots in the suture just as if we were in the actual operating room. So, would you like to have a go at this?

ALAN ALDA Ah, yea. Let me try. I can't wait. This is the going to be the first time I've ever done this.

ALAN ALDA (NARRATION) Despite years of doing fake operations in a fictional MASH unit, this was the first time I'd tried anything like the real thing. Fortunately, it wasn't the real thing.

ALAN ALDA Oh, oh my God! Oh wait a minute. I'm terribly sorry, I banged into the instrument and jammed it into the guy's intestines. Wait a minute. Michelle, control yourself. Snip, snip, okay.

MICHELLE Alan, you're ruining my image of you as Hawkeye, you know that.

ALAN ALDA I am not a real doctor, I just play one on TV. Now, I need to pick this side up.

MICHELLE Yea. Pick it up. Right where you are. Okay.

ALAN ALDA Okay, Oh it went through.

MICHELLE Yes.

ALAN ALDA Do I have too little of it?

MICHELLE No, that's just fine.

ALAN ALDA Oh, pull it with this?

MICHELLE Yes.

ALAN ALDA Oh, I see, I see, pull it with the right hand. Okay. And I can sort of ease this down with the left hand. Grab the tissue. Okay.

MICHELLE Pull it out.

ALAN ALDA (NARRATION) I was just one of many visitors to the Pentagon funded project who got to try it out for themselves.

ALAN ALDA There I got it. Look at that.

MICHELLE Yes, you did great.

ALAN ALDA I made a stitch. But the poor guy. I mean he's gonna have cramps from that stitch.

ALAN ALDA (NARRATION) Another visitor to the project in the mid 1990s was an entrepreneur who saw in the system the answer to a surgeon's dream -- the ability to operate right inside a patient with a pair of miniaturized hands -- to project their hands not so much across space as down into the patient's body. And it's this idea that five years later is being tested here at Ohio State University -- as a camera plunges through the chest wall of the coronary by-pass patient.

RANDALL WOLF That's the heart beating. And we're looking at the chest wall and there's the artery we want. The artery… That particular artery runs up underneath the breastbone under the ribs. We plan on using that artery. It's a little blue streak there.

ALAN ALDA (NARRATION) The plan is to free the artery from the chest wall and sew it on to the patient's coronary artery just beyond the blockage. This approach to coronary bypasses is becoming increasingly common. What's different here is that the job of harvesting the chest artery will be done by a pair of robot hands.

RANDALL WOLF While operating, my hands, all that motion will be transferred to this miniature hand if you will inside the chest. This is the working end of the system. If you think about it, why do we make big incisions? We're working on small arteries, we're using tiny suture. Because our hands are large. That's why we make big incisions. And what this system allows us to do is feel like our hands are inside the chest but we haven't made the big incision. The first thing I do is, I take off my shoes. So, I'll be using both feet and both hands. So I take off my shoes and then pull up to the screen. You can see it's binocular vision. We're going to activate this now.

ALAN ALDA (NARRATION) Randy Wolf's workstation is the commercialized version of the one I checked out five years ago. The controls for moving the instruments are now much more sophisticated.

RANDALL WOLF When I turn my left hand like this, it does it. When I pinch my fingers together this pinches together. It feels very natural. I pinch, I let go. I turn right, I turn left. Any angle my wrist makes, it make at the tip. And this is very helpful in sewing vessels, like this. You grab a suture, you can run it like this. I'll give you a more panoramic view. Any wrist motion is replicated.

ALAN ALDA (NARRATION) As Randy moves his hands at the controls, across the operating room his actions are mirrored by the arms of a robot inside the patient's chest.

RANDALL WOLF The vessel is in this tissue right here. So I'm very gingerly, or gently, pulling down on it to open that up. And the first rib, the highest rib is right here. Rib number 1, number 2 here, number 3 here, number 4 here.

