ENDOCRINE ELECTROLYTE DISTURBANCES
SODIUM

- Sodium Disorders
  - Hyponatremia
  - Hypernatremia
  - Pseudohyponatremia
POTASSIUM

- Hypokalemia associated with hypertension
- Hypokalemia associated with normotension
- Hyperkalemia
The most common electrolyte abnormality encountered in clinical practice. Defined as sodium < 135 mEq/L. Patients with chronic and otherwise asymptomatic hyponatremia are at increased risk of gait disturbances, attention deficits, falls, and fractures.
HYponatremia

- Critical to determine the symptoms of acute versus chronic hyponatremia.
- Acute hyponatremia might cause seizures, cerebral edema, coma, respiratory arrest, and death.
- Chronic hyponatremia is generally less symptomatic
HYPONATREMIA

- HYPERVOLEMIC: DILUTIONAL (FLUID OVERLOAD)
- HYPOVOLEMIC: DEPLETION (TOTAL BODY SODIUM DEFICIT)
- SIADH: Defined only in euvolemic individual
- RESET OSMOSTAT
HYPERVERVOLEMIC HYponatremia

- Hypervolemic: dilutional
  - Excess free water, hypotonic liquid
    Psychogenic polydipsia
    Polydipsia
    IV Fluids (hypotonic)
    CHF (but well compensated CHF might be euvolemic)
    Liver Failure and ascites
    Too much DDAVP (in patient with DI)
HYPOVOLEMIC HYPONATREMIA

- Hypovolemic: total body sodium depletion (spot urine sodium usually 20-30 or less)
  - Diuretics
  - Malnutrition
  - Illness
  - Burns
  - Primary adrenal insufficiency (Addison’s, etc.)

TREATMENT: NSS; avoid too rapid correction [Central Pontine Myelinolysis (CPM), which is an osmotic demyelination]
EUVOLEMIC HYponatremia

If spot urine sodium >50, euvoolemia likely (as long as not on diuretics). NSS not likely to help in this case (they will just lose sodium in their kidneys).

- SIADH
- Secondary adrenal insufficiency
- Hypothyroidism (check free T4 and TSH as they might have pituitary disease)
HYPONATREMIA: SIADH

- SIADH
  - Inappropriate release of ADH (anti-diuretic hormone)
  - Defined in a euvolemic population only (these patients have water expansion, but not clinically)
- Note: peripheral edema does not always indicate hypervolemia (venous insufficiency)
- Note: if a mixed picture and after treatment of hypovolemia, SIADH might then be diagnosed
SIADH

- Defined only in a euvolemic population
- Hyponatremia
- Order simultaneous serum sodium, serum osmolality, spot urine sodium (lytes), and spot urine osmolality
- Urine osmolality greater than serum osmolality
- Spot urine sodium: 20 or higher
If on diuretics, sodium might be elevated if within 24 hours of using the diuretic.

Urine sodium is otherwise low in patients with CHF, cirrhosis, volume depletion.

Renal sodium wasting can be caused by Addison’s, PCKD, cisplatin and other drugs.
SIADH TREATMENT

- Fluid restriction (aim for restriction that is 500 cc less than the 24 hour urine output)
- NaCl tabs might be useful in preventing hypovolemia due to fluid restriction
- Stop SSRI if on one
- Consider Vaptan if failure to respond to fluid restriction (can correct start to correct sodium by 8 hours)
- Consider demeclocycline if failure to respond to fluid restriction
- Aggressiveness based on symptoms
- If mental status changes, seizures, cerebral edema, especially with sodium under 120 or so, etc.:
  - Hypertonic saline (3% saline)

- Note: NSS will usually cause worsening of hyponatremia in patients with SIADH
SIADH TREATMENT

- Correct sodium up to 8 meq/l per day for acute hyponatremia
- Do not restrict sodium intake unless indicated
- Check sodium every 2 hours if correcting it with hypertonic saline; check sodium every 2-8 hours if sodium under 120 especially if treating
- Assess patient’s thirst mechanism
- If no response to fluid restriction in 1-2 days if symptomatic (or a few days if asymptomatic: this requires some patience), re-evaluate volume status for hypovolemia. IF SIADH truly present, consider Vaptan or demeclocycline.
FLUID RESTRICTION FAILURE

- Mild fluid restriction might not work if Urine Osmolality > 500. Might need more aggressive restriction or meds
- Mild fluid restriction might not work if 24 hour urine output is <1500 cc/day
- Sum of urine sodium and potassium is greater than the serum sodium
- Serum sodium increases less than 2 mEq/L in 24 hours (might be ineffective or might need more fluid restriction)
CORRECTING HYponatREMIA

