NORMOTHERMIA VERSUS HYPOTHERMIA DURING PEDIATRIC CARDIAC SURGERY: NO ANSWER AS YET To the Editor:

The interesting article by Caputo and colleagues¹ in the November 2011 issue is the first work to compare normothermia and hypothermia during pediatric cardiac surgery in a randomized trial. We believe that the work deserves some comments. Renal failure is cause of morbidity and mortality when associated with pediatric cardiac surgery with cardiopulmonary bypass (CPB). Although the incidence is lower than in adults, this clinical condition may be quite severe in the pediatric population. The causes are still unknown, probably because of the many factors involved in the management of these patients. Some independent risk factors have been correlated with this clinical condition: preoperative renal dysfunction, CPB time, temperature during CPB, low body weight, low cardiac output, use of vasoactive drugs, and others. Even so, controversy still exists.

In their introduction, the authors stated, "However, the combined effects of hypothermia, nonpulsatile perfusion, and reduced mean arterial pressure cause release of angiotensin, renin, catecholamines, and antidiuretic hormones. These circulating hormones promote renal vasoconstriction, reduce total renal blood flow, and redistribute intrarenal blood flow to the renal me-

dulla. Also, organ immaturity can result in a reduced glomerular filtration rate and medullary concentration ability."¹ This statement deserves some attention. Much of the work on renal physiology during CPB has been done in adults and extrapolated to the pediatric population. The statement proposed comes from the work by Taylor K and associates² published in the 1970s in this journal. This work was carried out in an adult population, with pulsatile flow, hypothermic condition, and the techniques and materials routinely used at that time. To our knowledge those results have not been reproduced in any setting (clinical or laboratory research, adults or children). In fact, pulsatile flow is rarely used these days. Both surgery and CPB techniques have also changed enormously. Renal vasoconstriction has been strongly suggested as one of the main physiologic changes associated with CPB, especially during hypothermia.³ Those findings have been extrapolated to the children undergoing cardiac surgery with CPB. Studies from our group in pediatric as well as coronary bypass surgery, however, have shown that contrary to all previous reports, effective renal flow increases during CPB, especially during the hypothermic phase. Moreover, filtration fraction as well as renal vascular resistance decreases, suggesting vasodilatation rather than vasoconstriction. Glomerular filtration rate remains within normal ranges through the entire procedures.⁴ Hypothermia has been advocated as one of the methods to protect organs function during CPB. Then if effective renal flow and glomerular filtration rate are the parameters to consider, changes during hypothermia seem to be beneficial.

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Reply to the Editor:

We read with great interest the comments by Lema and Aeschlimann regarding our recent publication on renal damage during pediatric heart surgery and their work on a similar subject. We agree that much of the work in this field has been in adults, and the results have necessarily been extrapolated to the pediatric population. Nevertheless, there is convincing evidence from animal studies demonstrating the deleterious effects of hypothermia and rewarming on renal function. Rewarming from experimental hypothermia induces ultrastructural changes in renal tubular cells similar to changes observed in acute tubular necrosis, which is associated with renal failure.¹ Distribution of blood flow to vital vascular beds is altered as the body temperature is lowered. Tveita and colleagues² have reported significant reduction of renal blood both during hypothermia and immediately after rewarming. In a study that used bloodstream cooling by arteriovenous shunts, Delin and associates³ determined that there was a shift of blood flow away from the kidneys and toward the splanchnic bed.

We agree with Lema and Aeschlimann that the mechanisms of the increased renal vascular resistance and

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subsequent reduction of renal blood flow observed during hypothermia are probably unrelated to increased levels of circulating catecholamines or increased renal sympathetic nerve activity. Other metabolic process taking place in response to lowering of temperature have been proposed.⁴

Overall, the clinical evidence regarding the potential benefits of hypothermia during pediatric heart surgery are not convincing. In fact, there is increasing retrospective evidence⁵ showing several benefits of normothermic cardiopulmonary bypass. Our own study has provided the first randomized trial evidence of the impact of normothermic cardiopulmonary bypass on renal function, contributing to the accumulating evidence of this technique in a low-risk group of children undergoing heart surgery.

Much more work is needed if we are to understand whether normothermia is safe in patients at higher risk, such as neonates and patients with complex congenital heart disease, who are more likely to be affected by cardiopulmonary bypass-induced postoperative renal dysfunction.

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RESPIRATORY COMPLICATIONS IN PATIENTS WITH HETEROTAXY SYNDROME

To the Editor:

We read the interesting paper by Swisher and associates¹ on the respiratory complications after cardiac surgery in patients with heterotaxy syndrome. The authors compared the postoperative course of children with heterotaxy syndrome with that of patients with cardiac defects and similar surgical complexities following the Risk Adjustment in Congenital Heart Surgery.^{1,2}

The patients with heterotaxy syndrome showed higher surgical mortality and increased postoperative respiratory complications including postoperative hospital stay, longer mechanical ventilation, need for tracheostomies, and extracorporeal membrane oxygenation support.¹ Other very recent articles underlined specific problems and specific surgical solutions in children with heart disease and laterality defects.^{3,4} All these observations confirm the notion that the presence of genetic syndromes may significantly affect the perioperative management of patients with congenital heart defect.⁵

As described for patients with trisomy 21, deletion 22q11, Turner syndrome, and other genetic syndromes,⁵ the knowledge of specific cardiovascular and extracardiac defects deserves particular attention in the perioperative period in terms of specific diagnostic, operative, and intensive care protocols.

Heterotaxy syndrome characterized by complex cardiovascular malformations and extracardiac defects deserves specific cardiac and extracardiac preoperative assessment to recognize risk factors and to reduce the

operative mortality and postoperative complications.^{1,3,4}

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Reply to the Editor:

We thank Dr Martucci and her colleagues for their supportive letter, which emphasizes the general point that the presence of genetic syndromes may significantly affect the perioperative management of patients with a congenital heart defect. Specifically for patients with heterotaxy, we agree that these complex patients require "cardiac and extracardiac preoperative assessment to recognize risk factors and to reduce the operative mortality and postoperative complications." Extrapolating beyond the phenotype-genotype-prognosis paradigm of their cited reference,¹ we suggest adding "therapy" to the paradigm.