ROBERT MICHLER This is in simple terms, fun. It's fun because it allows us to do something that we love doing, which is heart surgery, but allows us to do it in a manner that is creative, in a manner the we think is going to benefit the patient by producing less trauma. OK, we're finished with mobilization. Note the time. So

an hour, exactly an hour and thirty minutes. OK? All right? Now that's long for us, but again, we were working under more unusual circumstances that usual.

RANDALL WOLF You didn't say extenuating, did you?

ROBERT MICHLER We were working under friendly fire.

ALAN ALDA (NARRATION) With the chest artery freed, the next job is to clip it so that it can be safely severed. Robert Michler inserts the instrument holding the clip.

ROBERT MICHLER How about right there? Maybe up a little bit?

RANDALL WOLF That's fine right there.

ROBERT MICHLER We'll give you scissors to divide it.

ALAN ALDA (NARRATION) The clips will seal the artery until it can be sewn to the coronary.

ROBERT MICHLER OK?

RANDALL WOLF Yup.

ROBERT MICHLER That looks good, don't you think?

RANDALL WOLF Yup.

ROBERT MICHLER Let's have the scissors back.

RANDALL WOLF There it is.

ROBERT MICHLER See the artery? That tube? So that's what we're going to sew to the surface of the heart.

ALAN ALDA (NARRATION) At this point in the operation, the robot's job is over. The Ohio State team is in the final stages of an FDA trial in which they have permission only to harvest the artery with the robot. Sewing it on to the heart still has to be done by hand. In the next phase of the trial, even this attachment of the artery to the coronary will be done by the robot.

ROBERT MICHLER The whole sewing on to the heart took us about ten minutes to perform. So once we have developed the technology with the robot to the point

where we can take the artery off the chest wall in ten or twenty minutes, it could shorten this operation dramatically from several hours to really under an hour.

ALAN ALDA (NARRATION) As well as being far less traumatic for the patient, the robot system could also make a big difference in the way surgeons learn new techniques. Right now Randy Wolf spends a lot of time on the road, training surgeons in the new technology. But that will change.

RANDALL WOLF If a Japanese surgeon wants to learn this system and they've got their first case and they want me to help them, I don't have to fly to Japan. We can go Internet 2, we can bring the image up, we can hook up my system to their system, I can mentor them, telementor them, while I'm sitting here at Ohio State University in Columbus Ohio and they may be in Tokyo, Japan. I'll get a lot less frequent flyer miles but I think I'll live longer.

ALAN ALDA (NARRATION) The next step for the robot surgeon here at Ohio State is to do a complete coronary by-pass operation -- something Randy Wolf has already done with a robot in Germany. Following that there are still more ambitious possibilities -- including doing heart surgery inside an unborn child.

RANDALL WOLF What's exciting to me is that it's all imagination. You really need to act like a little kid with this technology and use your imagination, because that's the only limit.

back to top

THE HEART FACTORY

ALAN ALDA (NARRATION) This is the story of a 20-year effort to develop an artificial heart -- an effort that, luckily for one of the players in this volleyball game, it was an effort that began to hit its stride in the early 1990s. Today the attempt to build a permanent artificial substitute for a failing heart may be on the brink of success. Back in 1993, Mike Dorsey's heart was so diseased that he was on the brink of death.

MIKE DORSEY I was very sick. I'd walk from here to you, and I'd been out of breath for that time. I couldn't do nothing. It gets a little frustrating when your wife comes and takes things from you, you know, and you can't carry them, you know, she would take them and carry them in for me. I wanted to do it, but just wasn't able to do it.

