

The man with one of the '10 weirdest hearts in Ontario'

The Arnold and Lynn Irwin Cardiovascular Anesthesia Imaging Centre allows cardiac surgeons to visualize and create life-saving solutions

By **Renee Sylvestre-Williams**

A HEART SITS in a storage container filled with water. Joshua Qua Hiansen, a biomedical and industrial designer, takes off the cover and reaches in to grab the heart. It's black, made of silicone and is based on an actual patient's heart.

Other hearts sit on the shelves, interspersed with models of the lower lumbar region of the spinal column. In the background is the hum of 3-D printers. The small space, located in the Peter Munk Cardiac Centre (PMCC), is the Arnold and Lynn Irwin Cardiovascular Anesthesia Imaging Centre and it's helping cardiac surgeons and interventional cardiologists plan and prepare for surgery.

"We can actually make the hearts with the defects," says Dr. Massimiliano Meineri, an Associate Professor of Anesthesiology and the Director of the Arnold and Lynn Irwin Cardiovascular Anesthesia Imaging Centre.

It's also collecting, storing and sharing information and images of hearts, so that the medical community can access realms of information. "One of the reasons this lab was funded is because we do about 1,200 cardiac operations a year, and the 3-D images for those operations would get lost or stored on DVD and difficult to retrieve." Now they are stored on

a server, so they can be used for research studies and 3-D printing. Imaging the heart meant obtaining two-dimensional images of the heart and would give you "slices" or sections of the heart. Imaging has improved and now a patient is put under anesthesia and a special probe is inserted via the esophagus. The probe takes 3-D pictures of the heart and generates images, so the surgeon can see the heart beating in 3-D in real time and pinpoint the problem.

A 3-D model can also be created on the computer for the surgeons to visualize the patient's heart. "If a patient comes in with a complex congenital problem, it's harder to visualize and measure the exact area you need to get to," says Mr. Qua Hiansen, pointing to a model that had a hole in the wall between two chambers. "If we're

01 Kenneth Kubiak was born with a heart defect

02 Dr. Eric Horlick, centre, holds the model of Kenneth Kubiak's heart, as Dr. Max Meineri far left, and team look on.



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looking at it on the flat displays used for CT, it's difficult to get a sense of how big [the hole] is."

The lab can print the entire heart or a slice, depending on the surgeon's request. Now, thanks to the imaging centre, they can hold a model of their patient's heart in their hand from CT scans and use it to plan the best approach. This is what Dr. Eric Horlick, a Structural Interventional Cardiologist, did for a patient who has an abnormal heart. A model sits on Dr. Horlick's desk. The pulmonary veins branch from the top of a model of the left atrium. The model is made of an orange plastic and looks like a beautiful piece of coral. It's part of a heart from a patient with total anomalous pulmonary venous return, a disease in which the four veins that take blood from the lungs to the heart do not attach

normally to the left atrium but may attach to other areas of the heart or the great veins. It's a congenital heart disease, and children born with it need to have surgery as soon as they are diagnosed. The patient, Kenneth Kubiak, who has been described as having "one of the 10 weirdest hearts in Ontario," had his first heart surgery at SickKids in 1957, when he was seven. He had spent the first six Christmases of his life in hospital, and he spent 13 hours on the operating table.

"I like to say the surgeon said, 'Hold that candle closer; I can't see' because everything was so archaic back then," jokes Mr. Kubiak, in reference to the time and the knowledge doctors had of congenital heart disease. He was one of 12 patients with congenital heart disease in the hospital and now he's the only one still around.

Everything was fine until 2016, when he had a mini heart attack. He was at work when it happened. "I got really, really hot and I was out of breath. I said to the guys I was with, 'I don't know why, but I've got to sit down.' I sat down for about 20 minutes and then I got up and I felt okay. I wasn't feeling perfect, but I felt better."

