

Dear ladies and gentlemen, dear ADVOS users and interested parties,

we are pleased to present you another issue of our ADVOS Literature Service. We regularly select one or more papers from international journals which might be of interest to you in connection with our ADVOS procedure. This month we have selected the following:

INCREASED SERUM BICARBONATE IN CRITICALLY ILL PATIENTS: A RETROSPECTIVE ANALYSIS.

Liborio et al.

Key Message

In most acid-base balance analyses acidosis is in the foreground. Liborio et al. took on the topic of alkalosis with some surprising results: the lowest mortality is not within the standard range for standardized bicarbonate, but continues in the alkaline range at 29-30 mmol/l with a mortality rate of 7.5 %. Patients with bicarbonate levels of 37-38 mmol/L had the same mortality rates as patients with 21-22 mmol/l (17.6 %). The highest mortality (29.8 %) was achieved when the serum bicarbonate level was < 20 mmol/l. It is also surprising that, in contrast to a standard distribution, the highest number of patients is in the alkaline range.

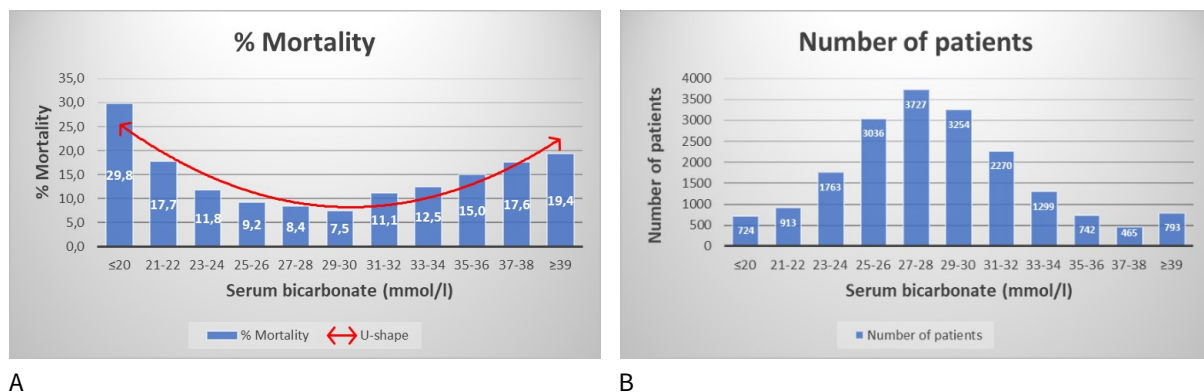


Figure 1. Hospital mortality according to the maximum serum bicarbonate concentration measured during ICU stays (A) and number of patients with different bicarbonate values (B). (Adapted from Liborio et al. 2015).

Background

Metabolic alkalosis is commonly found in critically ill patients and can potentially cause cardiac arrhythmias, respiratory suppression, hypokalemia and difficult mechanical ventilation weaning. In the present study, the prevalence rate of increased serum bicarbonate levels and the associated mortality is described.

Methods

18,892 patients from the Multiparameter Intelligent Monitoring in Intensive Care II database, who met the inclusion criteria were retrospectively analyzed. Adult patients with an intensive care unit length of stay (ICU-LOS) ≥ 24 hours who had at least one serum bicarbonate measurement within the first 36 hours after ICU admission were included. Patients with serum bicarbonate > 28 mmol/l associated with acidemia (serum pH < 7.35) and CO₂ partial pressure > 45 mmHg were considered to have pure respiratory acidosis and were excluded from the study.

The association between the maximum serum bicarbonate level as a continuous variable and in-hospital mortality was investigated. A regression model was assessed and multiple covariate analyses were applied.

Results

The mean age upon admission was 63.8 ± 17.5 years, and 8,159 were females (43.0 %). The mean SOFA score on admission was 5.9 ± 4.0 . The overall ICU and in-hospital mortality were 7.7 and 11.5 %, respectively.