ALAN ALDA (NARRATION) Mike Dorsey was rescued from death by a pump implanted under his own heart that helped propel blood around his body. It was almost 12 years earlier that the artificial heart first hit the world's headlines. But Barney Clarke's brave struggle to live, and his death after 4 months, cooled the early enthusiasm for his artificial heart - the Jarvick 7. After a few more unsuccessful implants, the device was abandoned. But research on mechanical hearts continued. The most promising were pumps that weren't intended to replace the heart, but boost it. One of them was called the Heartmate. The designers of the Heartmate took a novel approach to a major problem of the Jarvick 7 - blood clots that would form inside of it, and that could kill when they broke off and traveled to the lungs or brain. The Heartmate's interior was roughened so that a thin layer of blood clots over its entire surface, and sticks there firmly. Mike Dorsey's problem - one that he shares with thousands of others each year - was a weakening of his heart muscles so that the main pumping chamber - the left ventricle - could no longer pump blood around his body. Installing the Heartmate begins with cutting a hole in the left ventricle and sewing in a short tube. Then the electric pump itself is implanted in the upper abdomen. Blood flows from the heart, through the pump, then back to the patient's aorta. By February 1993, Mike Dorsey's heart was near total failure. His doctors estimated he had just hours to live. Only weeks before, the Heartmate had been approved by the Food and Drug Administration for use at Fairfax Hospital in Virginia to keep a dying patient alive until a heart transplant could be found. The operation began with sewing into Mike's left ventricle the tube that connected with the pump. Then the Heartmate itself was slid into place. The connection was made between the pump and the heart it will assist. Finally, the pump's outflow tube was plumbed into Mike's aorta. The pump was switched on. And at this point, no one knew for how long it would need to keep pumping.

EDWARD LEFRAK Right now this device is approved by the Federal Drug Administration as a bridging device, that is as a temporary bridge to help a otherwise dying patient to make it to heart transplantation. We're hoping that its long-term role will be much greater than that, and that actually serve as a substitute for heart transplantation patient.

ALAN ALDA (NARRATION) Powered by batteries and controlled by a small computer at Mike's waist, the Heartmate clearly had the potential to be an alternative to heart transplantation. Seven months after the operation, it was still working fine - and Mike was still waiting for a transplant. The hospital exercise room had become only too familiar.

MIKE DORSEY It's not really me, I'd rather be moving where I have a destination to go to, instead of standing in one spot, looking at the same old scenery. This is the battery charger here, in order to be more mobile, take two batteries, these, just connect the power source from here.

ALAN ALDA (NARRATION) That's the alarm that went off if there was ever a problem.

MIKE DORSEY There's only one way they fit in. You just drop them into the pouch like this, fold the flap down. Now I'm ready for travelling.

ALAN ALDA (NARRATION) Mike's travelling was confined to the hospital - where he'd become a familiar figure. NURSE Hello Michael.

MIKE DORSEY Transplant Center.

ALAN ALDA (NARRATION) To pass the time and make himself useful, Mike helped out in the transplant center. He became an invaluable source of knowledge, advice and reassurance for other heart patients - especially those who might also need transplants.

MIKE DORSEY I've been here since January 27th.

MAN Six months, seven months, already.

MIKE DORSEY Yeah.

MAN Have you been out yet, been outside the hospital?

MIKE DORSEY Haven't left the grounds.

MAN Oh.

MIKE DORSEY I've threatened to, but I haven't left yet. The staff, the nurses and everything have been great, but it's almost like being in prison. I mean you gotta ask permission to do this and do that. You know. I can't just go outside my door, outside and get a breath of fresh air, without asking first, and stuff like that. It's the little things you miss in life.

EDWARD LEFRAK He was desperately ill, and dying when we put the device in. The unit has allowed him to recover, so that he feels well, perfectly well now, completely different then when he entered the hospital. And of course, he feels that he shouldn't be in the hospital.

ALAN ALDA (NARRATION) But the care and maintenance of the systems that keep Mike alive meant that leaving the hospital, even for a short trip - was a very big deal. A lot of things could have gone wrong.

MIKE DORSEY This tube down here is for the vent line so the, allows the pump to breath, in and out. It circles around, up here, and this little sock on here filters it. And you can feel the air coming in and out.

ALAN ALDA (NARRATION) The pump sucked air in and out with every beat. And if the air tube became blocked the pump would slow and eventually stop.

MIKE DORSEY So one night I had rolled over on this side, and it had got kinked over like that, and I'm looking at the screen up here, and the numbers start dropping down, and I'm wondering what's going on, and all of a sudden the alarm went off. And you know as soon as I sat up the alarm stopped.

