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## Acid-base changes during acute normovolaemic hemodilution

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## Keywords

acid base balance, colloid infusion, hyperchloraemia, Stewart approach

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## Comments

This study found a slight but significant acidosis after acute normovolaemic haemodilution (ANH) with both colloids. The acidosis was metabolic in origin and may have been related to dilution of bicarbonate in the extracellular fluid (ECF). Indeed there was excellent correlation between the predicted and calculated amount of bicarbonate in the ECF after ANH. Similarly chloride concentration showed good correlation with predicted values. However, this model does not account for the effect of albumin on acid-base balance. An alternative method for explaining acid-base changes is the Stewart model, although this did not adequately explain the decrease in bicarbonate in the hydroxyethyl starch (HES) group. This may be because the Stewart model oversimplifies the presence of different anionic charges of synthetic albumin molecules. These data suggest that a small but significant degree of acidosis occurs with ANH and is caused by the dilution of bicarbonate and an accompanying hyperchloraemia. This seems to be at odds with two other publications in the same journal suggesting that changes in chloride concentration are of primary importance.

## Introduction

ANH is frequently performed yet the acid-base consequences of this process have not been studied. ANH may be expected to produce acid-base changes by virtue of withdrawing bicarbonate and by infusing anions and cations. This study seeks to theoretically predict changes in anions and cations and to use the Stewart approach to evaluate the effect of changes in albumin on acid-base balance. The study also aims to evaluate acid-base changes during ANH in a prospective, randomised clinical study.

## Methods

- 20 female patients scheduled for radical hysterectomy with ANH used as a blood saving method were studied
- 10 patients were randomised to receive 6% HES (Na<sup>+</sup> 154 mM and Cl<sup>-</sup> 154 mM)
- 10 patients randomised to receive 5% albumin solution (HA) Na<sup>+</sup> 158 mM, Cl<sup>-</sup> 150 mM, octanoate 4 mM, N-acetyltryptophanate 4 mM
- General anaesthesia was induced and end tidal CO<sub>2</sub> maintained as close as possible to 40 mmHg
- Measurements were taken for haematocrit (Hct), plasma volume, red cell volume, arterial blood gases, serum sodium, potassium, chloride, calcium, lactate, and phosphate
- Measurements taken at baseline and then blood was withdrawn at 60 ml/min and replaced with HA or HES
- 20 min after target Hct of 22% was achieved, the measurements were repeated
- Plasma volume was calculated using a dye dilution method with indocyanine green. Red blood cell volume was determined using radiolabelled autologous red blood cells

## Results

- Blood removed and colloid infused was significantly greater in the HES group due to a greater body weight in this group
- Albumin decreased by 50% in the HES group after ANH
- Base excess and bicarbonate decreased significantly in both groups
- Protein decreased in the HES group but not the HA group
- Chloride significantly increased in both groups (+3 mM in the HA group and +6 mM in the HES groups)
- In both groups the calculated mean values for bicarbonate and Chloride differed only slightly from the calculated predicted values

## Additional information

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#### **There is also an accompanying Editorial View**

Prough DS: **Acidosis associated with perioperative saline administration.** Dilution or delusion? *Anesthesiology* 2000, **93**:1167-1169.

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