congenital heart disease is important across several domains: prenatal counseling, assessment of programmatic variation in outcomes, and risk modeling to name a few. Therapeutic decision making and its fit with growth-restricted patients is another vast and largely uncharted area for future investigations.³

In its purest form, athletics (as in many other disciplines) teaches lessons about character, pain and loss, joy and fulfillment—lessons about life. The somewhat glib but nonetheless spot-on observation of a master at his discipline

applies some 30 years later to the field of neonatal cardiac surgery: You're a lot better off if you're bigger.

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Commentary: The growing problem in congenital heart surgery

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In this issue of the *Journal*, Steurer and colleagues¹ carefully separate the risk of absolute weight and that of being born small for gestational age in patients undergoing congenital heart surgery. Their work adds to a growing body of evidence on the adverse effects of low birth weight z-score on surgical outcomes. The strength of this study is the large and nationally representative patient population from the Society of Thoracic Surgeons Congenital Heart Surgery Database, allowing a robust evaluation of the risk of even mild growth restriction. The finding that patients with a birth weight z-score between -1 and -0.5 have 38% increased mortality compared with those with just a slightly improved birth weight z-score between 0 and $+0.5$ is of major impact. For perspective, in a 39-week gestation male, this

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CENTRAL MESSAGE

Although weight is an important determinant of outcomes after congenital heart surgery, the ability to grow, even prenatally, is equally important. Strategies to address this increased risk are untested.

approximates a birth weight of 2.9-3.15 kg versus 3.35-3.6 kg. This is of particular importance, given that the average patient undergoing the Norwood procedure is in this higher-risk group.^{2,3} Nearly as striking from this study is the additive effect of early term delivery, particularly for infants born at 37-38 weeks of gestation.¹ Most diagnoses of congenital heart disease necessitating neonatal intervention are now made prenatally,⁴ and delivery dates are often scheduled. Although recent publications demonstrating the detrimental effects of even slightly early delivery⁵ have attempted to push back elective timing, 75% of the patients in this study were born at ≤ 39 weeks.

Although this study explains some of the variation in outcomes of congenital heart surgery, it is unable to elucidate best ways to mitigate risk. Fundamentally, we lack understanding of the cause. Postnatal poor growth in patients with congenital heart disease has been well studied, and preoperative and postoperative interventions that address growth and nutrition have improved outcomes after congenital heart surgery.^{6,7} The fetal environment introduces additional complexities, however. Maternal health status and nutrition,⁸ as well as the placenta's ability to deliver appropriate nutrition, impact growth. Placental insufficiency, likely related to increased placental resistance, has been associated with worse growth measures and neurodevelopment outcomes at age 2 years.⁹ Both prenatal and postnatal interventions could be of benefit. Maternal health interventions before delivery could optimize the fetal environment to maximize fetal growth. As Steurer and colleagues note, one strategy already in use postnatally involves palliating patients with pulmonary artery bands or hybrid procedures to augment growth before more definitive surgery. Unfortunately, we do not know the impact of such strategies on long-term outcomes. Given the increased risk associated with multiple operations which patients benefit from this delay in timing of their more definitive operation remains unclear. Optimal timing of intervention remains one of the most important current questions in congenital heart disease and is, unfortunately, a difficult one to answer.^{10,11} Precise timing of operation and congenital heart disease care, not merely counseling, in fetal life may prove critical for continued improvement in outcomes rather than simply adjusting for risk.

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