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EDITORIAL COMMENTARY

Hypothermic circulatory arrest is not just about temperature

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See related article on pages 2888-94.

The enlightened ruler is heedful, and the good general full of caution.

—Sun Tzu, *The Art of War*

In this issue of the *Journal of Thoracic and Cardiovascular Surgery*, Algarni and colleagues¹ report improved outcomes with moderate hypothermic circulatory arrest (22°C-28°C) in 75 patients undergoing acute ascending aorta dissection. Readers should be interested in this article because it directly compares outcomes of that group with 53 patients treated with profound hypothermic circulatory arrest

(<20°C). The enlightened reader, however, will identify 3 areas of concern in this article: composite end points, surrogate variables, and overly exuberant statistical prowess.

Algarni and colleagues¹ used a composite end point to increase the power of their study because the sample size was limited. This technique may be of dubious value here.² Death is death; but there are different grades of stroke and low cardiac output syndrome. No definition of stroke is given in the study; the definition of low cardiac output syndrome may be too encompassing. Intra-aortic balloon pump therapy is one extreme end of the spectrum (ie, mechanical support); the need for inotropic support to maintain systolic blood pressure greater than 90 mm Hg and cardiac index greater than 2.2 L/min/m² may represent the other end.

Operation for acute ascending aorta dissection is associated with a significant risk of complications including bleeding, stroke, and death. The associated morbidity and mortality is related not just to the pathology of the dissection but also to the repair of the dissection with hypothermic circulatory arrest. In this article, temperature strategy is the main focus. That strategy misses the mark, however; because

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in the repair of acute ascending aorta dissection, hypothermic circulatory arrest is not just about temperature.

Algarni and colleagues¹ make the point that cooling to less than 28°C does not decrease brain oxygen consumption efficiently. Perhaps there is no advantage to cooling to less than 28°C; but there certainly is a disadvantage. In this study, the mean cardiopulmonary bypass time with moderate circulatory arrest temperature was 159 ± 71 minutes in comparison with 174 ± 60 minutes for profound circulatory arrest temperature ($P = .03$). This raises the question of whether the improved outcomes reported with moderate hypothermic circulatory arrest are because of the higher temperature? Or is higher temperature just a surrogate for reduced cardiopulmonary bypass time?

Outcomes related to hypothermic circulatory arrest in the repair of acute ascending aorta dissection are also influenced by baseline patient characteristics, extent of dissection, arterial cannulation strategy, and adjunct cerebral perfusion, just to mention a few. How these and other nuances interact has a profound impact on operative decision making and ultimately, treatment outcomes. How do you assess the many nuances of acute ascending aorta dissection? The answer in this study is statistical analysis.

In reporting the benefit of moderate hypothermic circulatory arrest, Algarni and colleagues¹ analyzed 26 covariates and accounted for them in a statistical model. Using the general rule of 10 end point events for each covariate studied in a multivariable model, 260 end points are required (ie, death, stroke, or low cardiac output syndrome).³ In this study, however, there were only 27

deaths and a relatively undisclosed number of strokes and low cardiac output syndrome events.

Additional important confounders that were more common in the profound hypothermia group included a significantly greater prevalence of acute DeBakey type 1 aorta dissection, preoperative kidney injury, and femoral arterial cannulation. Why were outcomes worse in the profound hypothermia group? Was it because of the temperature difference as concluded by Algarni and colleagues? Possibly, but it could also have been because those patients had worse dissections, had more baseline comorbidity, had less optimal arterial cannulation, and spent more time on cardiopulmonary bypass.

Algarni and colleagues¹ have worked hard to report their experience; and they do make an important contribution to the literature about acute ascending aorta dissection. It is not that moderate hypothermic circulatory arrest is better than profound hypothermic circulatory arrest. It is that in properly selected patients undergoing operation for acute ascending aorta dissection, moderate hypothermic circulatory arrest may result in good outcomes.

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