hypernatraemia [created by Paul Young 15/12/07]

general

- hypernatremia can be induced by several illnesses in the critical care setting.
- Hypernatremia is generally categorized according to the causal factors involved:
(i) hypervolemic,
(ii) hypodipsic, and
(iii) increased free water losses

aetiology

Water depletion (decreases in total body water in excess of body solute)

1. Insufficient water intake
   - Unavailability of water
   - Hypodipsia (osmoreceptor dysfunction, age)
   - Neurologic deficits (cognitive dysfunction, motor impairments)
2. Hypotonic fluid loss*
   - A. Renal: diabetes insipidus
     - Insufficient AVP secretion (central diabetes insipidus, osmoreceptor dysfunction)
     - Insufficient AVP effect (nephrogenic diabetes insipidus)
   - B. Renal: other fluid loss
     - Osmotic diuresis (hyperglycemia, mannitol)
     - Diuretic drugs (furosemide, ethacrynic acid, thiazides)
     - Postobstructive diuresis
     - Diuretic phase of acute tubular necrosis
   - C. Nonrenal fluid loss
     - Gastrointestinal (vomiting, diarrhea, nasogastric suction)
     - Cutaneous (sweating, burns)
     - Pulmonary (hyperventilation)
     - Peritoneal dialysis

Solute excess (increases in total body solute in excess of body water)

1. Sodium
   - Excess [Na^+] administration (NaCl, $NaHCO_3$)
   - Sea water drowning
2. Other
   - Hyperalimentation (intravenous, parenteral)

Hypodipsic hypernatremia

- Decreased water intake, or hypodipsia, probably represents the leading cause of hyperosmolality encountered in intensive care settings.
- Outside of critical care settings this etiology is particularly prevalent among the elderly or patients who have altered mental status who do not respond appropriately to physiologic stimuli that signal increased thirst

Hypernatremia from increased water losses

- A variety of diseases can cause increased free water losses in the critical care setting, including gastrointestinal water losses, intrinsic renal disease, hypercalcemia, hypokalemia, and solute diuresis and glucosuria.
- Although these etiologies represent the most frequent causes of hypernatremia with critical illnesses, they must be differentiated from diabetes insipidus, which represents the quintessential clinical cause of hypernatremia.
- Generally, a urine osmolality less than 800 mOsm/kg H_2O in the setting of elevated serum osmolality is indicative of a renal concentrating defect. In the absence of glucosuria or other causes of osmotic diuresis, this generally reflects the presence of diabetes insipidus.

Central diabetes insipidus
- Central diabetes insipidus is caused by a deficiency of AVP secretion from the posterior pituitary but does not become fully manifest until more than 85% of the magnocellular AVP-secreting neurons are damaged.
- Central diabetes insipidus is rare, with a prevalence of 1:25,000. Most cases (40% to 50%) are secondary to a hypothalamic lesion, such as a tumor, or infiltrative diseases such as sarcoidosis and histiocytosis.
- Approximately 20% to 30% of central diabetes insipidus is categorized as idiopathic, but most of these patients most likely have underlying autoimmune disease.
- Sellar lesions and pituitary adenomas are not a common cause of diabetes insipidus, because, over time, the secretion of AVP from magnocellular neurons can shift to regions higher in the hypothalamus. Because these lesions are typically slow growing, if a sellar lesion is detected in the setting of new-onset diabetes insipidus, this suggests the presence of a rapidly enlarging sellar mass such as metastatic disease.

Nephrogenic diabetes insipidus
- Nephrogenic diabetes insipidus is caused by end-organ resistance of the kidney to the antidiuretic effects of AVP. Whereas familial or hereditary nephrogenic diabetes insipidus is secondary to mutations of the AVP V2 receptor or the AQP2 water channel, acquired nephrogenic diabetes insipidus is caused by hypercalcemia, hypokalemia or medications such as lithium and demeclocycline.

Distinguishing central and nephrogenic DI
- A plasma AVP level is useful to distinguish central diabetes insipidus from nephrogenic diabetes insipidus; however, to differentiate definitively nephrogenic diabetes insipidus from central diabetes insipidus and from normal individuals with primary polydipsia, performance of a water deprivation test is often necessary.

treatment

- Treatment goals of hypernatremia include correcting the established water deficit and reducing ongoing excessive urine water losses.
- The following formula is used to estimate the pre-existing water deficit:

$$\text{Water deficit} = 0.6 \times \text{premorbid weight} \times \left[1 - 140/(\text{serum } [Na^+] \text{ mmol/L})\right]$$

- This formula assumes that total body water is 60% of body weight and does not take ongoing water losses into account.
- The treatment of central diabetes insipidus with DDAVP is an effective means of improving polyuria and hypernatremia. Initial doses in the acutesetting are 1 to 2 mcg (intravenous, intramuscular, or subcutaneous).
- If hypernatremia in the setting of central DI, free water should also be given in an effort to correct serum sodium, with 5% dextrose in water as the preferred intravenous replacement fluid.
- Although some cases of nephrogenic diabetes insipidus respond to large doses of DDAVP,traditionally, nephrogenic diabetes insipidus is treated with sodium restriction and thiazide diuretics (any drug in this class may be used with equal potential for benefit), which block sodium absorption and act to decrease renal diluting capacity and free water clearance.