Authors have nothing to disclose with regard to commercial support.

matters. We read with interest the institutional protocol reported by Galantowicz and Yates¹ for second-stage management of these patients. Their work is a tremendous contribution to the literature on this subject; however, both they and the accompanying editorial fail to adequately appraise the published literature.

First, Galantowicz and Yates describe a learning curve in terms of patient selection for a comprehensive second stage identical to that recently published by our group.² They advise “avoidance of procedures on an emergent basis or in patients aged <3 months” and “use of a systemic PA shunt in cases of too-small superior vena cava and/or PA.” Our own learning curve and subsequent published protocol advises avoidance in those “with suspected increased pulmonary vascular resistance...; those presenting with an indication for an early second stage...; those with anomalous pulmonary venous drainage, in whom intervention on the superior vena cava or longer complex procedure is anticipated; and those in whom better development of branch PA is required.”²

Second, there is already wide agreement that the branch PA banding during the hybrid procedure makes later reconstruction difficult.³ Moreover, our group and others have described the anatomic LPA constraints between the neo-aorta and descending aorta.^{4,5} These factors increase the risk of thrombosis. In the presented series, implementation of an exit angiography revealed 4 patients requiring LPA reintervention. This vigilance, rather than anticoagulation, could be responsible for the absence of further thrombosis. In our own comprehensive second-stage series, the sole case of thrombosis was due to a kink in the branch PA.² Furthermore, there are no reported cases of late thrombosis in our series or in that of Galantowicz and Yates to support a 6-week policy of anticoagulation.

We agree with the editorial by Sanjiv Gandhi, that the ultimate goal is to push patients forward to the comprehensive stage II. However, our published experience agrees with that reported by Galantowicz and Yates—that is to say, there are clear indications for a “2-stage” second stage (ie, arterial shunt first and delayed venous cavopulmonary shunt). Moreover, in our series, those undergoing this 2-stage approach have shown better PA development at the time of Fontan surgery.²

Finally, Galantowicz and Yates have made a significant contribution to the hybrid literature with their proposed protocol. With time, our knowledge and experience are

building, and it's becoming increasingly evident which patients will benefit from which strategy.

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HYBRID PALLIATION AND PULMONARY ARTERY ARCHITECTURE Reply to the Editor:

I read the recent article by Galantowicz and Yates with regard to improving surgical outcome of comprehensive stage II hybrid palliation in patients with hypoplastic left heart syndrome (HLHS) with great interest.¹ The study is the largest clinical series of comprehensive hybrid stage II palliation consisting of 119 consecutive patients. The study focused on the impact of the changes in perioperative management protocol on survival and morbidities.

New treatment paradigms for HLHS as alternatives to the classic Norwood palliation, such as the Sano

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procedure and hybrid palliation, are mainly aimed at improving early survival following stage I palliation. Beyond immediate postoperative survival, the most important question to be answered is which palliative strategy best prepares candidates for subsequent cavopulmonary connection, with regard to ventricular and atrioventricular valve function, and pulmonary artery (PA) architecture and physiology. We previously employed hybrid palliation as an alternative treatment to the classic Norwood palliation between 2004 and 2012.²⁻⁵ In more recent years, we have employed Norwood palliation as our standard of care over hybrid palliation because of a higher PA re-intervention rate and non-superior medium-term survival of the hybrid palliation, and our intention to concentrate on a single strategy rather than employing multiple strategies. Approximately half of the patients who underwent hybrid palliation required balloon angioplasty or stent placement following the comprehensive hybrid stage II procedure in our series,^{4,5} which is consistent with another large series from Giessen where 38% of the patients required left PA stent following the stage II palliation.⁶ We currently reserve hybrid palliation as a bridge to a delayed stage I Norwood for neonates deemed to be too unstable or premature to tolerate a Norwood operation, as a bridge to transplant, or a bridge to potential biventricular repair. For these patients, we feel that hybrid palliation offers significant advantages over the classic Norwood palliation.

The implementation of both Norwood and hybrid palliation strategies in standard risk patients in the same era provided us the unique opportunity to compare the many different aspects of these two strategies. Our series of studies showed that hybrid palliation had equivalent early and medium-term survival, comparable ventricular and atrioventricular valve function, and a similar rate of ventricular and atrioventricular valve dysfunction.⁷ Our most striking finding was the much higher rate of PA re-intervention after comprehensive stage II palliation, and a somewhat higher number (18%) of patients who were deemed not to be Fontan candidates because of inadequate PA architecture and physiology in the hybrid group.⁵ Unlike Galantowicz's study, the mechanism of the left PA problem in our population was not thrombosis but primarily anatomic stenosis that resulted in re-intervention and inadequate growth following stage II palliation.

Galantowicz and Yates presented a detailed management protocol to prevent left PA thrombosis, which contributed to a reduction in mortality from 19% to 4%. We agree with

many aspects of their protocol, including a low threshold to use a systemic-to-pulmonary shunt over a cavopulmonary shunt in cases of inadequate PA architecture after PA de-banding, the use of exit angiography to delineate PA anatomy, and a low threshold for intraoperative surgical revision or catheter-based stent placement for significant left PA stenosis. We do not, however, use systemic anticoagulation in all patients with a single superior vena cava, although we routinely anticoagulate patients with bilateral superior vena cavae because of their high risk of thrombosis.⁸ We have recently used bilateral PA banding as a bridge to delayed Norwood stage I procedure for premature or low-body-weight neonates. In these patients, we have witnessed deterioration in their PA architecture even after a relatively short banding period such as 6 to 8 weeks. We agree that a systemic-to-pulmonary shunt is a safer option in many settings where PA anatomy is in question after bilateral PA banding.

Galantowicz's group should be congratulated on their excellent results on comprehensive stage II palliation with a meticulous management protocol. Nonetheless, there remains considerable concern regarding PA architecture, high PA re-intervention rate, and suboptimal left PA growth in patients undergoing a hybrid palliation, which may affect the rate of Fontan completion. Furthermore, although the deployment of an intravascular PA stent may alleviate early stenosis, it does not have same compliance as the "normal" well-developed PA and may adversely affect Fontan physiology in the long term. Longer-term follow-up studies that compare patients who completed the Fontan operation after hybrid palliation with those who underwent a conventional Norwood approach will be important to clarify these issues.

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