

Updated Review of Sodium Correction for Hyperglycemia

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Abstract

Hyponatremia is a disorder of decreased tonicity, which generally results from water excess and has important treatment considerations given the effects of altered hypotonicity on the brain. However, in patients with hyperglycemia, measured serum sodium levels can be low despite no decrease in tonicity. This is due to osmotic water shifts from the intracellular to extracellular compartment resulting in hyponatremia. Distinguishing between true and dilutional hyponatremia is imperative for clinical decision making and to guide treatment strategies. To guide management decisions such as choice of fluids, in the presence of hyperglycemia, a correction factor is generally applied to calculate “corrected sodium,” defined here as serum sodium adjusted for hyperglycemia. There is a non-linear relationship between decrease in serum sodium with hyperglycemia and, depending on serum glucose, the corrected sodium ranges from 1.6 mEq/L to 4.0 mEq/L sodium increase for every 100 mg/dL rise in serum glucose. Clinicians should act on the corrected sodium level, not the unadjusted measurement. In fact, studies show that in cases of hyponatremia with concurrent severe hyperglycemia, the true tonicity disorder is often hypertonicity rather than hypotonicity. Moreover, outcomes tend to correlate with corrected rather than measured serum sodium. Finally, as in all disorders of plasma tonicity, frequent monitoring of sodium levels and in cases of hyperglycemia correction for resulting hyperosmolality, is essential as tonicity can fluctuate rapidly with management.

I. HOW TO USE

When to Use

In patients with high blood glucose levels with low serum sodium levels on laboratory investigation use this calculator to determine corrected serum sodium.¹

Pearls / Pitfalls

The classic correction factor of 1.6 mEq/L in serum sodium for every 100 mg/dL increase in serum glucose was challenged by a paper by Hillier et al. in 1999, which suggests using 2.4 mEq/L factor, particularly in patients with severe hyperglycemia (glucose levels > 400 mg/dL).²

Repeat sodium levels regularly, as serum sodium will shift with ongoing fluid replacement. On initial laboratory tests, check serum osmolality, a normal serum osmolality despite low measured sodium indicates pseudohyponatremia rather than a true tonicity disorder.

In patients with extreme hyperglycemia, the corrected sodium may reveal true hypernatremia, which may be

associated with worse outcomes.^{3,4} Therefore, regular serum sodium measurement must be ensured during fluid replacement and glucose control.

The formula assumes a uniform osmotic response across all patients, which may not be the case in certain conditions (e.g., extreme hyperglycemia, critical illness). Alternative correction factors or direct serum osmolality assessments may provide better accuracy in some cases.

Why Use

Corrected sodium allows selection of appropriate intravenous fluid selection and other interventions appropriate for serum sodium level and associated tonicity disorder, if present.⁵ To guide clinical treatment and modify rate of correction of sodium with fluctuating levels of glucose.

II. NEXT STEPS

Advice

Make clinical decisions based on corrected sodium levels as a starting point of therapy which must be followed by frequent and longitudinal monitoring of laboratory parameters such as serum glucose, sodium, and osmolality.

Management

Initial management involves measuring the listed laboratory parameters to determine if hyponatremia is true or dilutional and assessing serum osmolality to rule out pseudohyponatremia from other causes. Clinical decisions should be based on corrected sodium values, and adjustments to fluid type and rate should be based on corrected sodium trends and made in view of the overall clinical status.

Critical Actions

Calculate corrected sodium and base all clinical decisions on corrected, not measured sodium values. Monitor frequently, check glucose and sodium frequently; recalculate corrected sodium with each measurement and control the correction rate to prevent complications, particularly in children. Measure serum osmolality if corrected sodium is inconsistent with clinical presentation or to exclude pseudohyponatremia. If corrected sodium continues to be low recognize cause of true hyponatremia and treat the condition.

III. EVIDENCE

Validity: The physiological basis for sodium correction in hyperglycemia is well established; hyperglycemia causes osmotic water shifts that dilute serum sodium. However, the original derivation studies were limited with more recent evidence suggesting variability in the actual correction factor, from 1.6 to 4.0 mEq/L per 100 mg/dL glucose elevation, particularly at higher glucose levels.

Reliability: While the formula is widely cited and applied, external validation reveals that the appropriate correction factor varies across populations (e.g., ICU patients, varying degrees of hyperglycemia).

Applicability: The formula is straightforward, easy to use, and clinically useful for distinguishing true hyponatremia from dilutional hyponatremia in hyperglycemic states.

Limitations: The formula does not account for varied osmotic responses across in extreme hyperglycemia or critical illness. Alternative correction factors or direct measurement of plasma osmolality may provide greater accuracy in specific clinical scenarios.

Formulae

Corrected Sodium (Katz, 1973) = Measured sodium + (0.016 * (Serum glucose - 100))

Corrected Sodium (Hillier, 1999) = Measured sodium + (0.024 * (Serum glucose - 100))

Note: Serum glucose must be in mg/dL for these formulae to work.

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