ALAN ALDA (NARRATION) But the air tube could also be a lifeline -- offering the hope of at least a brief break from the hospital. This hand pump could be connected to Mike's air tube, and would keep the Heartmate pumping blood even if its power supply or computer control failed -- which is what happened unexpectedly during a routine check.

DOCTOR How are you feeling Mike?

MIKE DORSEY Okay.

ALAN ALDA (NARRATION) During the 5 or 6 minutes it took to figure out the problem -- a loose connection -- Mike's artificial heart was kept beating with the hand pump.

MIKE DORSEY Oh, just another day here I guess, to me.

ALAN ALDA (NARRATION) As long as the hand pump went everywhere he went, Mike had at least partial freedom, and he was able to stroll the hospital grounds. Mike was one of the first of what has become several hundred patients whose lives have been extended by the Heartmate while on the waiting list for a human heart.

MIKE DORSEY You gotta look at it both ways, unfortunately somebody's gotta pass away in order for you to have a donor. You know, and, I'm not gonna wish that on anybody, but at the same time I would like to be transplanted and released too.

ALAN ALDA (NARRATION) Mike's first taste of freedom came with a short trip with his family -- along with plenty of medical back up. Too cumbersome to itself be a permanent solution, the Heartmate was an important bridge not only for those like Mike awaiting human hearts, but also to the future of mechanical alternatives. Mike got his heart transplant only three weeks after this trip -- and

seven years later, he's still alive and well. Meanwhile, the Heartmate itself has been reborn -- and it is now small and efficient enough that it could soon be a practical alternative to heart transplantation. Like its predecessor, however, the Heartmate II is designed to assist a failing heart -- not substitute for it. But these chambers are incubating a device that is intended not just to help a heart, but to replace it entirely. We visited the factory where mechanical hearts are being manufactured by the hundred justa few weeks before the first one was scheduled to be implanted in a human patient. The Abiomed artificial heart is modeled on the human one, with two main pumping chambers and valves to control blood flow.

ALAN ALDA As the blood goes through there it pushes its way through but it can't come back the other way, right?

DAVID LEDERMAN Correct.

ALAN ALDA Can that be relied on, after it pumps thousands of times after you pass through, after it flexes thousands of times, to maintain that same resiliency?

DAVID LEDERMAN The answer is yes, and it's not thousands of times. It's approximately one hundred thousand times per day.

ALAN ALDA Oh boy.

DAVID LEDERMAN Which is close to forty million times per year.

ALAN ALDA Forty million times. You can flex this material forty million times…

DAVID LEDERMAN Without it breaking.

ALAN ALDA Not only breaking, but just weakening and softening and fluttering and that kind of thing.

DAVID LEDERMAN Correct.

ALAN ALDA So this is where you test the valves.

DAVID LEDERMAN Yes. This is where…We have many valves under test. And we test them under very severe conditions and at an accelerated rate so we can demonstrate twenty years equivalency in one year.

ALAN ALDA (NARRATION) Just like its rival, the Heartmate, the Abiomed heart is designed to avoid the danger of blood clots forming inside. But while the Heartmate has a deliberately roughened interior surface, the Abiomed heart aims

to be completely smooth and seamless. Clotting is also avoided by swirling the blood -- simulated here by a suspension of fish scales -- so that it doesn't pool anywhere inside the pump. But it's not until I get to hold the heart while it's pumping that I really appreciate how powerful it has to be to substitute for a human heart.

ALAN ALDA I can really feel the beating. Now interestingly, when you see a heart pumping, the outside of the heart is going like that, you see the motion on the outside. Here all the motion is inside this device. I've held this heart long enough, Would you mind holding that for a day or so?

TECHNICIAN So right now I'm going to take away the skin.

