Estimating Brain Temperature during Hypothermia

In this issue of Anesthesiology, Stone et al. report the findings of a clinical experiment that has been needed for decades. The results are clear and important, and it is unlikely this work will ever be repeated, nor its findings challenged. The authors investigated the concordance between brain temperature and other temperature monitoring sites during perfusion cooling and profoundly hypothermic circulatory arrest (PHCA).

Although PHCA is used most commonly in the repair of congenital heart disease, it also is often used in adult aortic arch procedures and occasionally in selected urologic, hepatic, and, as in the report by Stone et al., neurosurgical procedures. Because hypothermic brain protection is graded, with increasing protection as brain temperature decreases, achievement of the desired level of cerebral hypothermia before the onset of ischemia (arrest) is probably the single most important determinant of the effectiveness of the technique. However, in only the rarest of circumstances is it practical or possible to measure brain temperature. Instead, in the vast majority of cases, other sites, most often nasopharynx or tympanic membrane, are used to estimate brain temperature before PHCA. Recent studies by Greeley et al. and Kern et al. suggest that, in 15–30% of cases, brain temperature may be significantly warmer than that measured at surrogate sites.

Directly measuring brain temperature, Stone et al. found poor concordance between brain temperature and temperatures at other sites. For example, nasopharyngeal temperature varied from 4.9°C greater than to 4.7°C less than actual brain temperature. Tympanic membrane, esophageal, and pulmonary arterial temperatures were no better. That surrogate monitoring sites sometimes overestimate brain temperature (i.e., the brain is colder than indicated) is probably not problematic; at least one is assured of the desired degree of brain protection. However, that surrogate monitoring sites sometimes underestimate brain temperature (i.e., the brain is warmer than indicated) almost certainly is a problem. How, in any given patient, can one be assured of achieving desired brain temperature? Stone et al. recommend simultaneous use of at least three “central” sites (nasopharynx, esophagus, tympanic membrane, pulmonary artery) and suggest values must be in near-agreement before PHCA. Although this seems reasonable, their data indicate that this is also no guarantee. Graphic data from three individual patients show that, although central sites agreed before PHCA, brain temperature was underestimated in two patients and overestimated in one. Perhaps the only other thing we have on our side is time. Computer modeling studies indicate brain cooling during cardiopulmonary bypass is principally determined by the temperature of the blood perfusing the brain, cerebral blood flow, and the time allowed for cooling. The shorter the period allowed for cooling (especially periods shorter than 20 min), the less likely it is brain temperature equilibration has occurred. Therefore, it would seem reasonable, once a desired surrogate temperature has been reached, to simply continue perfusion cooling for 5–10 min more. This little extra time will increase the likelihood of achieving desired brain temperature.

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References

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