That was about 6:15 that evening. Mr. Kubiak finished work at seven, went home and told his wife about the pressure in his chest. He was off work the next day but still felt the pressure on his chest. "It wasn't elephant syndrome or that sort of thing," he says. "But I felt uncomfortable." His wife, when she came home from work and heard this, insisted that they go to the hospital, where they were told that, yes, he did have a heart attack.

"[The doctor] said to me, 'It's not like how it's on TV where they fall down.' Sometimes it's very minimal."

pictures of the thing, but they're not showing me the right pictures. They're saying, 'Well, this is what's kinda happening' and I'm looking at this and I'm visual and I don't understand what's going on."

A diagnostic angiogram was arranged to sort things out, but Mr. Kubiak's ablation proved ineffective and he was in a very fast rhythm and because he wasn't on blood thinners, he was at risk for stroke, and the procedure could not be carried out optimally. He had another ablation in Kingston, a very complicated procedure, and unfortunately ended up in the ICU on dialysis and on a ventilator, mostly as a result of his disease.

Months go by, and Mr. Kubiak was still sick but then he miraculously recovered. The issue then becomes what to do about the initial problem. The first thing Dr. Horlick needed to find was the pinhole. "The first step was 'Where is it?' If you tell me it's on the roof of the atrium as opposed



"My questions are very technical. Is it tubular or is it a focal kind of area of narrowing? The second question is: Is this soft and fluffy? Is it fragile? Is it thick? Is it going to break? Is it going to stretch? And I don't think anyone was really certain of that. This gives me the orientation of where I need to go."

PMCC Cardiologist **Dr. Eric Horlick**, in reference to patient Ken Kubiak's heart

Mr. Kubiak was sent to the hospital in Kingston, where he stayed for 14 days, 12 of those where nothing happened. The staff were talking to the PMCC and just as Mr. Kubiak was about to sign himself out, he was transferred to the PMCC, where he met Dr. Horlick, who took on his case.

Mr. Kubiak's surgically-modified vein was providing some blood to the atrium, but things were not as they should be. Dr. Horlick described it as blood trying to get through a pinhole.

Mr. Kubiak didn't need surgery for a while but recently went through a few procedures. "He has a rhythm problem and he had an ablation in Kingston," says Dr. Horlick. "He's seen by one of our doctors. They're showing me

to further angled back or further forward, that's a good starting point. The other thing is you've got to figure out the geometry [of the surgery]."

Dr. Horlick needed to figure out how to fix the pinhole: Would a balloon work to enlarge the hole or would he need a stent? Stents in these unusual large spaces and chambers can dislodge, re-narrow and cause problems – not a trivial decision. The type of stent Mr. Kubiak would need is seven times the size of a stent placed in a coronary artery.

"When I was asking people where it was and what it looked like, they were saying, 'Well, we think it's here,' and I said, 'My questions are very technical. Is it tubular or is it a focal kind of area of narrowing?' The second



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[Dr. Meineri] and say, 'I'm doing a case next week.' and instead of waiting two to three weeks to send something off to be printed elsewhere, all this stuff is downstairs."

The 3-D models also have the advantage of being a low-cost option. Mr. Qua Hiansen says that each model costs less than \$20 to produce and less in some cases "It's low-cost in terms of the material," says Dr. Meineri. There is the cost of having someone build the model, and there are the costs of the printers. The lab currently uses low-cost printers because they're not a major financial commitment and are widely available. The lab does plan on getting more and versatile printers and printing more models, as requested. We cannot print implantable, custom-made heart valves and devices as yet, but it is a dream, says Dr. Meineri.

Mr. Kubiak says he's back to 95 per cent full health and is slowly working on gaining that additional 5 per cent. He's sleeping now, whereas before he was relying on medication, and he's working around the house. The only side effect that he sees is that he can no longer deal with the heat. Throughout the entire process, from diagnosis to surgery, he says he never had any fear. "I don't know how to thank them [at the PMCC]." ▽