ALAN ALDA (NARRATION) This is a CT scan of a potential patient. Converted to computer graphics, the patient's body can be stripped of its major organs -- including most of the diseased heart. Then a technician at Abiomed can insert a virtual artificial heart into the virtual patient, helping the surgeon plan how best to fit the heart to the real patient during the operation. The Abiomed heart gets its power from rechargeable batteries that transmit their energy through the skin -- avoiding the tubes and wires that so plagued Mike Dorsey seven years ago. As well as being tested in tanks here at Abiomed, the entire system -- heart and power supply -- has been implanted in cows.

DAVID LEDERMAN Through our telephone lines we are dialing in to one of our implanted cows, somewhere in the United States. This one happens to be in Kentucky.

ALAN ALDA And it's standing near a window? What does that mean?

DAVID LEDERMAN It means there are several cows and one happens to be near the window. So we are monitoring….

ALAN ALDA So it's literally near the window.

DAVID LEDERMAN We haven't given them a name yet, so….

ALAN ALDA Now this is fascinating. So you're going to see now information coming in from a particular cow whose using one of these artificial hearts. And there it is.

ALAN ALDA (NARRATION) Similar real time data from the artificial heart will also be gathered from the first human patients.

ALAN ALDA How do they get a signal that's something's going wrong? They're having dinner and all of a sudden they get a phone call from you saying, lie down immediately. What happens?

DAVID LEDERMAN My first comment to you with regard to that question is wouldn't it be nice if we could do that with our natural heart?

ALAN ALDA Yeah, it would be.

DAVID LEDERMAN It would be very nice if we could have remote monitoring of hearts if anything goes wrong we would have an alert that tells us, gee, we can fix it, get to the hospital. Now how do you do that? We have cell phone technology so the patient has a cell phone. Now we can call the patient and say you the output of your heart is not quite what we think it ought to be so why don't you come back to the hospital?

ALAN ALDA (NARRATION) During our filming, Abiomed was already manufacturing hearts ready for implantation -- and was opening a new plant to scale up production further. Meanwhile, five medical teams in hospitals around the country are on standby, awaiting only approval from the FDA, before one of the teams implants the first of these hearts in a human patient.

ALAN ALDA Are you going to be extending a lot of people's lives because now they'll be able to have an artificial heart?

DAVID LEDERMAN We hope yes. The fact is that two thousand years ago the average life span was 30 years, and a hundred years ago the average life span was 47 years and today the average life span is 75 years. And there are a large number of people who reach 75 and beyond who are neurologically intact, who are very productive, and the only thing that's wrong is a hip, which we replace, or a muscle like the heart, which we should be able to replace. And there is no reason why the end o f life should come prematurely. And it doesn't matter what the age. You can be 80 or 90, if you are productive you should be able to live longer.
back to top

HOW'S YOUR HEART?

ALAN ALDA (NARRATION) Twenty miles west of Boston is a town whose chief claim to fame was once that it housed the world's first shopping mall. But today it can claim another honor-- that collectively its inhabitants have saved more lives, running perhaps into the millions -- than any other group of ordinary citizens in the world. The town is Framingham. Just over fifty years ago, five thousand of its

people signed up for what became known as the Framingham Heart Study. Year after year, those five thousand have allowed themselves to be hooked up to machines that monitored anything and everything that might conceivably have a connection with heart disease. Over the years, they've even recruited a few guests.

DAN LEVY Your blood pressure and heart rate are normal, they're responding in a very normal way to exercise. You look extremely comfortable and are not having any symptoms. There are some people who we put through here that do develop symptoms even during this minor amount of effort.

ALAN ALDA (NARRATION) The data from all those thousands upon thousands of tests are stashed away in the basement. Here are the medical records of both the original five thousand participants as well as the records of a second generation -- another five thousand who are the sons and daughters of the first volunteers.

ALAN ALDA You can find the very first person who was a participant in the study?

DAN LEVY Sure.

ALAN ALDA Ha, this is like a James Bond movie.

DAN LEVY This is participant number 001.

ALAN ALDA How old was this person when the study began?

