beneficial detailed approaches to the care of single ventricle patients. The next steps for improvement may well come from the second interstage.

References

1. Stern HJ. Fontan "ten commandments" revisited and revised. *Pediatr Cardiol*. 2010;31:1131-4.
2. Ghanayem NS, Hoffman GM, Mussatto KA, Cava JR, Frommelt PC, Rudd NA, et al. Home surveillance program prevents interstage mortality after the Norwood procedure. *J Thorac Cardiovasc Surg*. 2003;126:1367-77.
3. Callahan CP, Jegatheeswaran A, Barron DJ, Husain SA, Egtesady P, Welke KF, et al. Factors associated with mortality or transplantation versus Fontan completion after cavopulmonary shunt for patients with tricuspid atresia. *J Thorac Cardiovasc Surg*. 2022;163:399-409.e6.
4. Kulkarni A, Patel N, Singh TP, Mossialos E, Mehra MR. Risk factors for death or heart transplantation in single-ventricle physiology (tricuspid atresia, pulmonary atresia, and heterotaxy): a systematic review and meta-analysis. *J Heart Lung Transplant*. 2019;38:739-47.
5. Baek JS, Park CS, Choi ES, Yun TJ, Kwon BS, Yu JJ, et al. The impact of additional antegrade pulmonary blood flow at bidirectional Glenn shunt on long-term outcomes. *J Thorac Cardiovasc Surg*. 2021;162:1346-55.e4.
6. Nathan M, Gauvreau K, Liu H, Pigula FA, Mayer JE, Colan SD, et al. Outcomes differ in patients who undergo immediate intraoperative revision versus patients with delayed postoperative revision of residual lesions in congenital heart operations. *J Thorac Cardiovasc Surg*. 2014;148:2540-6.e1-e5.
7. Lamers L, Jimenez EE, Allen C, Hoyme D, Lushaj EB, Anagnostopoulos PV. Intraoperative completion angiogram may be superior to transesophageal echocardiogram for detection of pulmonary artery residual lesions in congenital surgery. *Pediatr Cardiol*. 2018;39:884-91.

See Article page 399.

Commentary: There are no facts, only interpretations

Bahaaldin Alsoufi, MD

In the current issue of the *Journal*, Callahan and colleagues¹ report their study of infants born with tricuspid atresia and normally related great arteries from the Congenital Heart Surgeons Society (CHSS) cohort. They focused on outcomes following cavopulmonary shunt (CPS) and examined factors associated with Fontan completion, death, or transplantation following CPS. They found that by 5 years after CPS, 5% of the patients died or underwent transplantation and 91% transitioned to Fontan. They determined that preoperative moderate or greater mitral regurgitation, concomitant mitral repair, a pulmonary artery band (PAB) at CPS, and postoperative superior vena cava interventions, including CPS takedown, were associated with death or transplantation. In addition, a PAB at CPS and prenatal diagnosis were associated with decreased Fontan completion. They concluded that several risk factors contributed

Bahaaldin Alsoufi, MD

CENTRAL MESSAGE

Causality between risk factors and outcomes might be difficult to explain, thus limiting our ability to recommend practice changes that would improve results.

From the Department of Cardiovascular and Thoracic Surgery, University of Louisville School of Medicine, Norton Children's Hospital, Louisville, Ky.

Disclosures: The author reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

Received for publication April 25, 2021; revisions received April 25, 2021; accepted for publication April 26, 2021; available ahead of print May 2, 2021.

Address for reprints: Bahaaldin Alsoufi, MD, Department of Cardiovascular and Thoracic Surgery, University of Louisville School of Medicine, Norton Children's Hospital, 201 Abraham Flexner Way, Suite 1200, Louisville, KY 40202 (E-mail: balsoufi@hotmail.com).

J Thorac Cardiovasc Surg 2022;163:411-2
0022-5223/\$36.00

Copyright © 2021 by The American Association for Thoracic Surgery
<http://dx.doi.org/10.1016/j.jtcvs.2021.04.079>

to the mortality following CPS, and that a PAB at CPS contributed to both death and lack of progression toward Fontan.¹

The CHSS has accumulated a large number of patients who were enrolled in numerous study cohorts, including patients with tricuspid atresia. Their sophisticated analyses of these cohorts have contributed to our understanding and subsequently have helped shape the management strategies for various complex congenital heart defects. Advantages of these CHSS studies include the large cohort, the comprehensive dataset, and the long follow-up. Disadvantages include the differing practice patterns among centers and the common lack of clinical information that often

contributed to decision making. Repeatedly in the CHSS studies, some demographic, morphologic, clinical, and surgical factors are identified as significantly associated with outcomes without the ability to clearly explain the cause-and-effect nature of this association and thus propose a clear inference.

