THE CASE FOR TOTAL ARTERIAL REVASCULARISATION Reply to the Editor:

We thank our long-time colleagues Drs Habib and Schwann for their continuing interest in our work and in our study. Their contribution to the field of arterial conduits and long-term survival benefits after coronary artery bypass grafting is substantial, and we have been grateful for data they have previously shared with us. They rightly point out that we omitted to cite their 2009 article on the same subject matter,¹ which was an oversight. Their data are comparable with our own, except with regard to the magnitude of the benefit of total arterial revascularization (TAR). The greater effect that they showed may reflect the difficulties both studies encountered in correcting for the differences between patients who undergo TAR and those who do not, irrespective of whether TAR is applied broadly as in our series (with other than TAR reserved for a minority subset) or selectively as in their series (with TAR used only for a selected minority).¹ Although the clinical practice may differ between countries, the statistical problem remains equivalent in trying to estimate the effect of TAR on survival.

With reference to the 3 points made by our colleagues, we state the following: (1) We agree that a primary point of interest in our study, which is not known from their previous series, is that the benefit of TAR extends to older patients. We have recently presented elsewhere² data showing that the benefit of a radial artery as a second arterial graft to supplement the left internal thoracic artery (ITA) can be demonstrated in older patients, even when TAR is not performed. Both these findings run counter to preconceptions that the benefits of multiple or all arterial grafts are confined to young patients, although it is acknowledged that these are nonrandomized data, however carefully propensity matched. Our Radial Artery Patency and Clinical Outcomes trial is due to report 10-year outcomes later this year, with random assignment of a smaller number patients older than 70 years to receive a radial or saphenous vein graft for the second graft, and this may offer further information in this field. (2) The impact of complete versus incomplete revascularization is difficult to quantify, because when 2 grafts are performed in a patient with 3-vessel disease, it is not clear whether the third graft would have made any clinical contribution to outcome. In retrospective analyses from databases, key information about whether the third graft was “rightly” or “wrongly” withheld may risk assumptions unless considerable explanatory information is available (was this an inadequate or insignificant target, infarcted territory of runoff, what was the degree of collateralization from other patent or grafted vessels, etc). For this reason, we did not include completeness of revascularization in our analysis. Whereas their series¹ suggested that

completeness of revascularization increases the benefit from TAR, the reverse has been reported by Kieser and colleagues,³ who suggested that in their Canadian experience the use of arterial grafts in fact negated (or mitigated) the impact of incomplete revascularization.³ (3) The application of TAR in our series has been broader than that reported in their¹ and other published series, which likely reflects some international differences in practice, although we believe that the results can be generalized. We are not certain, however, whether the use of TAR could be even higher, as our colleagues have suggested, because of the rise in radial angiography and uncertainty regarding the safety of using as bypass conduits radial arteries that have been cannulated for angiography. If not, even to maintain current rates of TAR will require an increase in use of bilateral ITAs, which may or may not be acceptable to surgeons. Because our as yet unpublished data suggest, however, that in patients undergoing TAR the survival benefit is greater when bilateral ITAs and a single radial artery are used than when a single ITA and bilateral radial arteries are used, such a shift might increase the actual survival benefit from TAR relative to left ITA and vein strategies.

We again thank Drs Habib and Schwann for their comments and interest.

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HYBRID PALLIATION FOR HYPOPLASTIC LEFT HEART SYNDROME: NAVIGATING THE GRAY ZONE

To the Editor:

We read the article by Davies and colleagues¹ with great interest. The hybrid procedure has emerged in the last decade as an alternative stage I palliation for neonates with hypoplastic left heart

physiology, being mostly used to treat patients for whom the risk of the stage 1 Norwood procedure is believed to be high or prohibitive. Initial enthusiasm for this strategy has somewhat tapered off, because potential advantages are yet to be determined and overall outcomes remain similar to those of the stage 1 Norwood procedure.² Compared with patients undergoing the stage 1 Norwood procedure, those who undergo a hybrid procedure usually have higher prevalences of prematurity, low birth weight, chromosomal abnormalities, and unstable preoperative hemodynamics.³ Davies and colleagues¹ have succeeded in demonstrating that patient's risk factors are not always mitigated by the hybrid procedure, and in about 28% of the cases an early stage 1 Norwood procedure may be required. In their experience, 8 patients underwent an unplanned stage 1 Norwood procedure after a complete hybrid palliation: indications were progressive hypoxia, resolution of contraindication to cardiopulmonary bypass, increased flow acceleration through the ductal stent or recoarctation, and excessive pulmonary blood flow. Overall mortality was 50%. These data highlight the existence of a "gray zone" of patients: those for whom we have to face an early failure of the procedure because of either technical factors or intrinsic patient characteristics.

From September 2011 to date, we adopted a 100% hybrid procedure use policy at our institution. Twenty-nine consecutive patients underwent neonatal hybrid palliation, and 7 (24%) of these had conversion to a stage 1 Norwood procedure, with 2 deaths. Indications for proceeding to a stage 1 Norwood procedure rather than waiting for a comprehensive stage 2 procedure were as follows: restrictive atrial communication not amenable to stenting (n = 3), poor hemodynamics with marginal somatic growth (n = 2), reverse coarctation (n = 1), and ductal stent displacement (n = 1). Analysis of the implications of this innovative approach at our institution is still ongoing. As pointed out by Caldarone,⁴ we have no evidence yet that the routine interposition of stage 1 Norwood procedure between the hybrid palliation and the comprehensive stage 2 is associated with a decrease in overall lifetime morbidity and mortality. On the other hand, hybrid procedures are usually not considered "preparatory" to a stage 1 Norwood procedure, with the goal instead being to bridge the patient successfully to a comprehensive stage 2 procedure with a more physiologic source of pulmonary blood flow (superior cavopulmonary connection). To the best of our knowledge, the majority of early stage 1 Norwood conversions are performed as rescue procedures and are thus undertaken when the hybrid palliation is overtly failing; this carries the risk of high procedural mortality. Lloyd and associates⁵ recently drew the attention to the need for an early stage 1 Norwood procedure after hybrid palliation. Because of the complexity of the comprehensive stage 2 procedure, and to reduce the significant morbidity associated with branch

pulmonary artery stenosis, they are switching their management strategy to an intermediate stage 1 Norwood procedure beyond the neonatal period. There is growing evidence that there is a subgroup of neonates, considered to lie within a gray zone where decisions as to surgery versus hybrid palliation are not black and white. For them we advocate the preemptive use of a 4-stage approach.

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A RANGE OF OPTIONS FOR STAGED PALLIATION OF HYPOPLASTIC LEFT HEART SYNDROME

Reply to the Editor:

We read with interest the letter by Trezzi and colleagues that described their experience with staged palliation for hypoplastic left heart syndrome. Their approach is to use a hybrid palliation strategy with conversion to stage 1 Norwood when the hybrid approach fails. Current reports in the literature, including our own experience, suggest that there is no strategy clearly better in all patients.¹ To date, it has been difficult to identify a single management strategy that could provide optimal outcomes for all patients, particularly considering the vast range and combination of non-modifiable patient factors. Considering the existing data, it is likely that the best strategy may depend on a combination of factors, including surgeon and center experience as well as patient characteristics.^{2,3}

It is critically important to recognize the diversity of strategies included within a hybrid approach. The use of ductal