

Cite this article as: Poncelet AJ, Momeni M. Warm versus cold blood cardioplegia in paediatric cardiac surgery: where do we stand 2 decades later? Eur J Cardiothorac Surg 2023; doi:10.1093/ejcts/ezad098.

Warm versus cold blood cardioplegia in paediatric cardiac surgery: where do we stand 2 decades later?

Alain J. Poncelet ^{a,b,*} and Mona Momeni ^{b,c}

^a Department of Cardiovascular and Thoracic Surgery, Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium

^b Institut de Recherche Expérimentale et Clinique (IREC), Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium

^c Department of Anesthesiology, Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium

* Corresponding author. Department of Cardiovascular and Thoracic Surgery Unit, Cliniques Universitaires Saint-Luc, Université catholique de Louvain, Avenue Hippocrate 10, 1200 Brussels, Belgium. Tel: +32-2-7646107; fax: +32-2-7648960; e-mail: alain.poncelet@uclouvain.be (A. Poncelet).

Keywords: Congenital • Myocardial Protection • Cardioplegia • Randomized Trial

In this issue of the *European Journal for Cardio-thoracic Surgery*, Stoica *et al.* [1] provide a detailed analysis of their single-centre randomized control trial on the effect of temperature of blood-based cardioplegia on myocardial protection in a moderate-risk group of paediatric patients undergoing open-heart surgery.

Over the last 20 years, the Bristol group has published several important articles on myocardial protection both in adults and more recently in paediatric patients [2, 3].

The use of normothermic cardiopulmonary bypass (CPB) in paediatric cardiac surgery was introduced in 1996 [4]. Since then, a few European centres led the initial clinical studies whereas a more conservative approach of mild/moderate hypothermic CPB was still the preferred strategy both in the USA and most European countries [5].

In 2001, based on their encouraging early clinical results, the leading French group combined normothermic CPB with intermittent warm blood cardioplegia in paediatric cardiac congenital surgery [6].

Two decades later, as underscored by Stoica *et al.*, only a handful of clinical studies have adequately compared normothermic CPB and intermittent warm blood cardioplegia to one of the many other strategies used worldwide [5, 7].

In this study, specific biochemical and other surrogate markers of myocardial protection have been extensively evaluated and are presented in the manuscript and its appendices. Taken altogether, the authors demonstrate that intermittent warm blood cardioplegia provides similar myocardial protection to cold blood cardioplegia as assessed with cardiac troponin-T measurements. These results are in line with our own observations [8]. One should however keep in mind that immediate postoperative cardiac troponin measurements in congenital open-heart surgery are lesion and/or surgery dependent and that only concentrations at later time (beyond 24 h) may reflect myocardial ischaemia and/or necrosis [9].

As hypothesized by the authors, it is likely the unbalanced number of re-interventions for residual lesions in the warm

blood cardioplegia group negatively influenced some of the end points but those differences are unlikely to be related to the method of myocardial protection.

Among details, the authors did not exclude troponin measurements in those patients who benefitted from intraoperative cardioversion or defibrillation. While the former is unlikely to result in an increased troponin release, the latter surely does [10].

Finally, though intermittent warm blood cardioplegia was previously shown to preserve stored energy metabolites in comparison to cold crystalloid cardioplegia, the authors did not perform cardiac biopsy, so the cellular mechanisms of their observations will remain unknown.

Unfortunately, existing randomized control trials, including current Stoica's study, only enrolled moderate-risk paediatric congenital cardiac patients, with reasonable CPB and cross-clamp time, so it will remain unknown whether intermittent warm blood cardioplegia would be beneficial or detrimental in higher risk-adjusted congenital heart surgery score categories of patients.

Again, the Bristol group has to be complemented for pursuing well-designed studies on important topics within congenital cardiac surgery for which important heterogeneity exists among centres worldwide.

REFERENCES

- [1] Stoica S, Smartt HJ, Heys R, Sheehan K, Walker-Smith T, Parry A *et al.* Warm versus cold-blood cardioplegia in paediatric congenital heart surgery: a randomized trial. *Eur J Cardiothorac Surg* 2023;ezad041. doi: 10.1093/ejcts/ezad041.
- [2] Caputo M, Pike K, Baos S, Sheehan K, Selway K, Ellis L *et al.* Normothermic versus hypothermic cardiopulmonary bypass in low-risk paediatric heart surgery: a randomised controlled trial. *Heart* 2019;105:455–64.
- [3] Lotto AA, Ascione R, Caputo M, Bryan AJ, Angelini GD, Suleiman MS. Myocardial protection with intermittent cold blood during aortic valve operation: antegrade versus retrograde delivery. *Ann Thorac Surg* 2003; 76:1227–33; discussion 1233.
- [4] Durandy Y, Hulin S, Lecompte Y. Normothermic cardiopulmonary bypass in pediatric surgery. *J Thorac Cardiovasc Surg* 2002;123:194.

- [5] Kotani Y, Tweddell J, Gruber P, Pizarro C, Austin EH 3rd, Woods RK *et al.* Current cardioplegia practice in pediatric cardiac surgery: a North American multiinstitutional survey. *Ann Thorac Surg* 2013;96:923–9.
- [6] Durandy Y, Hulin S. Intermittent warm blood cardioplegia in the surgical treatment of congenital heart disease: clinical experience with 1400 cases. *J Thorac Cardiovasc Surg* 2007;133:241–6.
- [7] Ferguson ZG, Yarborough DE, Jarvis BL, Sistino JJ. Evidence-based medicine and myocardial protection—where is the evidence? *Perfusion* 2015;30:415–22.
- [8] Poncelet AJ, van Steenberghe M, Moniotte S, Detaille T, Beauloye C, Bertrand L *et al.* Cardiac and neurological assessment of normothermia/warm blood cardioplegia vs hypothermia/cold crystalloid cardioplegia in pediatric cardiac surgery: insight from a prospective randomized trial. *Eur J Cardiothorac Surg* 2011;40:1384–9.
- [9] Momeni M, Poncelet A, Rubay J, Matta A, Veevaete L, Detaille T *et al.* Does postoperative cardiac troponin-I have any prognostic value in predicting midterm mortality after congenital cardiac surgery? *J Cardiothorac Vasc Anesth* 2017;31:122–27.
- [10] Lund M, French JK, Johnson RN, Williams BF, White HD. Serum troponins T and I after elective cardioversion. *Eur Heart J* 2000;21: 245–53.