HYPERNATREMIA IN THE ELDERLY

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Hypernatremia is defined as a plasma sodium concentration greater than 145meq/liter. This is primarily due to water loss in adults although increased salt ingestion may be a cause for it. When plasma sodium concentration rises above 145meq/liter, thirst is stimulated, this results in ingestion of water. Hypothalamic osmoreceptors cause synthesis and release of an antidiuretic hormone. Normal renal response causes reabsorption that prevents further loss of water. These normal physiological responses help bring plasma sodium back to normal.

Persistent hypernatremia, therefore, implies an inability to sense thirst or lack of access to water, since ingestion of water will prevent development of significant hypernatremia even in the absence of antidiuretic hormone release or lack of renal response to its effect.

Elderly persons have decreased thirst, and therefore, ingest less amounts of water than their younger counterparts. Hospitalized elderly patients and frail nursing home residents are at an increased risk for the development of hypernatremia because they rely on others for their water needs. Therefore, adequate water must be prescribed and given to these individuals.

In this article, we review the risk factors, pathophysiology, causes, prevention, and management of hypernatremia in the elderly. (*J Natl Med Assoc.* 2002;94:701-705.)

Key Words: elderly hypernatremia ◆ decreased thirst

Elderly people typically have decreased thirst, thus resulting in reduced water intake.[1] The ability to concentrate urine also diminishes with advancing age.[2] Hypernatremia is present in about 1% of hospitalized patients over 60 years of age; prevalence of the condition is much higher in febrile nursing home patients.[3] Also, hypernatremia is associated with higher mortality.[4]

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WATER PHYSIOLOGY

Plasma sodium concentration gives an insight into the state of water balance. Sodium is the predominant cation in the extracellular fluid and is the main contributor to serum osmolality.[5] Hypernatremia occurs when there is a decrease in total body water, except in cases of increased salt ingestion. On the other hand, hyponatremia means there is an increase in total body water.

Thirst is the ultimate defense against development of hypernatremia, such that an increase in plasma sodium above 145 meq/liter stimulates thirst with the resultant increased ingestion of water, and hypothalamic osmoreceptors cause synthesis and release of antidiuretic hormone that promotes water reabsorption in the cortical collecting tubules. These

