Future investigation with both a larger patient cohort and a significant follow-up period is therefore necessary to confirm the technique's effectiveness.

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References

1. Floten HS, Ravichandran PS, Furnary AP, Gately HL, Starr A. Adventitial inversion technique in repair of aortic dissection. *Ann Thorac Surg.* 1995;59:771-2.
2. Tamura N, Komiya T, Sakaguchi G, Kobayashi T. 'Turn-up' anastomotic technique for acute aortic dissection. *Eur J Cardiothorac Surg.* 2007;31:548-9.
3. Shimamoto T, Komiya T. Advantage of continuous telescopic inversion technique does not overcome the disadvantage of "turn-up" technique in aortic anastomosis. *J Thorac Cardiovasc Surg.* In press 2011.

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NORWOOD PROCEDURE WITH RIGHT VENTRICLE TO PULMONARY ARTERY SHUNT: AN UNDERESTIMATED TECHNICAL SURGICAL VARIABLE

To the Editor:

The recent well-designed randomized study comparing shunt-related outcomes among patients with hypoplastic left heart syndrome at the time of the Norwood operation is a fine addition to the repertoire of evidence-based pediatric cardiac surgery.¹ There are further potential important technical confounders, however, that may explain the increased incidence of re-interventions after the more recent right ventricle (RV) to pulmonary artery (PA) connection. Why?

We surgeons have our own set of acquired skill sets that can predict good and poor outcomes. We value our experience and that of others, yet we are always inquisitive about which best procedure-patient match predicts

lowest morbidity and mortality. We all have our own mental functional equations for outcomes that vary qualitatively and quantitatively. These are based on personal experiences as well as on the collective experiences of others. Variations in transference and application of techniques provide a continued variation in surgical outcome. During this process, room for error generation can prevail. The variety of technical details for reconstructing the RV to PA shunt is one such important example that has both implications and ramifications. These relate to technical redundancy, lack of standardization, and interinstitutional and intrainstitutional practice variations. Another ramification relates to selecting the shunt type and conduit size modification best suited for each particular patient during first-stage palliation.

The modifications include use of different materials (ringed vs plain Gore-Tex, homograft conduit), sizes

TABLE 1. Clinical comparison studies of RV-PA shunts during Norwood procedure

Trial	RV-PA modification	Modified vs control	Comparison in-hospital death (30-d mortality)	RV-PA conduit relation to neo-aorta	PA confluence patch (distal anastomosis)	Direction of potential selection bias
Hasaniya ² 2010	Ventricular wall fixation	13 (ventricular fixation) vs 15 (epicardial fixation)	0% vs 20%	Not stated	Yes	Ventricular wall fixation prevents proximal stenosis (0% vs 20%)
Schreiber ³ 2006	Standard nonringed Gore-Tex vs ringed Gore-Tex	28 CC vs 24 RC	10.7% vs 13.2%	Right	Yes	Ring enforced prevents stenosis (23 vs 45%) and reinterventions (15 vs 24%)
Reinhart ⁴ 2006	Valved homograft conduit vs nonhomograft	66 vs 8	88.6%, insufficient numbers for subgroup analysis	Left (per article figure)	No	Aortic valve homografts had early conduit interventions and death (OR, 1.34) compared to pulmonary homografts
Barron ⁵ 2008*	Orientation in relation to neo-aorta	128 right side vs 28 left side	88% vs 75%	Right or Left	Yes	Right sided improved 6 month survival (75 vs 64%) compared to left sided

RV, Right ventricle; PA, pulmonary artery; CC, nonring-enforced Gortex; RC, ring-enforced Gortex. *Control group not included.

(4, 5, or 6 mm), position in relation to neoaorta (right or left of the aorta), and anastomosis both proximally either with ventricular fixation or epicardial fixation as well as distally with Gore-Tex or biologic patch or direct anastomosis. A review of controlled trials²⁻⁵ is given in Table 1. Each of these technical modifications can behave as a confounder at the time of the RV to PA conduit reconstruction. Furthermore, they can have long-term effects on the PA architecture, whether central or branch pulmonary artery stenosis. The PAs are essential for healthy Fontan circulation.

This lack of a standardized surgical technique for the RV to PA shunt construction in itself allows for error-generating boundaries. All of the entities in Norwood procedures are essential but have limitations inherent in the surgeon's cognition that is worthy of appraisal and understanding. These are difficult to measure with existing tools. We should not, however, underestimate the role of variable surgical technique in contributing to increased rate of reinterventions.

