

Anesthesiology  
2000; 92:624  
© 2000 American Society of Anesthesiologists, Inc.  
Lippincott Williams & Wilkins, Inc.

## Saline Infusion, Acidosis, and the Stewart Approach

*To the Editor:*—The report by Scheingraber *et al.*<sup>1</sup> highlights the phenomenon of acidemia after infusion of 0.9% saline in the perioperative period. The accompanying editorial<sup>2</sup> discusses several relevant points; however, we are disappointed that neither the article nor the editorial addresses the central issue of the relative merits of the Stewart approach<sup>3</sup> in describing acid-base physiology and pathophysiology.

Compared with the Henderson-Hasselbalch approach, the Stewart approach has a number of appealing features. (1) The control of acid-base and water homeostasis can be explained in terms of both sodium and chloride regulation. (2) Acid-base status is partly controlled by a number of plasma electrolytes, notably sodium and chloride. These electrolytes can be manipulated in the clinical setting to optimize acid-base status. (3) The factors controlling acid-base status are independent. Criticisms of the Henderson-Hasselbalch approach include a lack of independence between carbon dioxide and bicarbonate.<sup>4</sup> (4) The Henderson-Hasselbalch approach does not allow assessment of nonvolatile buffers, whereas the Stewart approach explicitly includes assessment of weak acids.<sup>4</sup>

Comparison of the Stewart and Henderson-Hasselbalch approaches is complicated by the fact that both approaches adequately describe the acid-base end point, as Scheingraber *et al.* demonstrate.<sup>1</sup> Further study is required to determine which approach better describes the mechanisms of acid-base physiology.

Previous animal studies<sup>5</sup> have suggested that the alkalinizing effect of lactate-containing solutions in acute resuscitation is time dependent, which underscores the concept of lactate as a strong ion. The removal of lactate from the circulation will increase the strong ion difference and reduce acidosis.<sup>3</sup> This effect may be supplemented by further increases in the strong ion difference associated with lactate metabolism<sup>6</sup>; in contrast, added chloride ions appear to persist longer in the circulation. Subsequently, a smaller strong ion difference is maintained along with greater acidosis, as seen in the report by Scheingraber *et al.*<sup>1</sup>

Anesthesiology  
2000; 92:624-5  
© 2000 American Society of Anesthesiologists, Inc.  
Lippincott Williams & Wilkins, Inc.

## Article Supports Findings of Previous Comparison

*To the Editor:*—The article by Scheingraber *et al.*<sup>1</sup> supports the findings of a previous comparison of saline with a balanced salt solution carried out by McFarlane and Lee in 1994.<sup>2</sup> The accompanying editorial by Prough and Bidani described this study as a clinical report of the

**David A. Story, M.B.B.S.(Hon), B.M.Sci(Hon), F.A.N.Z.C.A.**  
Staff Anaesthetist  
Department of Anaesthesia  
davids@austin.unimelb.edu.au  
**Frank Liskaser, M.B.B.S., F.A.N.Z.C.A.**  
Staff Anaesthetist  
Department of Anaesthesia  
**Rinaldo Bellomo, M.B.B.S., M.D., F.R.A.C.P.**  
Associate Professor  
Intensivist and Director of Research  
Department of Intensive Care  
Austin and Repatriation Medical Centre  
Austin Hospital  
Heidelberg  
Melbourne, Victoria 3084, Australia

### References

1. Scheingraber S, Rehm M, Schmisch C, Finsterer U: Rapid saline infusion produces hyperchloremic acidosis in patients undergoing gynecologic surgery. *ANESTHESIOLOGY* 1999; 90:1265-70
2. Prough DS, Bidani A: Hyperchloremic metabolic acidosis is a predictable consequence of intraoperative infusion of 0.9% saline (editorial). *ANESTHESIOLOGY* 1999; 90:1247-9
3. Stewart PA: Modern quantitative acid-base chemistry. *Can J Physiol Pharmacol* 1983; 61:1444-61
4. Fencel V, Leith DE: Stewart's quantitative acid-base chemistry: Applications in biology and medicine. *Respir Physiol* 1993; 91: 1-16
5. Traverso LW, Lee WP, Langford MJ: Fluid resuscitation after an otherwise fatal hemorrhage: I Crystalloid solutions. *J Trauma* 1986; 26:168-75
6. White SA, Goldhill DR: Is Hartmann's the solution? *Anaesthesia* 1997; 52:422-7.

(Accepted for publication September 23, 1999.)

administration of "unusually large volumes of saline."<sup>3</sup> The study was, in fact, a randomized-controlled comparison of saline with a balanced salt solution, both of which were administered at  $15 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ . This rate of administration was half the rate used by Scheingraber *et*