Sodium and Neurosurgery

Michael Horowitz, MD
Pittsburgh, PA
Why are neurosurgeons concerned about serum sodium?

- The serum sodium level has a major effect on serum osmolality (mOSm/L)
- Serum Osm is essentially the concentration of solutes in serum
- Serum Osm and intracellular Osm are in equilibrium so that cell volume remains constant
- If serum Osm is lower than normal (282-295 mOsm/L), fluid can enter cells of the brain since water enters the cells in response to the higher Osm in the cell compared to the serum
- Cellular swelling can cause brain dysfunction and death due to increase in intracranial pressure
Sodium Levels

- Normal serum sodium (Na) is 135 - 145 ng/ml.
- Neurosurgeons are concerned with both hyponatremia and hypernatremia since these aberrations can affect cerebral blood flow, blood pressure, blood volume, brain swelling and intracranial pressure.
- In neurosurgical practice hypontremia is most commonly due to:
  - Syndrome of Inappropriate Antidiuretic Hormone Release (SIADH)
  - Cerebral Salt Wasting (CSW)
- In neurosurgical practice hypernatremia is most commonly due to:
  - Diabetes insipidus (DI)
Hyponatremia (Na < 133 ng/ml)

- SIADH
- CSW
Hormonal control of fluid and sodium levels

- Antidiuretic Hormone (arginine vasopressin) is produced and released by the supraoptic nucleus (SON) of the hypothalamus.
- ADH acts on the kidney’s renal tubules to increase water reabsorption thus diluting the blood serum.
- ADH also causes constriction of blood vessels.
- When serum osmolality increases ADH increases and water is retained so that the serum Osm returns to normal through the effect of hemodilution.
- When serum volume is reduced ADH also increases so that more water is reabsorbed by the kidney and enters the blood stream thus increasing blood volume towards normal.
What usually causes hyponatremia in neurosurgical patients?

- Syndrome of inappropriate antidiuretic hormone release (SIADH)
  - Sodium concentration reduction in serum due to water retention and its dilution effect on serum sodium
  - Sodium reduction with hypervolemia

- Cerebral salt wasting (CSW)
  - Sodium reduction due to Na excretion (natriuresis) and hypervolemia
SIADH

- ADH released without an osmotic reason (therefore inappropriate)
- Serum sodium reduced (<134)
- Serum Osm reduced (<280)
- Urine osmolalility elevated due to water reabsorption by the kidney and resultant urine concentration (urine Na 50-150)
- Hypervolemia due to fluid reabsorption despite the fact that the individual is not dehydrated
- Hyponatremia with Hypervolemia
What can cause SIADH?

- Malignant tumors
- Neurological abnormalities such as infection, head injury, tumors, subarachnoid hemorrhage
- Following cranial surgery
- Pulmonary disorders
- Stress
- Medications such as chlorpropamide, oxytocin, diuretics, Tegretol, opiates
SIADH Symptoms

- Changes in mental status
- Nausea
- Vomiting
- Fluid overload
SIADH Diagnosis

- Serum sodium less than 134 mEq/L
- Serum Osm less than 280 mOsm/L
- Elevated urine sodium (usually 50-150 mEq/L)
- Normal renal function
- Normal thyroid function
- Euvolemia (no dehydration or over hydration)
SIADH Treatment

- Fluid (water) restriction to less than 1000 ml per day
- Sodium replacement including salt tablets or if necessary hypertonic saline
- Blood transfusion if patient is anemic
- Lasix along with oral sodium (since Lasix causes water loss and sodium loss in urine)
- Demeclocycline to inhibit ADH activity in kidney
- Dilantin to reduce ADH release
Cerebral Salt Wasting (CSW)

- SIADH and CSW are easily confused with one another
- While SIADH has low serum sodium concentration due to hypervolemia, CSW has low serum sodium due to salt loss at the kidney and hypovolemia
- Therefore both have low serum sodium but one has hypervolemia and one has hypovolemia
- In CSW the kidneys do not save sodium and there is salt wasting
- In CSW plasma volume is low while in SIADH plasma volume is elevated
Treatment of CSW

- Volume replacement
- Salt replacement
- Blood transfusion if anemic
- Florinef (Fludrocortisone) IV or PO (0.2 mg) may increase sodium absorption
Hypernatremia (Na > 150 ng/ml)

- Diabetes insipidus
- Due to low levels of ADH
- Two types
  - Neurogenic- pituitary/hypothalamic injury/dysfunction
    - Genetic
    - Traumatic/surgical
    - Sarcoidosis
    - Infection
    - Autoimmune
    - Vascular/Vasculitis
    - Drugs (alcohol, dilantin)
- Nephrogenic (rarely seen by neurosurgeons)
Signs and Symptoms

- High urine output (>250 cc/hour)
- Urine mOsmol/L <200
- Urine specific gravity < 1.003
- Normal or elevated serum Osmolality (normal 282-295)
- Craving for water (ice water)
- Dehydration
Treatment

- Fluids (PO, IV)
- Replace ADH (vasopressin)
  - Desmopressin (DDAVP) PO, IV, SQ, nasal spray (IN)
    - 0.5 micrograms  IV TID
    - 1.0 microgram IV BID
    - 10 micrograms IN BID