

Anesthesiology
68:651, 1988

Use of Glucose-containing Solutions during Surgery

To the Editor:—In concluding their review on the intraoperative use of glucose, Sieber *et al.*¹ wrote, "In certain instances, the adverse effects of glucose may outweigh the potential benefits obtained from glucose administration. Withholding glucose or giving it in moderation so as to keep the blood glucose level below 200 mg · dl⁻¹ is recommended whenever brain ischemia may occur intraoperatively." This recommendation is not supported by the data they present and some data they overlooked.

A benefit of glucose administration not mentioned relates to its addition to crystalloid priming solutions for operations requiring cardiopulmonary bypass (CPB), including coronary artery bypass grafting, which the authors consider an operation with risk of brain ischemia. The use of lactated Ringer's solution with 5% dextrose, rather than lactated Ringer's solution alone, increased urine output twofold, reduced additional CPB fluid requirements by 90%, and restored post-CPB hemoglobin concentrations to pre-CPB levels without the use of blood products or diuretics.* These are clear benefits. No adverse outcome has yet been demonstrated from priming with glucose solutions.

Of additional relevance is our observation² and that of others^{2,3} that, even when no additional glucose is administered to patients before, during, or after CPB, blood glucose is almost always greater than 200 mg · dl⁻¹. To remedy this situation requires insulin, exposing patients to the risk of hypoglycemia already demonstrated by Walts *et al.*⁴ in attempts to maintain blood glucose levels below 200 mg · dl⁻¹ in diabetic patients.

No study cited in the review demonstrated that patients profit from an intraoperative blood glucose level below 200 mg · dl⁻¹, nor are they harmed specifically by blood glucose levels above 200 mg · dl⁻¹. The recommendation of 200 mg · dl⁻¹ as the maximum recom-

mended level of blood glucose in patients who may undergo brain ischemia thus proposes a standard unsubstantiated, and perhaps refuted, by existing data, which, if accepted, blindly renders physicians liable for any stroke in a patient with an intraoperative glucose of over 200 mg · dl⁻¹. Some physicians may be intimidated into withholding glucose from patients who may benefit from it, or treating clinically inconsequential elevations of glucose with insulin, a practice fraught with hazard.

Recommendations published by respected authors in respected medical journals may be uncritically embraced as a standard of care before evidence is available to verify better patient outcome from the practice. Sieber *et al.* make a recommendation earlier in their text that is more appropriate to the data: "In view of the findings in animal studies, the trends seen in human studies, and the fact that intraoperative glucose appears to have minimal beneficial effects, withholding glucose from the intraoperative fluid regimen *should be considered* for patients undergoing the above-mentioned procedures" (my italics).

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(Accepted for publication December 7, 1987.)

* Metz S, Hacker J: Effect of dextrose-crystalloid priming solution on fluid requirements and urine output during cardiopulmonary bypass. *Texas Heart Institute Journal* 13:341-344, 1986.

Anesthesiology
68:651-652, 1988

In Reply:—We would like to thank Dr. Metz for his comments on our recent discussion of intraoperative glucose use.¹ Specifically, Dr. Metz expresses concern

that our conclusions may be too dogmatic, that they might lend themselves to inappropriate use in a court of law, and that we may have overlooked specific benefits

from intraoperative glucose that, in fact, justify its use in certain situations. We did not intend our review to do any of the above, and attempted, we thought, to be very circumspect in our recommendations and conclusions. In addition, in a distinct section, we carefully delineated many of the situations in which intraoperative glucose is specifically indicated. With respect to being excessively dogmatic, at many points during our discussion, particularly with respect to glucose and its possible relationship to brain damage, we made note of the fact that we were discussing animal studies, and that their relation to humans was as yet unknown. We also attempted to make clear that the use of glucose, as well as any other drug, requires a specific risk benefit analysis with results that may differ with individual patient circumstances. At no point in our article did we state or imply that we were attempting to define the "standard of care" with respect to glucose. However, using reasoning similar to ours, many practitioners of neurosurgical anesthesia have stopped using intraoperative glucose, and this was happening before the publication of our review. Comprehensiveness in a review is always a problem, and, despite an extensive literature review, it is possible to miss a significant publication. The time lag from submission to publication is an additional issue, and, in fact, we were able to include very few 1986 citations.

Concerning the use of our material in a court of law, it is our impression that medical journals, of which ANESTHESIOLOGY is but one example, relate to the science and practice of medicine (anesthesia). As such, they must contain conclusions that may or may not become standards of practice. Many articles published in journals contain information that, in fact, becomes accepted practice, while other information may not stand the test of time or the accumulated wisdom of those who practice medicine. To judge each contribution with respect to its influence on the legal system would, in our opinion, have a detrimental effect on the exchange of scientific information and the growth of medicine in general and our specialty in particular.

With respect to the specific issues raised by Dr. Metz, it is our impression that neurologic and behavioral changes after cardiopulmonary bypass continue to be a major problem and a significant factor in the morbidity of operations requiring this technique.² In one center, the use of high doses of thiopental, with all of its attendant problems, has been recommended to prevent these complications.³ Until further data are available, the potential benefit of withholding glucose, if one believes that the animal studies have any relevance to the human situation, compared to the benefits of improved urine output and decreased fluid requirements need to be determined by the individual practitioner.

Glucose levels during cardiopulmonary bypass appear to vary with the anesthetic agents administered. Sebel *et al.* used a fentanyl anesthetic technique and reported intraoperative blood glucose levels of around 6.5 mmol/l (120 mg/dl),⁴ and, in a later study using sufentanil, they reported maximal glucose levels of 9.2 ± 0.39 mmol/l (166 ± 7 mg/dl, mean \pm SEM).⁵ Thus, blood glucose levels of less than 200 mg/dl do occur during cardiopulmonary bypass. The work of Lanier *et al.*⁶ suggests that intracellular glucose levels may be more important in neurologic damage than blood glucose levels. Considering that insulin has some enhancing effect on transport of glucose into the brain, its use to regulate glucose may not be as good as withholding glucose if the possibility of glucose-enhanced neurologic damage is a concern.

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(Accepted for publication December 7, 1987.)