Disorders of Sodium and Water Balance

Theresa R. Harring, MD*, Nathan S. Deal, MD, Dick C. Kuo, MD*

KEYWORDS

• Dysnatremia • Water balance • Hyponatremia • Hypernatremia
• Fluids for resuscitation

KEY POINTS

- Correct hypovolemia before correcting sodium imbalance by giving patients boluses of isotonic intravenous fluids; reassess serum sodium after volume status normalized.
- Serum and urine electrolytes and osmolalities in patients with dysnatremias in conjunction with clinical volume assessment are especially helpful to guide management.
- If an unstable patient is hyponatremic, give 2 mL/kg of 3% normal saline (NS) up to 100 mL over 10 minutes; this may be repeated once if the patient continues to be unstable.
- If unstable hypernatremic patient, give NS with goal to decrease serum sodium by 8 to 15 mEq/L over 8 hours.
- Correct stable dysnatremias no faster than 8 mEq/L to 12 mEq/L over the first 24 hours.

INTRODUCTION

Irregularities of sodium and water balance most often occur simultaneously and are some of the most common electrolyte abnormalities encountered by emergency medicine physicians. Approximately 10% of all patients admitted from the emergency department suffer from hyponatremia and 2% suffer from hypernatremia.[1] Because of the close nature of sodium and water balance, and the relatively rigid limits placed on the central nervous system by the skull, it is not surprising that most symptoms related to disorders of sodium and water imbalance are neurologic and can, therefore, be devastating. Several important concepts are crucial to the understanding of these disorders, the least of which include body fluid compartments, regulation of osmolality, and the need for rapid identification and appropriate management.

The difference between a minor symptom and a life-threatening condition caused by a sodium imbalance is often a result of the rapidity of the change in sodium concentration, not necessarily the overall deficit; and how quickly the imbalance is recognized

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Section of Emergency Medicine, Ben Taub General Hospital, Baylor College of Medicine, Emergency Center, 1504 Taub Loop, Room EC 61, Houston, TX 77030, USA
* Corresponding authors.
E-mail addresses: harring@bcm.edu; dckuo@bcm.edu

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and then treated by clinicians. Because emergency physicians do not always have the most complete background information on their patients in acute settings, this article delineates the types of sodium and water imbalances, the symptoms and signs the clinician encounters, pitfalls and complications of correcting these imbalances too aggressively, and how to base initial management of these patients.

- Sodium and water disorders occur simultaneously and most commonly affect the neurologic system, potentially leading to devastating outcomes.

PHYSIOLOGY

Total body water (TBW) accounts for approximately 60% of the total body weight in adults (**Fig. 1**); however, this figure changes with extremes of age, and within the sexes.[2] A more accurate picture of TBW can be calculated by (Equation 1, **Table 1**):

$$\text{TBW} = \text{weight (kg)} \times \text{correction factor} \qquad (1)$$

The TBW is further divided into intracellular fluid, approximately 40% of total body weight; and extracellular fluid (ECF), approximately 20% of total body weight. Of the ECF, approximately two-thirds comprises interstitial fluid and one-third comprises intravascular fluid. The intravascular fluid is correspondingly close to 5% of the total body weight. The primary solute of the ECF is sodium, with a normal concentration of 140 mEq/L. As the concentration of sodium changes, neurologic symptoms may begin to manifest because of the confining nature of the skull. These symptoms may be minor or they can lead to life-threatening conditions.

Sodium regulation primarily occurs via 2 mechanisms: vasopressin and thirst regulation. For proper fluid balance, an average healthy adult requires an intake of approximately 1 to 3 L of water per day.[3,4] This amount of water replaces the amount of water lost from the body in insensible losses and urinary output, including approximately 500 to 700 mL/d from the respiratory tract, 250 to 350 mL/d from the skin, and 100 mL/d from the feces.[3] Additional water replacement may be necessary for other excessive losses, such as sweating caused by exercise or fevers.

Water diffuses via transport channels across cellular membranes, allowing osmolality to remain relatively constant between the spaces, but in effect changing the electrolyte concentrations of these compartments. Normal osmolality of plasma is 275 to 295 mOsm/L H_2O and can be estimated by (Equation 2):

$$\text{Serum osmolality (mOsm/kg)} = 2 \times \text{Na} + \text{glucose (mg/100 mL)}/18 + \text{blood urea nitrogen (mg/100 mL)}/2.8 \qquad (2)$$

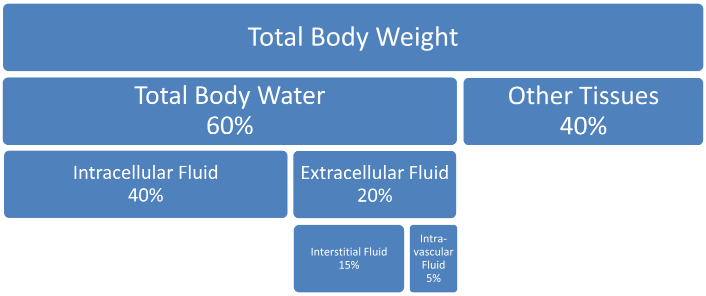

Fig. 1. Relationship of fluid compartments to total body weight. Percentages are expressed as related to total body weight.