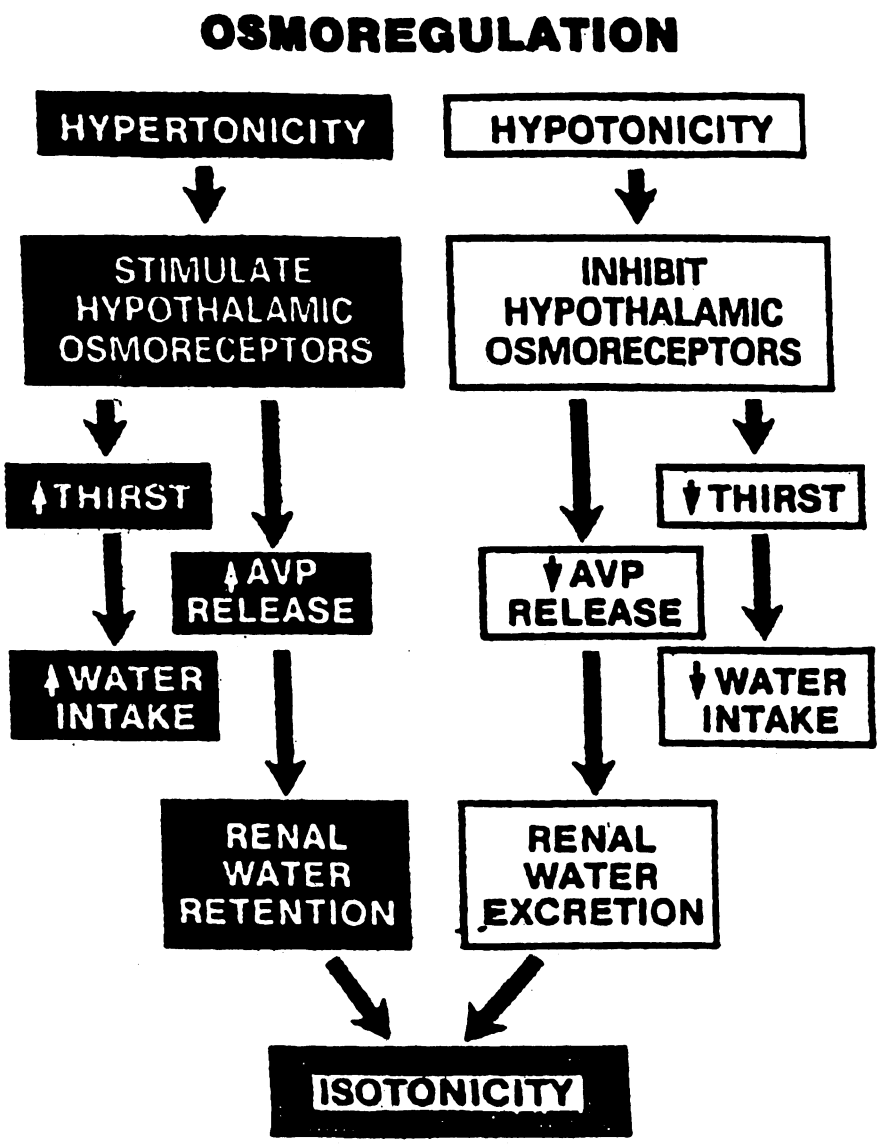

Figure 1. Overview of water balance reprinted with written permission from Robert G. Narins.[7] Osmoregulation.

physiologic responses help bring plasma sodium back to a normal level. Therefore, persistent hypernatremia signifies a reason for decreased water intake. On the other hand, hyponatremia signifies increased water ingestion coupled with an inability of the kidney to excrete it. Because in the presence of hypotonicity, antidiuretic hormone secretion is suppressed, leading to the excretion of dilute urine[6,7] (See Figure 1).

Age-Related Changes in Water Physiology

Thirst is decreased in older people as evidenced by response to water deprivation. Older persons, when compared with younger people, ingest smaller amounts of water during 24-hours of water deprivation.[1,8,9] Similar observation was made by some investigators when older and younger persons were given hypertonic saline. Older persons drank less water, when compared with their younger counter-

parts, after being given hypertonic saline to induce hypertonicity.[10]

The ability to dilute or concentrate urine during water loading or deprivation diminishes with advancing age.[2] Glomerular filtration rate falls with advancing age and older people have decreased total body weight, such that loss of equal amounts of water in both older and younger persons leads to a more pronounced development of hypernatremia in the older individuals.[11]

EPIDEMIOLOGY

The cost of care for elderly patients with hypernatremia is expensive. In 1991, more than 60% of hospitalized Medicare patients had dehydration (hypernatremia) as one of the top five diagnoses, at a cost of $446 million.[12] The mortality rate from hypernatremia is said to be 40% to 55%, and the majority of deaths are related to underlying disease process rather than the hypernatremia per se.[13,14]

Risk factors

Numerous factors increase the susceptibility of elderly persons to hypernatremia including age greater than 85 years, female gender, having more than four chronic conditions, taking more than four medications, limited mobility, infections, and altered mental status.[15]

Other risk factors include hypertonic infusions, tube feedings, osmotic diuretics, laxatives, and mechanical ventilation.[16]

Causes

Net water loss is the cause for the majority of cases of hypernatremia.[17,18] Causes of hypernatremia in the elderly can be classified into the following groups:[6,19]

- **Decreased water intake.** This may be due to an inability to express thirst secondary to altered mental status, disease of osmoreceptors and cortical thirst centers. Lack of access to water may also be a reason for decreased water intake. Older persons voluntarily reduce intake to avoid urinary incontinence. Physical restraints as part of management in combative patients, may cause reduced water ingestion.
- **Increased water loss.** Diabetes insipidus, vomiting, osmotic diarrhea, sweating, fever, and hyperventilation may all contribute to increased water loss.
- **Redistribution of water from extracellular space into intracellular compartment.** Examples include strenuous exercise, seizures and rhabdomyolysis.
- **Increased salt gain.** From hypertonic sodium bicarbonate intravenous infusion given to patients during cardiopulmonary resuscitation (CPR) and in correction of some metabolic acidosis, as well as ingestion of seawater in individuals involved in near drowning.