DAN LEVY She was about 30 when the study began, and she died about 30 years after that. We're able by going back to look at the relationship between blood pressure or cholesterol or smoking habit and risk for developing cardiovascular disease over time.

ALAN ALDA How often did she come in for a round of tests?

DAN LEVY The original 5000 participants were brought back every two years. In fact right now we're in the midst of our 25th cycle of exams on the original study participants. And in fact 80% of our original participants have died. Twenty per cent though are still alive.

JOSEPH PAVIA I was only 39. I was working for ------ the car dealer. But I was raising my children, she and I, Lorraine.

ALAN ALDA You were only 32 when it started?

LORRAINE PAVIA We've been going over 50 years now.

JOSEPH PAVIA Yeah, been going over 50 years.

LORRAINE PAVIA And we've been going every two years, for exams. ALAN ALDA And has that been a bother for you?

JOSEPH PAVIA No it's great. I love it.

LORRAINE PAVIA You get used to it.

JOSEPH PAVIA You get a $500 exam for nothing.

LORRAINE PAVIA You know what he says, I feel great when I go in there and they always find something.

ALAN ALDA (NARRATION) We're having lunch with the Pavia family. From them and the others in the study we've learned most of what we know about the risk factors for heart disease -- things like high blood pressure, cholesterol, smoking. Indeed, the very term "risk factors" comes from the Framingham study.

BILL CASTELLI Half the men and women watching this program are going to die from some kind of a vascular disease in the United States.

ALAN ALDA (NARRATION) Bill Castelli ran the Heart Program for over 15 years, from 1979 to 1995.

BILL CASTELLI The average person who's, you know, at a risk to get a heart attack feels fine until the day they actually get the heart attack, and then they learn too late.

ALAN ALDA Well I guess that's what so important about having figured out that there are such things as risk factors. Because the risk factors are the ones that can tell you before you ever have a sign that you have a problem.

BILL CASTELLI That's right. See if the motors going good, you're not going to look under the hood.

ALAN ALDA Exactly.

BIRGITTA LEHMAN Mr. Alda. I'm going to tell you about this test. I'm going to inflate this blood pressure cuff for five minutes….

ALAN ALDA (NARRATION) The Heart Study is always on the look out for new and better predictors of trouble ahead. One of the latest candidate tests has Birgitta Lehman checking out the springiness of the artery in my arm -- a process which appears to involve first putting my arm to sleep by choking off its blood supply.

ALAN ALDA Why do you put that cloth here, to help my arm go to sleep, what is it?

BIRGITTA LEHMAN Somehow it reminds people that they shouldn't move it because they feel if they start moving their fingers they feel that they are moving it because it has a towel effect. Just my own invention.

ALAN ALDA Very good. A little thing like that, you see, a simple invention like that will save millions of lives eventually.

BIRGITTA LEHMAN So let me find your brachial artery. There, you have a beautiful artery, you don't see any bumps or any white stuff. It's just as clear and smooth as I ever seen it. I'm going to inflate the cuff now on your arm. It's going to be very, very tight and it happens very, very suddenly. Right now. Was that sudden enough?

ALAN ALDA That was pretty sudden, yeah.

ALAN ALDA (NARRATION) After five minutes of pins and needles…

BIRGITTA LEHMAN I'm going to release the cuff. You hear that? That's a great return, that's a great blood flow. It was like opening up a dam when I released the cuff, and the blood was just rushing forward. With very thick arteries, there's almost no change. There's almost no change. It takes so long for these stiff, stiff arteries to bounce open, it maybe takes them two to three minutes. So I don't get that psssh…, psssh… sound.

ALAN ALDA (NARRATION) Another test being explored in the Framingham Heart Study is a little more elaborate. But its goal is the same -- to find early warning signs of cardiovascular disease long before there are any symptoms. This magnetic resonance machine is at Beth Israel Deaconess Medical Center in Boston. Happily, they provide music.

TECHNICIAN We are going to start your first scan. It lasts for about a minute.

