pathway. Identifying neonates who will not do well with any approach may be the most important part of the next chapter.

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Commentary: Neonatal heart transplant: A good option in a bad situation

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Lin and colleagues¹ present an excellent analysis of 30 years of outcomes data for neonatal orthotopic heart transplantation with a single institution retrospective study. This study is among the few long-term outcome series for neonatal transplant and is a valuable addition to the literature. The outcomes are generally favorable, suggesting neonatal transplantation as a reasonable approach to congenital cardiac malformations where the risk of palliative surgery is high.¹ This study focuses on neonatal cardiac transplants, due to the excellent outcomes described in this cohort, believed to be due to immunologic privilege.²

Children's Hospital Colorado was an early advocate of neonatal heart transplantation, and accrued a series of 21

CENTRAL MESSAGE

Three decades of data at a single institution have shown favorable outcomes with neonatal heart transplantation. Frequency of neonatal transplant is decreasing as palliative surgical outcomes improve.

patients over 30 years highlighting the rarity of this operation overall. Furthermore, only 3 transplantations took place over the most recent decade, indicating an overall decline attributable to improved surgical palliative strategies such as the Norwood operation and its modifications.³ It is notable that a neonatal transplant has not been performed at this center since 2016.

Survival at 5 years was 75% (95% confidence interval [CI], 46%-86%), at 10 years 72% (95% CI, 45%-85%), and at 20 years 60% (95% CI, 26%-70%). Transplants in patients listed as neonates, but transplanted after the neonatal period, showed similar survival rates. Rejection

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episodes occurred in 67%, and retransplantation in 10%. The incidence of coronary allograft vasculopathy was 40% and post-transplant lymphoproliferative disease was 15%. No preoperative or intraoperative variables were identified as predictive. Waitlist mortality was 25%, with an average wait time of 74 days for those receiving a transplant. Extracorporeal membrane oxygenation was the only form of mechanical circulatory support used in pretransplant patients. The authors note that transplant survival must be assessed within the context of overall survival while listed, and give some targeted recommendations on potential expansion of the donor pool.

The strength of this study is the reporting of relatively long-term outcomes data for an operation that has only been performed since 1984. Limitations were generic and related to retrospective chart reviews, small number of subjects, and likely incomplete capture of changing variables and frequency by decade.

This analysis deals with a very challenging group of patients. Issues in this patient population include not only the fragility of the neonatal patient as a whole, but also of the tenuous circulation present in these patients. Based on this study, neonatal heart transplantation is an excellent alternative to high-risk palliative strategies. Despite advancements in palliation techniques, there are likely high-risk anatomic considerations where primary transplantation would yield superior long-term outcomes in overall survival and freedom from reoperation or hospitalization. However, we take issue with the statement that neonatal heart

transplantation has fallen out of favor—as if this were a reasonable choice. The paucity of appropriate donors for neonates, the prevalence of single-ventricle heart disease, and the progressive improvements in outcomes for palliative surgery make neonatal heart transplantation a strategy that should be reserved for relatively unique situations. Another problem with this strategy is supporting the highest risk patients with the most fragile circulations until a suitable donor is available, which sometimes necessitates a salvage palliative or reparative approach.

As technology progresses and high-risk anatomy can be further delineated, there will be instances where primary transplantation is the preferred strategy. Future comparison studies with long-term results may be beneficial for improving patient selection. These data reassure us that in the privileged group of neonates that successfully undergo heart transplantation, outcomes are good. Given the overall need, efforts are also needed to improve palliative and reparative surgical, and medical, and mechanical support options for the highest-risk neonates.

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