

Hyponatremia and fluid shifts in diabetic hyperglycemia; secondary analysis of a prospective clinical trial

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Abstract Background: Hyponatremia is a common feature of severe hyperglycemia in diabetic patients. We studied whether it is due to plasma dilution, a sodium deficit, or both. **Methods:** In 17 patients with diabetes-induced severe hyperglycemia, blood hemoglobin and the concentrations of glucose, sodium, and other electrolytes in plasma and urine were measured during and after an intravenous infusion of 1 L of 0.9% saline over 30 min on two consecutive days. Fluid volume and electrolyte kinetics were applied to study relationships between the glucose and electrolyte levels and to estimate the sizes of the body fluid compartments. **Results:** There was a statistically significant inverse linear relationship between plasma glucose (highest value 53 mmol/L) and plasma sodium (lowest 120 mmol/L). The correction factor was 1.6 or 2.2 depending on how the comparison was made. The hyperglycemia on admission corresponded to a fluid shift from the intracellular space of 350 mL, which was sufficient to explain the difference in baseline plasma sodium between the two study days. However, this dilution co-existed with a 20% reduction of the plasma and extracellular fluid volumes, and the body contents of sodium and chloride were 26% and 30% below normal, corresponding to deficits of 400 mmol. Restoration of the acid-base balance and the kidney function, rather than decreasing plasma glucose levels, seemed to drive the normalization of plasma sodium. **Conclusions:** Hyponatremia in severe diabetic hyperglycemia can be explained both by dilution and a sodium deficit. The medical treatment should consider both factors. **Key words:** Dehydration, diagnosis, urine, physiopathology, diabetes mellitus, physiology; normal saline; pharmacokinetics.

The physicochemical theory of gas bubble formation-triggered microcirculatory dysfunction in the critically ill with supporting evidence from retrospective observational study

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Background: There is growing evidence of microcirculatory dysfunction being a major factor in determining the extent of multiorgan failure and, so, the outcome of critically ill patients. Quick acidification of a bicarbonate anion (HCO₃⁻)-containing solution causes carbon dioxide (CO₂) supersaturation-triggered gas bubble formation in that solution. Blood is a HCO₃⁻-containing solution as well. Accordingly, we believe that rapid occurrence of profound metabolic acidosis could result in gas bubble formation in the critically ill. Gas bubbles form due to CO₂ supersaturation at first, then other gases diffuse into bubbles in proportional amounts.

Gas bubble-blood interface-triggered platelet adhesion and activation with consequent capillary occlusion could explain microcirculatory dysfunction. **Methods:** With a retrospective observational study including all admitted patients to our ICU in 2020 we investigated if there exists a correlation between the severity of metabolic acidosis in patients upon their admission to the ICU and their platelet count trend in the following two days. Base excess (BE) from blood gas analysis with the lowest pH around ICU admission was used as a marker of the severity of metabolic acidosis. Platelet count in patients upon admission and lowest platelet count on their second day were used to calculate patient's relative platelet count decline after ICU admission; $\Delta P = ((P_2 - P_0) / P_0) \times 100$. **Results:** Comparison of ΔP in all six groups of BE showed a statistically significant difference (Kruskal-Wallis test; $p < 0.001$). Patients from groups with more negative BE values tend to have more negative ΔP . **Conclusions:** Patients with more profound metabolic acidosis upon their ICU admission tend to have larger relative platelet count decline in the following days. Although in a very indirect way, these findings support our theory of gas bubble-blood interface-triggered platelet consumption with resulting microcirculatory dysfunction in most severely ill ICU patients.

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Patient-specific in silico lung modelling: simulating the effect of a severe lung injury on alveolar recruitment

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