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Research Article

Hypertonic Sodium Therapy of 5%Nacl and 8.4%$Naco_3$ for Acutely Ill and Shocked Patients

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Abstract

Fluid resuscitation using hypertonic saline results in volume expansion and less total infusion volume. It is a lifesaving therapy in many acute clinical conditions. This may be of interest in oedematous patients with intravascular volume depletion. When such strategies are employed, renal effects may differ markedly according to prior intravascular volume status. In hyper-volumetric states with depleted intravascular volume, hypertonic sodium therapy of 5% NaCl and 8.4% $NaCo_3$ turns it into hypervolaemia with massive diuretic effect. Hypertonic saline induced changes in serum osmolality and sodium return to baseline within a limited period. Sparse evidence indicates that resuscitation with hypertonic saline results in less perioperative complications, ICU days and mortality in selected patients. In conclusion, the use of hypertonic saline may have beneficial features in selected critically ill patients when carefully chosen. Hypertonic sodium therapy of 5% NaCl and 8.4% $NaCo_3$ has proved lifesaving in treating the TUR syndrome, hyponatraemia and ARDS. Further clinical studies assessing relevant clinical outcomes are warranted.

Keywords: hypertonic sodium therapy; hyponatraemia; hyper-volumetric

Introduction

Clinicians use hypertonic fluids to increase intravascular fluid volume and restore blood pressure. Hypertonic saline can be utilized in the treatment of hyponatremia. Hypertonic saline and mannitol are both indicated to reduce intracranial pressure.

Hypertonic saline is a crystalloid intravenous fluid composed of NaCl dissolved in water with a higher sodium concentration than normal blood serum. Both 3% and 5% hypertonic saline (HS) is currently FDA-approved for use in hyponatremia and increased intracranial pressure (ICP). Patients with hyponatremia with severe features should have their serum sodium gradually corrected with boluses of hypertonic saline. Patients should have their serum sodium monitored at regular intervals and can receive multiple boluses a day.[1]

Hypertonic saline increases the osmolarity of the blood, which allows fluid from the extravascular space to enter the intravascular space, which leads to decreases in brain edema, improved cerebral blood flow, and decreased CSF production. Research shows that 3% hypertonic saline decreases ICP similarly to 20% mannitol.[2] Both hypertonic fluids have similar effects on haemodynamic. Hypertonic saline leads to increases in serum sodium and has less of a diuretic effect than mannitol, likely due to the increased serum sodium causing ADH release. Hypertonic saline administered after mannitol in traumatic brain injury has also demonstrated improvement of cerebral oxygenation in addition to lowering ICP.[3]

Due to there being no guidelines regarding the administration of hypertonic saline for increased ICP, various studies have used concentrations of 3% to 23.5% NaCl.[4] While not FDA-approved, small doses of hypertonic saline are thought to be effective in hypovolemia and shock due to fluid movement from the intracellular to intravascular spaces, increasing intravascular fluid volume and improving capillary blood flow.[5]

Hypertonic fluids contain a higher concentration of solute compared to plasma and interstitial fluid; this creates an osmotic gradient and drives fluid from the interstitial space into the intravascular space. This increase in intravascular volume increases mean arterial pressure (MAP), stroke volume (SV), and cardiac output (CO) when compared with equal volumes of normal saline or other isotonic fluids.[6] There is also a significant increase in end-diastolic pressure and a subsequent decrease in pulmonary vascular resistance. Hypertonic saline requires less overall volume administered to achieve similar plasma volumes as larger volumes of normal saline.[7] Hypertonic saline stimulates vasopressin release from the pituitary gland, which decreases water loss through the kidneys.[8]

Hypertonic fluids are administered parenterally via intravenous infusion. Infusion volumes and rates depend on clinical indication.

Hypertonic Saline: In patients with severe hyponatremia, serum sodium should undergo correction by 4 to 6 mEq/L per day, which can be achieved with 100 mL boluses of 3% HS at 10-minute intervals up to three total boluses. Some authorities recommend up to 8 mEq/L per day.[9] Less severe hyponatremia can achieve control with enough hypertonic saline to manage symptoms.[10] Due to the insufficient number of patients over age 65 in various trials, hypertonic fluids should start at the lowest ends of the dosing scale in the geriatric population. Pediatric traumatic brain injury generally receives treatment with a 6.5 to 10 mL/kg bolus of hypertonic saline.[11] Administration via a peripheral intravenous catheter is acceptable if no other access is available, but central venous access is the preferred route.

