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SUMMARY

Hypertonic saline solutions (HTS) are used to treat a variety of neurologic conditions in the ICU. HTS bolus has been shown to be effective in treating increased intra-cranial pressure (ICP) and cerebral edema due to traumatic brain injury, cerebrovascular accident, and aneurysmal hemorrhage. High quality evidence is lacking to define the optimal strategy for treating elevated ICP and cerebral edema as either repeated, symptom-based boluses or continuous HTS infusion. Maintaining normal serum sodium concentrations is a best practice strategy against developing cerebral edema (1). The purpose of this guideline is to outline strategies for the administration of HTS solutions to treat intracranial hypertension, cerebral and associated hyponatremia in the trauma ICU population.

HYPERTONIC SALINE BOLUS DOSING					
	Concentration	Usual Dose	Maximum Rate	Monitoring	IV Access
Emergent Intracranial Process ¹	23.4% NaCl	30 mL	Over 15-20 min via infusion pump (Recommend syringe pump due to small volume)	Stat serum sodium levels must be assessed every 4 hours	Central line required; <i>Exception: ONE</i> dose may be given peripherally in an emergent situation
	1.5% ³	250mL 500mL	999 ml/hr via infusion pump	Stat serum sodium levels must be assessed every 4 hours	Central line preferred; administration through a large peripheral vein with adequate IV access is acceptable
	3% ³	250mL 500mL			
	7.5% ⁴	250mL			
Symptomatic Hyponatremia ² OR Serum Na ≤ 125mmol/L	3% NaCl	100mL 250mL 500mL	999 mL/hr via infusion pump	Stat serum sodium levels must be assessed <u>at least</u> every 4 hours	Central line preferred; administration through a large peripheral vein with adequate IV access is acceptable

¹ Emergent Intracranial Process

- Acute intracranial hypertension defined as sustained elevation in ICP > 22 mmHg
- Known intracerebral lesion (e.g. hemorrhage /mass/cerebral edema) with signs/symptoms of impending cerebral herniation
- Acute cerebral edema defined as evidence new / worsening cerebral edema on brain imaging.

² Symptomatic Hyponatremia

- Documented acute drop in serum sodium (Na) within a 24-hour period accompanied by neurologic sequela (e.g. change in mental status, seizures, etc...)
- Serum Na ≤ 125 mmol/L with neurologic sequela (e.g. altered mental status, gait changes, seizures, etc.)

³ 1.5% or 3% may be prepared as NaCl, NaAcetate, or 50:50 NaCl:NaAcetate mix

⁴ 7.5% may be prepared as NaCl or 50:50 NaCl:NaAcetate mix

DISCLAIMER: These guidelines were prepared by the Department of Surgical Education, Orlando Regional Medical Center. They are intended to serve as a general statement regarding appropriate patient care practices based on the medical literature and clinical expertise at the time of development. They should not be considered to be accepted protocol or policy, nor are intended to replace clinical judgment or dictate care of individual patients.

Choosing which HTS to bolus can be guided by estimating the expected rise in serum sodium. Adroque and Madias described a formula to estimate the expected change in serum sodium by infusing 1 liter of a chosen sodium concentration infusate (2).

$$\text{Change in serum Na} = \frac{\text{infusate Na (mEq/L)} - \text{serum Na (mEq/L)}}{[0.6 \text{ L/kg (total body water for men)} \text{ OR } 0.5 \text{ L/kg (total body water for women)}] \times \text{Wt (kg)} + 1}$$

This equation was used to extrapolate the estimated changes in serum Na concentration for different saline concentrations and bolus doses:

Estimated Increase in Serum Sodium Following Hypertonic Saline Bolus
(Estimated using Serum Na = 130 mEq/L)

Bolus Dose	Weight	Expected Increase in Sodium	
		Male	Female
3% 500mL (256 mEq)	70 kg	~4 mEq/L	~ 5 mEq/L
	80 kg	~4 mEq/L	~4-5 mEq/L
	90 kg	~3 mEq/L	~4 mEq/L
	100 kg	~3 mEq/L	~3-4 mEq/L
7.5% 250mL (320 mEq)	70 kg	~6-7 mEq/L	~8 mEq/L
	80 kg	~6 mEq/L	~7 mEq/L
	90 kg	~5 mEq/L	~6 mEq/L
	100 kg	~5 mEq/L	~5-6 mEq/L
23.4% 30mL (120 mEq)	70 kg	~2 mEq/L	~3 mEq/L
	80 kg	~ 2 mEq/L	~3 mEq/L
	90 kg	~1-2 mEq/L	~2 mEq/L
	100 kg	~1-2 mEq/L	~2-3 mEq/L

The maintenance of normal serum sodium levels is accepted as best clinical treatment practice in patients with TBI to avoid the development or worsening of associated cerebral edema. Infusion of HTS can be used to help raise serum sodium levels. Below are recommendations for the infusion of HTS to raise serum sodium levels:

HYPERTONIC SALINE CONTINUOUS INFUSION			
Concentration	Maximum Rate	Monitoring	IV Access
1.5% NaCl (256 mEq/L) OR NaAcetate (260mEq/L) OR 50:50 NaCl:NaAcetate (260 mEq/L)	150 mL/hour	Patient specific	Central line preferred; administration through a large peripheral vein with adequate IV access is acceptable
3% NaCl (512 mEq/L) OR NaAcetate (512 mEq/L) OR 50:50 NaCl: NaAcetate (512 mEq/L)	150 mL/hour	STAT serum sodium levels must be assessed at least every 4 hours	Central line preferred; administration through a large peripheral vein with adequate IV access is acceptable

REFERENCES

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