
A. Bhimaraj, M.D., M.P.H.


M. Loebe, Ph.D.

AN INTERVIEW WITH DR. GEORGE P. NOON

Arvind Bhimaraj, M.D., M.P.H.

Facilitated by Matthias Loebe, M.D.

Houston Methodist DeBakey Heart & Vascular Center, Houston Methodist Hospital, Houston, Texas

"We [the Moderns] are like dwarves perched on the shoulders of giants [the Ancients], and thus we are able to see more and farther than the latter. And this is not at all because of the acuteness of our sight or the stature of our body, but because we are carried aloft and elevated by the magnitude of the giants," said Bernard of Chartres. I have had the extreme honor of working in an institution known for its significant historical achievements in cardiovascular medicine and where giants in our field have treaded such hallways. Dr. George P. Noon is one of them.


G. P. Noon, M.D.

Dr. Noon needs no introduction to those in cardiovascular medicine, having worked alongside Dr. Michael DeBakey and having had a separate and significant role in the development of continuous-flow left ventricular assist devices. I had the pleasure of sitting down with both Dr. Noon and Dr. Matthias Loebe, a close colleague of his, in January 2014 for a conversation about their early experiences and personal perspectives regarding the development of continuous-flow assist devices.

AB: What were some of your experiences in the earlier efforts to build a total artificial heart?

GN: In 1963, Dr. DeBakey testified to the appropriations committee headed by Mr. Hill, and he was able to get $10 million dollars appropriated to the NIH to develop an artificial heart program, at that time between Baylor and Rice University. In 1976, we had a joint program with the Soviets; their team was headed by Valery Shumakov, who performed the first heart transplant in Russia. We didn't come up with an artificial heart that was ever implanted in a human being, but we had a lot of fun collaborating with them.

AB: How did that collaboration start?

GN: We had operated on the head of the soviet scientific program, Mstislav Keldysh, in the 1970s. He was involved in the Soviet space program and got us connected with Shumakov for the artificial heart program.

AB: How did the association change from the Soviets to NASA?

GN: Baylor College of Medicine had an affiliation with NASA to study astronaut physiology, but it had nothing to do with mechanical assist devices. David Saucier was a NASA engineer who ended up receiving a heart transplant with us in 1984. Dr. DeBakey and I had discussions with him about whether his knowledge of rocket pumps could help us build a mechanical pump for humans. He introduced us to three engineers who had experience with axial flow pumps, which are used to pump fuel in a shuttle. We started working on it soon after he recovered from his surgery, and gradually that work became a formal association with some funding. I remember once when we were talking to the NASA scientists about the progress made, I commented to them, "I don't know how this is taking you so long when you are the guys who got a man to the moon," and they replied, "We got a lot more money to put those men on the moon!"

AB: The initial implants of continuous-flow pumps happened in Europe. How did the collaboration with those centers start? Was there work on continuous flow being performed in Berlin?

ML: All the development, design, preclinical testing, and so forth for the pump happened here [at Baylor], and when it came to clinical application, Drs. DeBakey and Noon went to Berlin and a couple of places in Europe. It ended up that Berlin was the place where the first pump was inserted.

AB: How was the concept born of sustaining life on a continuous-flow pump? Was it with the experience from the Hemopump?

GN: Right, that was a temporary pump. With the experience from the Hemopump, we knew that you could support a patient with that type of short-term circulatory support. Long-term support was still a doubt back then. There had been experiments done on cows at the Cleveland Clinic, where the animals were kept alive for 90 days or so with a completely pulseless state. They made it a reality in animals, but we didn't know if we could achieve similar results in human beings. We ended up having some early human experience in short-term support with the BioMedicus pump, where we were able to bridge a patient to transplant, and then I had implanted BioMedicus biventricular support in a patient who did very well for 2 weeks [he later developed sepsis and died]; this patient had no pulse at all in the pulmonary and systemic circulation.

AB: Dr. Loebe, how did you get involved in this work?

ML: I was a student at Baylor in 1982 when I became exposed to the work here. As a background, Berlin had a very active artificial heart program for many years, starting in the 60s. The primary focus was on total artificial hearts but also some work on LVADs. They had a conference at the German Heart Institute in 1994-1995, and that's when Dr. Noon came to Berlin and saw our work and facilities. After that visit to Berlin, the idea was born to collaborate. At that time they [the Baylor team] were working here on the Micromed® project, and they were approaching the point where they needed a place for the first clinical implant. So they looked at Vienna and Zurich and ended up in Berlin.

AB: It seems like the Micromed® DeBakey Noon ventricular assist device, being the first pump implanted in humans as a proof-of-concept for humans to survive without a pulse, doesn't get as much credit as it should. Is that fair to say?

ML: Yes. I don't remember all the details of the other pumps being developed at that time, but in 1998 the first implant was performed by us. Obviously there was a lot of research done before then, such as with the Nimbus pump in Pittsburgh [which later transformed to Heartmate II®] and the Jarvik 2000. When we were in the final phases of preparation to implant the Micromed pump, the British Broadcasting Company was making a documentary about the journey to the first continuous-flow pump implant with an assumption that the first implant would be the Jarvik in Oxford. I think they were all set up for this beautiful final stretch where the British would win and our story would be just a sideline, but we got there first.

AB: Who was the primary surgeon on the first implant?

GN: It was done by Roland Hetzer, Matthias, and me. We were all there together.

AB: Do you remember the patient, the scene, the mood, the excitement, and the anxiety? I can only imagine the complexity of the emotions for the first implant.