The association between in-hospital mortality and maximum serum bicarbonate levels during ICU stays results in a U shape (Figure 1). The lowest mortality was noted with serum bicarbonate levels between 25 and 30 mmol/l (“Normal” group). The highest mortality was achieved when the serum bicarbonate levels were < 20 mmol/l (“metabolic acidosis” group). Mortality increased if the patient experienced at least 1 day of serum bicarbonate > 30 mmol/l (“Increased” group). Overall, 17.9 % had metabolic acidosis, 52.8 % had normal values and 29.3 % had increased bicarbonate levels for at least 1 day.

Regarding the causes, more than one-third of patients (37.1 %) undergoing RRT had high serum bicarbonate levels. Overall, the majority were exposed to multiple factors that are classically associated with metabolic alkalosis (mainly diuretic use, hypernatremia, hypokalemia and high gastric output).

Patients with increased serum bicarbonate exhibited increased ICU-LOS, more days on mechanical ventilation and higher hospital mortality. After multivariate adjustment, each 5- mmol/l increment in the serum bicarbonate level above 30 mmol/l was associated with an odds ratio of 1.21 for hospital mortality. The association between increased serum bicarbonate levels and mortality occurs independently of its possible etiologies.

Die Autoren schlussfolgern:

- Increased serum bicarbonate levels (> 30 mmol/l) were common and associated with longer ICU-LOS, prolonged mechanical ventilation, and increased mortality.
- Although metabolic alkalosis has been classically associated with several comorbidities, most patients developed increased serum bicarbonate levels during their ICU stay.
- Patients with high serum bicarbonate levels had been exposed to multiple factors.
- Hypernatremia and low serum albumin levels were more frequently observed in patients with increased serum bicarbonate concentrations.
- It is difficult to assert that an increased serum bicarbonate level itself is responsible for a prolonged ICU stay.

Unser Kommentar:

We were very surprised by these results. First, for the number of patients with bicarbonate values in the alkaline range. In fact, bicarbonate levels between 29-30 mmol/l classically considered alkaline are associated with the lowest mortality. Moreover, maximum mortality rates of 12 % were shown for the whole range of values between 23 mmol/l and 34 mmol/l. What does this mean in practice: Do intensive care patients possibly have other normal ranges associated with optimal survival? This can also mean that slower reaction to changes can be more beneficial.

In fact, renal replacement therapy is commonly associated with electrolyte imbalance, including among others, hypernatremia, hypokalemia and acid-base disturbances. In this regard, acidosis has been classically treated with sodium bicarbonate infusions. This study shows not only the already known risks for low bicarbonate levels, but also the hazards for elevated levels.

This means that bicarbonate might turn into a double-edged sword. On the one hand, it may correct plasma acidemia, even if for that an intracellular acidosis would be triggered. In fact, it can result into elevated pCO₂ levels in the absence of adequate ventilation. On the other hand, as shown in this study, each increase of 5 mmol/l over a serum bicarbonate of 30 mmol/l means a 10 % increase in mortality rates.

However, the study shows that the classical normal range for bicarbonate (22-28 mmol/l) does not fit for critically ill patients. According to this study, patients with bicarbonate levels of 21-22 mmol/l have higher mortality rates than those with 35-36 mmol/l (17.7 vs. 15.0 %). In fact, the highest mortality occurred in patients with bicarbonate < 20 mmol/l.

Therefore, the correction of metabolic acidosis, even if a slight elevation from “normal” bicarbonate levels occurs is of utmost importance. Anyway, when possible, the mitigation of a risk for metabolic alkalosis results essential. Thus, pH correction by other means different to bicarbonate addition is warranted. Finally, electrolyte imbalances must be controlled, specially in those critically ill patients subjected to extracorporeal support therapies.

ADVOS provides acid-base balance through a recirculating dialysate with a modifiable pH. Moreover, electrolyte, and specially bicarbonate levels can be controlled through its interchangeable concentrates. This makes ADVOS a totally flexible therapy that can be specially adapted for the needs of the patients with either alkalosis or acidosis.

If you have further questions or suggestions - please contact us at marketing@advitos.com.