Simple randomization in the trial of Ohye and colleagues¹ to 2 different shunts does not mean that these shunts were constructed in the same exact manner at each surgery and by every surgeon. In particular, the RV to PA shunt more often can be constructed in different ways given the modifications, predetermined patient sample selection, and unweighted confounding. For example, surgeons elect not to place RV to PA shunts if there is a crossing coronary artery or presence of an important papillary muscle.

With regard to the modified Blalock-Taussig shunt, the major variations are limited to length and diameter. The number of variable boundaries in the RV to PA shunt construction is thus far greater than that in the Blalock-Taussig shunt. The blood flow patterns vary in each shunt as well as each reconstruction. Although the RV to PA shunt has been popular among the sur-

gical community, attention to the details in its construction is needed. Material-compliance mismatch (eg, Gore-Tex to PA or Gore-Tex to pericardial patch to pulmonary artery) at the distal anastomosis is another boundary that could be associated with further reinterventions in the RV to PA conduit.

If we were to revisit our techniques critically and systematically and reinterpret the intricate boundaries for each surgical variable, we could provide a quality improvement initiative and reduce the rate of reintervention after the Norwood procedure.

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References

1. Ohye RG, Sleeper LA, Mahony L, Newburger JW, Pearson GD, Lu M, et al. Comparison of shunt types in the Norwood procedure for single-ventricle lesions. *N Engl J Med*. 2010;362:1980-92.
2. Schreiber C, Kasnar-Samprec J, Hörer J, Eicken A, Cleuziou J, Prodan Z, et al. Ring-enforced right ventricle-to-pulmonary artery conduit in Norwood stage I reduces proximal conduit stenosis. *Ann Thorac Surg*. 2009;88:1541-5.
3. Hasaniya NW, Shattuck H, Razzouk A, Bailey L. Modification of ventricular-to-pulmonary shunt to minimize proximal conduit obstruction after stage I Norwood reconstruction. *Ann Thorac Surg*. 2010;89:e4-6.
4. Reinhartz O, Reddy VM, Petrossian E, MacDonald M, Lamberti JJ, Roth SJ, et al. Homograft valved right ventricle to pulmonary artery conduit as a modification of the Norwood procedure. *Circulation*. 2006;114(1 Suppl):I594-9.
5. Barron DJ, Brooks A, Stickley J, Woolley SM, Stümper O, Jones TJ, et al. The Norwood procedure using a right ventricle-pulmonary artery conduit: comparison of the right-sided versus left-sided conduit position. *J Thorac Cardiovasc Surg*. 2009;138:528-37.

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CONVENTIONAL RATHER THAN OFF-PUMP CORONARY ARTERY BYPASS GRAFTING SHOULD BE PERFORMED FOR NON-HIGH-RISK PATIENTS

To the Editor:

We read with great interest an editorial by Patel and Angelini,¹ which

cited 2 meta-analyses^{2,3} of randomized controlled trials of off-pump coronary artery bypass grafting without cardiopulmonary bypass (OPCAB) versus conventional coronary artery bypass grafting with cardiopulmonary bypass (ONCAB) that demonstrated similar late mortality. The meta-analysis (published in 2008) by Møller and associates² of 18 trials (2864 patients) showed no significant difference in late (>30 day) mortality (3.1% in OPCAB vs 2.7% in ONCAB; $P = .55$). In the meta-analysis (published in 2009) by Feng and colleagues³ of 10 trials (2018 patients), late (≥ 1 year) mortality was not significantly reduced (odds ratio, 1.00; 95% confidence interval [CI], 0.56–1.77; $P = 1.00$). More recently (published in 2010), we⁴ performed a meta-analysis of 11 results of 12 trials (4326 patients) including the Randomized On/Off Bypass (ROOBY) trial.⁵ Despite the results of previous meta-analyses,^{2,3} our pooled analysis demonstrated a statistically significant increase in late (≥ 1 -year) mortality by a factor of 1.37 with OPCAB relative to ONCAB (risk ratio, 1.373; 95% CIs, 1.043–1.808; $P = .024$).⁴ Furthermore, our updated meta-analysis of 15 results of 16 trials (by a comprehensive search current through September 2010) (4865 patients) also demonstrated a statistically significant increase in late (≥ 1 -year) mortality by a factor of 1.39 with OPCAB relative to ONCAB (risk ratio, 1.39; 95% CIs, 1.07–1.80; $P = .01$; Figure 1). This result was robust in sensitivity analyses: exclusion of any single result (including the result of the ROOBY trial⁵) from the analysis did not substantively alter the overall result of our analysis. Therefore, on the basis of the best evidence of our newest meta-analyses of randomized controlled trials, ONCAB rather than OPCAB should be considered for patients at least who meet the criteria for enrollment in the randomized trials (typically not high-risk but low- to moderate-risk patients),