ML: I remember it very well. It was Friday, November 13, 1998, and the preparation leading up to the implant went basically in three phases. First, I visited the United States to perform some animal implants at Texas A&M University in College Station. Second, they [Dr. Noon and team] came to Berlin, and we implanted in an animal there. Finally, we found patients, and Dr. Noon and Dr. DeBakey's team came back for the first human implant. As I said, they were looking at Vienna and then Zurich. Professor Hetzer was extremely reluctant to do the implant because he was convinced that with continuous blood flow, we would not be able to extubate the patient, and, even if we could, that the moment the patient sat up he would die because you need pulsatility. This viewpoint really represented a lot of beliefs at that time. So Dr. Noon and his team was there and two TV crews were there, too.

GN: BBC was there.

ML: Yes. BBC was there and ABC also. I remember this reporter who had just come from Sudan, where he had interviewed a totally unknown leader at that time by the name of Osama Bin Laden. The news crews were all waiting while we identified a patient. The first patient we found was in terrible shape—with a balloon pump, intubation, sepsis—and I think we had two other probable patients lined up.

AB: Was the American delegation there when Hetzer was expressing concerns?

ML: They were all there, including Dr. DeBakey and his wife. Hetzer said, "You know, when we put that [continuous-flow pump] in the patient, he will die, you understand." So I told him very blatantly, "Fine, if you think we shouldn't do it then tell them [Dr. Noon and Dr. DeBakey]. They have a patient in Zurich and a patient in Vienna. They are just going to move on and do it there." Hetzer paused and said, "No, I'll do it, but I'll do it in a dead patient and then nobody can tell me that I killed a patient for trying."

GN: Well, this is news to me. We didn't know anything about these background conversations between Matthias and Hetzer!

ML (chuckling): Probably. I don't think you've ever heard this before. So this patient received the first pump, and he actually surprised all of us. He died a month later when somebody tried to do a percutaneous tracheostomy, and he bled profusely. At that time it was an impressive feat that this extremely ill patient recovered. After that initial success, I think we did a second one right away, and then Drs. DeBakey and Noon moved on to Vienna.

GN: Yes. We did the next in Vienna.

AB: It was a short period of time with immediate success. So did you come back and start implanting in the United States?

GN: We started a few years later in 2000.

AB: Will the Micromed® DeBakey Noon VAD pump come back for clinical use?

GN: They are coming back in Europe right now and there are some implants that are scheduled in Turkey.

ML: The two great advantages Micromed has now are the remote monitoring and the flow meter in the outflow graft, with which you can really see the true flow and not just calculated flow like with the current pumps. I think this makes a huge difference. In fact, in the beginning, with the Micromed pump, we would see flow going down when there was a buildup in the pump, so we treated that aggressively, and the incidence of pump thrombosis was greatly over-reported. With the Heartmate II, it was probably under-reported or not picked up due to a calculated or presumed flow.

AB: What were some nuances that you remember thinking about continuous-flow [CF] physiology?

GN: We were the first team in the world that showed that you can resuscitate patients with CF physiology, that you can recover them and bring them back to normal activity. In the early days, we didn't know how much flow we needed because studies done by Yuki Nose showed that you needed a high-flow state. Then we realized that with low flows of even a cardiac index of 2 or 2.5, it was sufficient for the patients to get around. We also didn't know what would happen if patients were just in a fixed RPM mode and started to get more active. Well, it turns out that they are able to get around and probably compensate with changes in the hemodynamics—with an increase in heart rate, deltaP, and flow—without having a problem.

AB: With so much doubt prevailing, do you have a visual memory of the first patient getting up and walking?

GN & ML [concurrently]: The second one.

ML: The second patient was extubated, got up, and walked around. Today it sounds so funny that back then we were arguing whether a patient could be extubated or could ambulate as the vast majority of the people in the field were skeptic.

AB: So was the first patient not extubated because of such skepticism?

ML: No, it's just that he never got healthy enough to be extubated, but he lasted long enough to show that continuous flow works and organs do recover. The second patient did leave the hospital. We have come a long way, but to this day there is very little understanding of the importance of a pulse in this patient population. I think another fact worth emphasizing is that the Jarvik pump implantation went to the descending aorta, because at that time it was believed by some that these pumps could only be used as "booster pumps" to shift the starling curve to a better state. It was highly propagated by those who did a lot of Jarviks. Hence, with the Jarvik you never got nonpulsatile flow; the aortic valve always opened.

GN: A major issue with the Jarvik was that by placing the outflow graft into the descending thoracic aorta, we got stasis around the aortic root and the aortic valve thrombosed. So you had to decrease the flow enough to let the valve open. Because of this, Jarvik actually considered his pump as pulsatile.

ML: Yes, so Jarvik's pump would always run low to let the aortic valve open. I think a lot of the patients remained in heart failure and did not do that much better because they had very

minimal support. There were so many concepts and controversies floating around about what these continuous flow pumps could achieve or not achieve. We sometimes forget how controversial this entire concept was back then.

AB: I think we take a lot of physiological aspects for granted because we are seeing patients with CF pumps look and feel good. The sense of uncertainty that pioneers like you and others endured should be a reminder to the current generation that more work is needed to understand the physiological implications of a loss of pulse. Dr. Noon, when you started working on the concept of continuous-flow pumps, did you ever imagine that they would become so mainstream for end stage heart failure and that we would be dealing with such unique complications?

GN: We had no idea. Our focus was to support patients for long enough to get them a heart. It is very gratifying to see how many patients we are able to help with the current generation of left ventricular assist devices. I feel amazed when I give the opening speech for our LVAD patient celebration day and see people who look like nothing happened to them, with their silent humming pumps underneath their clothing.

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