Callahan and colleagues identify a number of factors that influence death, transplantation, or progression toward Fontan completion. For some of these factors, an explanation might be clear and generally agreed upon; for others, this might be subject to interpretation, and different physicians might have different takes on the findings presented in this study. The German philosopher Friedrich Nietzsche is quoted as saying “there are no facts, only interpretations,” and this is surely applicable in medical research, with the current study as a good example.

I feel that the reality of multistage management of single ventricle anomalies is that a number of patients will not qualify for or will fail this strategy for various morphologic or hemodynamic reasons.² The way to improve the outlook for these patients is to identify those who are not candidates for multistage palliation or who are not making progress at various palliation stages, and to timely triage these patients toward the only available alternative, heart transplantation.

Callahan and colleagues introduce a number of factors that were associated with outcomes in their study; the question is, can we learn something from their conclusions to influence our decision making? My interpretation of some of their findings might differ from those they propose. Consequently, I feel that this study might be one that brings up some problems without providing clear insight on potential solutions. For instance, prenatal diagnosis was associated with lack of progression toward Fontan—how does one interpret that? It is unlikely that prenatal diagnosis is identifying the higher-risk patients, and there is almost certainly no interconnection with decreased Fontan completion. Given the obvious clinical and emotional advantages of prenatal diagnosis, avoiding it would seem undoubtedly pointless. Mitral regurgitation was associated with death or transplantation, and so was mitral valve repair. Again, what does this mean? Should valve repair not be attempted? Should these patients not be considered candidates for multistage palliation? Is the mitral disease manifestation of a ventricular pathology? Drawing a conclusion is tough, given the lack of important information regarding morphologic and hemodynamic data and quality of repair.

Another factor that is more susceptible to different interpretations is a PAB at the time of CPS, which the authors

found to be associated with decreased Fontan completion and also with death. Surgeons have different philosophies about this controversial practice.³⁻⁵ Unfortunately, the current study does not offer any help in addressing this controversy. It remains unknown whether the PAB was placed as part of routine surgeon preference or because of anatomic factors (eg, hypoplastic pulmonary arteries, small bilateral superior vena cava) or hemodynamic reasons (ie, higher-risk patients). It also remains unknown whether not performing Fontan was due to poor candidacy (does not seem to be the case) or higher saturation in those with a PAB (owing to the hepatic factor and consequently lower development of arteriovenous malformations). Thus, delaying Fontan might be a planned strategy and not necessarily a negative endpoint.⁶ On the other hand, it could be that PAB with CPS is associated with increased complications and directly associated with worse outcomes, and it also could be that PAB is a proxy for morphology (obviously, patients with pulmonary atresia or severe stenosis will not get a PAB).^{4,5,7}

In short, it is inevitable that some single ventricle patients will fail to qualify or progress in the multistage palliation strategy. Timely identification of these patients to direct them toward heart transplantation is the only valid alternative that can improve survival. The causality relationship between some factors and outcomes is clear; however, it is less defined for other factors, underscoring the need for careful interpretation of study findings before implementation of practice changes.

References

1. Callahan CP, Jegatheeswaran A, Barron DJ, Husain SA, Eghtesady P, Welke KF, et al. Factors associated with mortality or transplantation versus Fontan completion after cavopulmonary shunt for patients with tricuspid atresia. *J Thorac Cardiovasc Surg.* 2022;163:399-409.e6.
2. Alsoufi B, Gillespie S, Kim D, Shashidharan S, Kanter K, Maher K, et al. The impact of dominant ventricle morphology on palliation outcomes of single ventricle anomalies. *Ann Thorac Surg.* 2016;102:593-601.
3. Ferns SJ, El Zein C, Multani K, Sajan I, Subramanian S, Polimenakos AC, et al. Is additional pulsatile pulmonary blood flow beneficial to patients with bidirectional Glenn? *J Thorac Cardiovasc Surg.* 2013;145:451-4.
4. Cleveland JD, Tran S, Takao C, Wells WJ, Starnes VA, Kumar SR. Need for pulmonary arterioplasty during Glenn independently predicts inferior surgical outcome. *Ann Thorac Surg.* 2018;106:156-64.
5. Alsoufi B, Manlhiot C, Awan A, Alfadley F, Al-Ahmadi M, Al-Wadei A, et al. Current outcomes of the Glenn bidirectional cavopulmonary connection for single ventricle palliation. *Eur J Cardiothorac Surg.* 2012;42:42-8; discussion 48-9.
6. Grelli S, Boulitrop C, Van Steenberghe M, Maldonado D, Bojan M, Raisky O, et al. Bidirectional cavopulmonary shunt with additional pulmonary blood flow: a failed or successful strategy? *Eur J Cardiothorac Surg.* 2012;42:513-9.
7. Alsoufi B, Schlosser B, Mori M, McCracken C, Slesnick T, Kogon B, et al. Influence of morphology and initial surgical strategy on survival of infants with tricuspid atresia. *Ann Thorac Surg.* 2015;100:1403-9; discussion 1409-10.