Clinical Features

The symptoms and signs of hypernatremia are due to cellular dehydration. Because of extracellular hypertonicity, water moves from intracellular compartment into extracellular space, resulting in cellular shrinkage. In the brain, cellular shrinkage may result in severance of dural veins and venous sinuses causing intracellular hemorrhage.[20,21]

Common clinical presentations include altered mental status, acute weight loss, irritability, restlessness, and hypereflexia.[16,22,23]

Patients with hypotonic losses may present with signs of hypovolemia, including tachycardia, orthostasis and dry mucous membranes.[22]

MANAGEMENT

We should emphasize that hypernatremia should not persist in a person that is awake, whose thirst mechanism is intact and has access to water. Hypernatremia usually depicts absolute free water deficit. Total body water (TBW) in liters should initially be estimated.

Total body water in liters is calculated as a fraction of body weight in kilograms. The fraction is 0.6 in non-elderly men, 0.5 in non-elderly women, 0.5 in elderly men and 0.45 in elderly women.[24] The water deficit is then calculated using the following formula:[25]

$$\text{Water deficit} = \text{total body water (TBW)} \times \left(\frac{\text{measured plasma sodium}}{140}\right) - 1$$

It is recommended to replace the water deficit plus ongoing losses, and also treat the underlying cause. For example: diarrhea, vomiting or diabetes insipidus, if feasible.

Rate of Correction

With acute hypernatremia, onset within hours, plasma sodium concentration should be reduced by 1 mmol per liter per hour, but with hypernatremia of unknown duration, rate of correction should be about 0.5 mmol per liter per hour.[26,27,28]

Half of the water deficit should be given in the first 24-hours and the remainder given in the next two to three days.[29,30] The fluid of choice depends on the type of hypernatremia. The preferred route of administration in stable patients is oral or through feeding tube when feasible. If parenteral replacement is required, 5% dextrose in water or 0.2% sodium chloride (one-quarter isotonic saline) or 0.45% sodium chloride (one-half isotonic saline) is given.

These patients can be divided into three clinical categories:[16]

- **Isovolemic hypernatremia.** These patients develop hypernatremia as a result of pure water loss. Examples include unreplaced insensible losses and diabetes insipidus. Ongoing losses and water deficit should be replaced with 0.45% sodium chloride, 0.2% sodium chloride, 5% dextrose in water intravenously or oral water depending on the clinical settings.
- **Hypovolemic hypernatremia.** There is hypotonic fluid loss consisting of solutes and free water, but with more loss of free water than solutes. These patients are usually volume depleted. Sources of fluid loss include renal secondary to diuretics, gastrointestinal loss due to vomiting and diarrhea. Isotonic saline should be given to replenish the intravascular volume, followed by 5% dextrose in water to correct the water deficit.
- **Hypervolemic hypernatremia.** The hypernatremia is caused by hypertonic sodium gain and is usually iatrogenic. Excess salt is removed with diuretics and free water is administered in form of 5% dextrose in water. In patients with renal failure, dialysis may be required.

PREVENTION

Health care givers including physicians, nurses, and dietary staff must pay close attention to fluid intake and losses in all hospitalized elderly patients. They should anticipate water balance problems in elderly, frail patients in long-term facilities and in the hospitalized settings; since these patients depend on others for their fluid requirements and adequate water must be prescribed and given. The health care team in cooperation with the patient's family members, especially in long-term facilities, must work together to prevent or reduce the degree of disturbance to water balance in susceptible, elderly patients.

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