Hypertonic Saline: There are no known specific contraindications for hypertonic saline, according to the FDA. However, caution is necessary with hypertonic saline in patients with congestive heart failure or renal insufficiency due to their already increased fluid and sodium loads.

Hyponatraemia is the most common electrolyte disorder seen in clinical practice and the consequences can range from minor symptoms to life-threatening complications including seizures, coma and cardiorespiratory distress. These effects occur as a result of fluid shifts due to deranged serum tonicity and subsequent cerebral oedema. The appropriate assessment and management of patients with hyponatraemia is not always achieved in clinical practice, which is partly related to challenges in teaching with limited clinical guidance.

Recent evidence on the use of hypertonic sodium therapy (HST) of 5%NaCl and 8.4%NaCo3

Hypertonic sodium therapy (HST) of 5%NaCl and 8.4%NaCo3 has proved lifesaving for treating the acute severe cases of the TUR syndrome, acute dilutional hyponatraemia and the acute respiratory distress syndrome (ARDS).

This HST was used successfully in treating the TUR syndrome, acute dilutional hyponatraemia of <120 mmol/l and ARDS in two clinical studies of a 23-cases series [12] and a cohort prospective study on 100 TURP patients [13] among whom 10 developed the TUR syndrome with hyponatraemia of <120 mmol/l. The studies demonstrated that two new types of cardiovascular shocks occur with volumetric overload of sodium-free fluid (TYPE 1) and sodium-based fluids (TYPE 2) or volumetric overload shock (VOS 1) and volumetric overload shock (VOS 2) [14]. Instantly hypertonic sodium corrects both shock and coma and brings the patient back from near death.

The treatment was given in bolus therapy of 200 ml alternating both fluids given over a period of 10 minutes and repeated after rechecking serum sodium monitored by clinical improvement and urine output [15]. More than 4 L of urine was excreted by the end of one hour period of treatment matching a remarkable clinical recovery from shock and coma. The effect of hypertonic sodium infusion on serum sodium and osmolality are shown in (Figure 1).

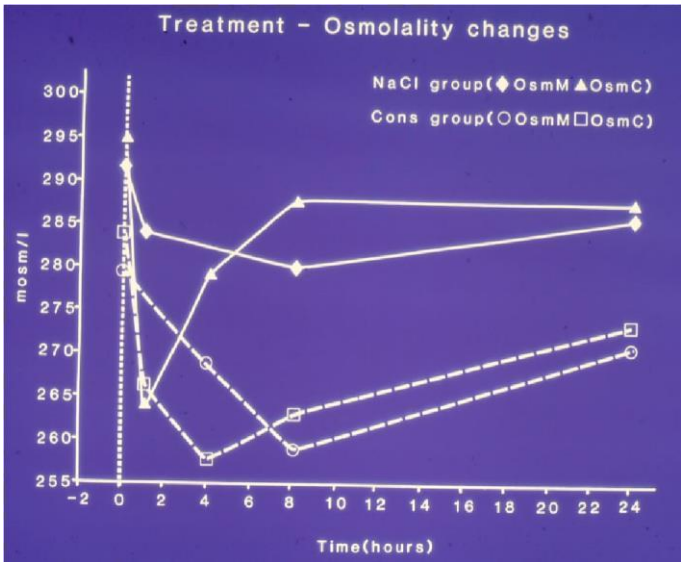

Figure: shows mean changes in measured serum osmolality (OsmM) and calculated osmolality (OsmC) in patients with the TURP syndrome comparing those infused with 5% hypertonic sodium (solid lines) and those treated conservatively (slashed lines). OsmC was calculated from the formula 2xNa+urea+glucose in mmol/l of serum concentration[48] thus reflecting changes in serum sodium concentration. The vertical dotted line represents the start of operation (Time B) followed by C, C1, C2 (end of treatment) and D, respectively.

Conclusion

Fluid resuscitation using hypertonic saline results in volume expansion and less total infusion volume. This may be of interest in oedematous patients with intravascular volume depletion. When such strategies are employed, renal effects may differ markedly according to prior intravascular volume status. Hypertonic saline induced changes in serum osmolality and electrolytes return to baseline within a limited period. Sparse evidence indicates that resuscitation with hypertonic saline results in less perioperative complications, ICU days and mortality in selected patients. In conclusion, the use of hypertonic saline may have beneficial features in selected critically ill patients when carefully chosen. Further clinical studies assessing relevant clinical outcomes are warranted.

Conflict of Interest: None

Funds Received: None

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