

**LETTER**

# Metabolic alkalosis is the most common acid–base disorder in ICU patients

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Publications give diverging information as to which metabolic acid–base disorder is the most common in the ICU [1,2]. We explored the distribution of base excess (BE) values in a large number of ICU patients and evaluated if this distribution was related to rising sodium values after admission. BE values were obtained during ICU admission in selected periods from a first level small community hospital, a second level central hospital with university affiliations, and a third level large Norwegian university/regional hospital. Sodium values were from ICU patients in the second level hospital. Laboratory values were anonymously retrieved from databases in each hospital, aggregated and analyzed in Qlikview or Excel and exported to GraphPad Prism for column statistics and analysis of variance and for preparing graphs and frequency histograms. Anonymous laboratory data are not personal data according to Norwegian data laws and studies using such data do not need informed consent. The study was approved by the local data protection officer.

A frequency histogram for all pooled BE values ( $N = 138,523$ ) is shown in Figure 1A and one for BE values divided by level of care is shown in Figure 1B. Figure 1C shows the rapid rise in BE values after admission in 118,014 samples.

Although acidosis is more common at ICU admission, bicarbonate increases over time (Figure 1D) [3]. Alkalosis can be pure or mixed. Post-hypercapnic

alkalosis is a complication of mechanical ventilation in patients with chronic obstructive pulmonary disease [4].

If the count of repetitive sampling influenced our results, we assume they are skewed towards acidosis, as unstable and acidotic patients tend to have acid–base samples drawn more frequently.

Data from the Norwegian National Intensive Care Registry [5] suggest that the difference in BE values between the three hospitals in our study may partly stem from difference in patients' lengths of stay. In our study, the second level hospital had the longest median length of stay (2.7 days).

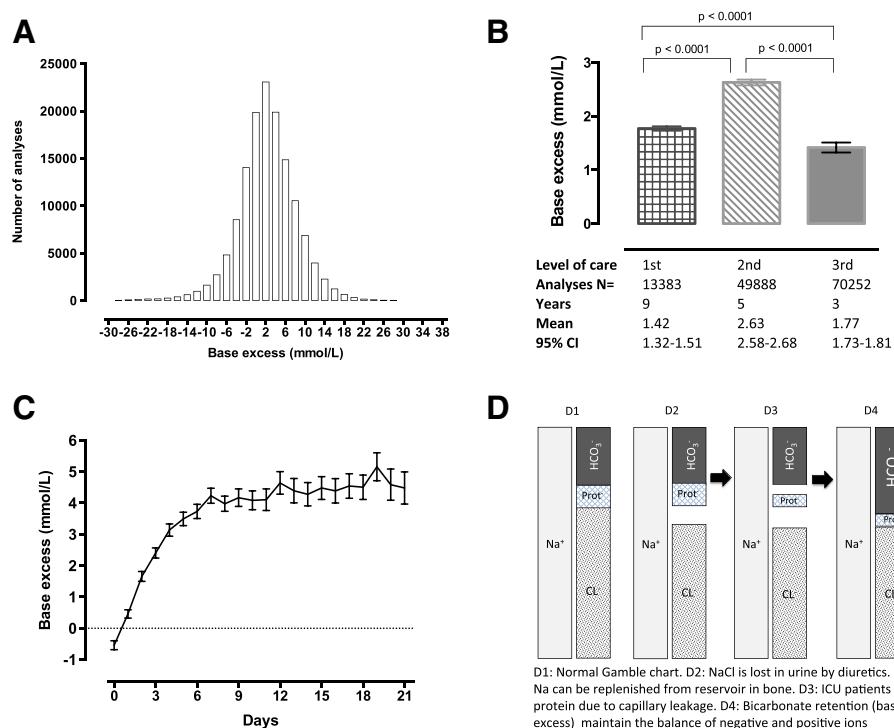
A coupling of metabolic alkalosis to rising sodium values proposed by Lindner and colleagues [6] did not seem to apply to patients in our study, as the day-by-day analyses of 118,014 sodium values after admission to the ICU in the second level hospital showed a mean of about 140 mmol/L on admission and a mean of 139 mmol/L over the following 21 days (data not shown).

To our knowledge, we have for the first time presented the distribution of BE values in a high number of ICU patients over their entire stay, from three hospitals of different care levels, and demonstrated an increase in BE values within the first days after admission. Our results show that metabolic alkalosis is, overall, the most common acid–base disorder in ICU patients.

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**Figure 1 Distribution, between-hospital differences, development and mechanisms of metabolic alkalosis in a large number of ICU patients.** (A) Frequency histogram for all pooled base excess values (N = 138,523) from all three hospitals. (B) Bar chart of mean base excess values with 95% CI from three hospitals of different care level. (C) The rise in 118,014 mean base excess values with 95% CI after admission to the ICU in the secondary level hospital over the following 21 days. (D) Cartoon explaining two important mechanisms behind metabolic alkalosis in ICU patients. Prot., protein.

#### Abbreviations

BE: Base excess.

#### Competing interests

The authors declare that they have no competing interests and meet the authorship requirements.

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