many of these valves are not and will not be amenable to a long-lasting repair). Some of us are working on it. Time is pressing.

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Commentary: When complicated statistics may be the best way to answer questions on complicated hearts

Joshua L. Hermesen, MD, Glen E. Levenson, PhD, and Petros V. Anagnostopoulos, MD, MBA

In this issue of the *Journal*, Guariento et al¹ report on a large single-center series of patients with truncus arteriosus treated at Boston Children's Hospital over a 34-year period. The real contributions of this article are not only the relatively unsurprising clinical conclusions regarding the impact of truncal valve insufficiency and original right-sided conduit size on mortality and the risk factors for reintervention, but also the reintroduction to the congenital heart surgical community of the statistical methods used to arrive at those conclusions.

Although surgeon-specific mastery of statistical methods varies considerably, all have some familiarity interpreting the normative Kaplan-Meier (KM) and Cox proportional hazard (CPH) outputs. So what is this "modulated renewal competing risk analysis," and how does it differ from what we are more accustomed to? Technically speaking, it is a modeling approach that allows for multiple types of outcomes and multiple observations/events per patient

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CENTRAL MESSAGE

The statistical methodology used in this single-center study of patients with truncus arteriosus patients should be more widely considered for studying patients with congenital heart disease.

over the course of the follow-up period.² Patients are not censored after the first occurrence of interest, save for mortality, which may be cause-specific. Whereas KM curves are graphical representations of raw data, the curves in this article depict the results from "modeling" survival based on functions and their associated parameters. The reason for the parallel colored lines that may catch one's eye and distinguish them from more familiar KM curves is that there is an underlying exponential function assumed to best represent overall survival, and group differences are estimated using a parameter of that function.

This methodology is not novel in our field but is more commonly used in fields such as oncology, where the question is whether the patient died from their cancer or from some other cause. We commonly ask ourselves similar questions, such as whether the patient died from their cardiac disease or from some comorbid condition or genetic syndrome.³ Our statistician colleagues inform us that accounting for competing risks is generally a more statistically robust and sound methodology that can help account for the fact that death and loss to follow-up may not be

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the same thing when performing an analysis, a fact missed in KM and CPH methodologies.

We are left wondering whether this type of analysis should become more (or “the”) standard for longitudinal analyses after congenital heart surgery. In the least, it is a valuable tool providing results that could be added to, or compared with, those based on the more typical KM or CPH approaches. We all care most about the long-term outcomes of our patients and are constantly questioning how our decisions and actions during relatively short episodes of care affect them over the life span. This kind of analysis may help us better answer some of the questions that we all

have about complicated patients in whom structural heart disease is often only one of multiple, and competing, risks they continually face.

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Commentary: As good as new: Using modulated renewal to analyze reintervention after truncus arteriosus repair

Mohan J. John, MD, and Travis J. Wilder, MD

As survival for patients with congenital heart disease (CHD) continues to improve, it is important to continuously evaluate our measures of success for these patients. In the current era, the goals of care have expanded beyond simply improving survival. As such, management strategies aimed at optimizing functional performance and overall quality of life should be carefully considered. Such aims are particularly relevant for patients with truncus arteriosus (TA). Although complete repair in early infancy is the established standard of care, with a reported survival rate of 76.8% at 20 years,¹ the morbidity for patients with TA is incurred in the form of multiple reinterventions. Because

Hypothetical repeated reinterventions after truncus arteriosus repair.

CENTRAL MESSAGE

Modulated renewal analysis of truncus arteriosus repair provides strategies to help improve the durability of intervention.

the right-ventricular outflow tract needs to be reconstructed with a right ventricle-to-pulmonary artery (RV-PA) conduit during the initial operation, multiple RV-PA conduit reinterventions are required.² In addition, these children may need truncal valve (TV) reoperations, especially in the setting of abnormal TV morphology.^{1,3,4} For patients with TA, surgical strategies that minimize the frequency and invasiveness of reintervention would improve their quality of life and perhaps improve long-term survival.

As clinicians caring for patients with CHD, we often modify clinical and surgical practices in an effort to provide the most contemporary, evidence-based care. Similarly, it is

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