Discussion

Dr David L. Morales (Cincinnati, Ohio). Sam, I want to congratulate you on a wonderful presentation and really all the authors on an article that will serve as a great reference to our specialty and growing interest in VAD therapy in children.

Now, the inability to support stage I patients with a VAD really highlights the use of salvage VADs, which are VADs used after an unsuccessful palliation, with these patients subsequently going to ECMO then a VAD. This type of patient has been shown repeatedly in many studies to have extremely poor results regardless of a single-ventricular or a biventricular physiology. Trying to salvage a failed Norwood is just the extreme example of salvage VADs, and it is why their outcomes here are so poor with 89% mortality.

I have 3 questions regarding this group.

Of the stage I patients who were supported during the neonatal period, how many were on ECMO then a VAD or on a VAD switched to ECMO?

The second question is: What was the time from operation to VAD for the stage I group?

And 3, was any Norwood discharged from the intensive care unit or home before moving to a VAD?

Dr Weinstein. David, thank you very much for your comments and your questions. Your expertise in this field is well recognized, and I have greatly appreciated your advice and personal insight as we have established our own assistance program at my institution.

Four of the 5 neonates who had a VAD implanted were patients who were already on ECMO. There was 1 neonate whose first surgery was an LVAD and a BT shunt, but this patient was converted to ECMO in the operating room for failure to support the cardiac circulation. All stage I patients in this review regardless of age were on ECMO before placement of the device.

Unfortunately, we do not have the information on previous surgeries or discharge data. However, regarding the patients who had a VAD implanted within 30 days of life, I think we can infer that their palliative procedures, ECMO, and subsequent VAD were all in close proximity. As well, there were 3 stage I patients who were aged 7 months, 8 months, and 17 months at the time of VAD implantation, and it may also be inferred that some of these patients were discharged home or at least achieved some form of stability before placement of their mechanical assist device.

Dr Morales. Even with the Glenn cohort, a Glenn who fails in the first few days after surgery is much different than a Glenn who goes home and comes back with a failing systemic ventricle. The Glenn that goes home and returns should be able to be successfully supported, where the one that immediately fails in the intensive care unit again is a salvage VAD and probably would not do well. So with regard to this group, what was the time from Glenn to VAD for survivors and nonsurvivors?

And 2, did any of the Glenns go home and return for their VAD, and what was their survival compared with those who never left the hospital?

Dr Weinstein. The Berlin Heart database does not have the data on the timing of any procedures performed before the VAD, but the median age of patients undergoing a VAD implant with Glenn shunt physiology was 2 years, and the oldest patient was 13 years. For similar reasons, I assume several of these patients left the hospital, some for perhaps a significant amount of time. So I think that these data support your presumption that the further out you are from any one of your staged palliations, the more likely you are to survive VAD support.

Dr Morales. And just a final comment. Single-ventricle patients are not different than other congenital patients and a failed palliation supported with a VAD will probably result in poor outcomes; however, the single-ventricle physiology just emphasizes this point.

Having said that, VAD therapy in patients who have systemic-pulmonary shunt and the late-failing Fontan are unique challenges compared with other single-ventricle patients and ones that we will have to continue to investigate I think. But again, you and your authors have given us a great first step with this article. Thank you.

Dr Christopher A. Caldarone (Toronto, Ontario, Canada). Sam, could you comment a little bit on the overall interpretation of your presentation. I mean, it sounds quite dismal in terms of the concept of mechanical support for the failing single ventricle, but that may be a function of some immutable bit of physiology among single-ventricle patients or it may be that we are just too slow to pull the trigger and go to mechanical support. This is a decision we wrestle with constantly. And can you get any insights from the data that you have here?

Dr Weinstein. I think that success is related as much to age as to stage, and I am not sure which variable is the most important. There were 4 patients who were supported with ECMO before VAD implantation who were not shunted patients, 2 Glens and 2 Fontans. And 3 of those 4 survived. So I think that for neonates and for shunted patients, and as a salvage procedure, it
does not seem, from this small group only, that it would be warranted. But I do think for older patients, patients that may be further out from stage II or stage III palliation, it is very much worth considering.

Dr Pedro J. del Nido (Boston, Mass). Do you have any information about, especially focusing on the neonatal group, the need for CPR before any mechanical support, either ECMO or if you went straight to a VAD? Do you have any data about that group? Because I would think that need for CPR may be the trigger point for you to decide whether you are going to put a child on this long-term assist or not.

Dr Weinstein. That is an excellent point. Unfortunately, the information about CPR or other status before ECMO implant is anecdotal.