ALAN ALDA OK

TECHNICIAN OK Mr. Alda, take a breath in, blow it out and hold it, don't breathe.

ALAN ALDA (NARRATION) While I hold my breath the machine is making snapshots of my heart and chest. By taking pictures repeatedly as the heart is at different points of its beat, over time the computer can build up a movie of the heart in motion.

WARREN MANNING First we have good news. Everything looks very normal.
ALAN ALDA What do you mean, first you have good news? Is there going to be bad news latter?

WARREN MANNING No, no, everything looks very good. These are some images we first took of your heart. And this is your breastbone. We have your heart contracting right here. And this is the front part of your heart. You can see it's contracting vigorously, and the heart is the gray part and the blood inside your heart is this white cavity right here. And you can see that all the walls, this is the bottom part of your heart, are contracting vigorously, squeezing, squeezing, squeezing. That all looks very good. These are some images…

ALAN ALDA (NARRATION) It was fun seeing my heart beating. But the real goal of the test is to get an image of my aorta, the big artery that carries blood from my heart to the lower half of my body.

WARREN MANNING This is your aorta, it's a nice black tube. And you can see that thin white line surrounding the aorta is normal vessel wall. We don't see any plaque. Looks very nice.

ALAN ALDA My aorta looks so good I'm going to start sending it out instead of an 8 by 10. It's really nice

WARREN MANNING We can give you a picture if you like.

ALAN ALDA Yeah, that'll be great, you know, because I believe its what's inside that counts, you know.

ALAN ALDA (NARRATION) In contrast to my impeccable aorta, this one has a visible build up of plaque -- which while it's unlikely to cause problems itself could be a warning sign that plaque is building up in more vulnerable blood vessels -- like the coronary arteries of the heart itself.

ALAN ALDA When the day comes that we'll use this for screening the whole population, if that day comes, not only will you be able to tell me I'm liable to develop symptoms soon, but you can use this picture to actually design a drug therapy that's just right for me?

WARREN MANNING That's our long-term hope. For example, today we know that if your cholesterol is high, that we could treat you. We should treat all people with high cholesterol. But it may be that we find from studies like the one going on in Framingham that if your cholesterol is high, but you don't have any plaque on your MR, that we don't have to be as aggressive. Just diet therapy alone without taking pills is sufficient. Similarly we know that some people with low cholesterol still have heart attacks, still have strokes. It may be that those people actually have plaques in the aorta, and it's not the cholesterol we should be monitoring but actually the plaques themselves.

ALAN ALDA (NARRATION) In an even more ambitious project, Warren Manning -- as well as many other researchers -- is working on an MR technique to visualize directly the coronary arteries themselves.

ALAN ALDA So what do you think, do you think some day this is going to be so predictive that we'll be crazy if we don't regularly get an MRI?

WARREN MANNING I hope so. I think at some point people will blow out the birthday candles when they reach 40 or 50 and say it's time to have a screening MR. That day is not here today, but I believe it will be here in the future.

ALAN ALDA (NARRATION) Bill Castelli, who headed the Heart Study for over 15 years, now runs a clinic to motivate people to change their risk factors. It turns out that his simplest advice is also advice most of us don't want to hear.

BILL CASTELLI Most Americans would do OK if they just got the portion sizes down. I mean, I go to France a lot. The French, you say, oh, they eat such rich foods…

ALAN ALDA But they give you such little teeny portions.

BILL CASTELLI Yeah, you go to dinner in France and you think it's the hors d'oevres. It's the whole meal.

ALAN ALDA That's right. That's why I stay away from France. You ever go to Italy, now ah ha…

BILL CASTELLI That's a little better.

ALAN ALDA (NARRATION) For over 50 years, the Pavia family and their neighbors in Framingham have helped write the rules for avoiding heart disease. As it enters its second half-century -- and begins recruiting a third generation -- the Framingham Heart Study will be refining those rules to the point where we'll

each know precisely our risks for heart disease. Then -- it is as now, but more so -- it will be up to us.
back to top

return to show page