- NSS
- Hypertonic saline (3%)
- Fluid restriction
- Demeclocycline (causes a post-receptor defect in the collecting duct cell, thereby impairing the concentration process): not FDA approved for this use
- Furosemide (to excrete free water, usually given with NSS or 3% saline)
- Salt tablets
- Vaptans: aquaretic agents (AVP receptor antagonists): can start improving sodium level in 8 hours
- Rarely mineralocorticoids
- Treatment of underlying disease
VAPTANS

- In SIADH: could consider a Vaptan if need to correct sodium faster than a fluid restriction alone would in a patient who needs surgery/procedures soon; patients on TPN who are getting some volume overload due to TPN; therapeutic trial in patients with neurologic symptoms and it is unclear whether the symptoms are related to hyponatremia; inability to tolerate fluid restriction; sodium under 125
PSEUDOHYponatremia

- Related to elevated blood sugar. No treatment necessary.
A group of disorders in which aldosterone production is inappropriately high, relatively autonomous, and non-suppressible by sodium loading. This can cause cardiovascular damage, suppression of plasma renin, hypertension, sodium retention, and potassium excretion that might lead to hypokalemia.
PRIMARY ALDOSTERONISM (PA)

- Causes
  - Adrenal adenoma (benign more than malignant)
    - Adrenal hyperplasia (unilateral or b/l)
    - Rarely Glucocorticoid-remediable aldosteronism (GRA)
  - Idiopathic
PRIMARY ALDOSTERONISM (PA)

- Frequency
  - Probably over 10% of hypertensive patients
How frequent is hypokalemia in PA?
- 9-37% incidence; thus normokalemic hypertension constitutes the most common presentation of PA
- Half the patients with aldosterone producing adenoma (APA) and 17% of those with idiopathic hyperaldosteronism (IHA) had serum potassium <3.5. Thus, the presence of hypokalemia has a low sensitivity and specificity, and a low predictive value for the dx of PA
These patients have a higher cardiovascular morbidity and mortality than age- and sex-matched patients with essential hypertension and the same degree of BP elevation.
When to test for this:

- Patients with stage 2 hypertension (>160/100-109 BP)
- Drug resistant hypertension
- Hypertension and spontaneous or diuretic induced hypokalemia
- Hypertension and adrenal incidentaloma
- Hypertension and family history and a family history of early onset hypertension or CVA (before 40 years old)
- First degree hypertensive relatives of patients with PA (ARR testing)
PRIMARY ALDOSTERONISM (PA)

- Work-up
  - Plasma aldosterone-renin ratio (ARR)
    - Ideally done on certain medications that minimal affect the levels: verapamil, prazosin, doxazosin, terazosin, hydralazine.

  Take off spironolactone, amiloride, triamterene, epleronone, potassium wasting diuretics, licorice root products for at least 4 weeks before testing.
PRIMARY ALDOSTERONISM (PA)

Interpretation of ARR:
- not fully established but probably use ARR 20-40 or higher
CONFIRMATORY TESTS IF ARR IS POSITIVE:

- Oral sodium loading
- Saline infusion test
- Fludrocortisone suppression test
- Captopril challenge test
PRIMARY ALDOSTERONISM (PA)

Work-up (cont)

- CT scan once biochemically proven
- B/L adrenal venous sampling (AVS) to confirm unilateral versus bilateral disease
- Genetic testing for glucocorticoid-remediable aldosteronism (GRA) in patients onset of hypertension earlier than 20 years old and in those with PA and a family history of PA or of strokes under 40 years old.
TREATMENT of unilateral PA [adenoma (APA) or hyperplasia (UAH)]
- Laparoscopic adrenalectomy
- If unsuitable for surgery: medical treatment with a mineralocorticoid receptor antagonist (spironolactone as first line agent; eplerenone as alternative)
Treatment of bilateral adrenal disease
- Medical treatment with mineralocorticoid antagonist (spironolactone as first line agent; eplerenone as alternative)
PRIMARY ALDOSTERONISM (PA)

- GRA treatment
  - Lowest dose of glucocorticoid that can normalize BP and serum potassium (rather than mineralocorticoid antagonist treatment); generally a longer acting glucocorticoid such as dexamethasone or prednisone
HYPOKALEMIA

- Endocrine causes
  - Aldosterone excess (hypertensive patient)
  - Diuretics
HYPERKALEMIA CAUSES

- Hyporeninemic Hypoaldosteronism in diabetics (RTA 4): normotensive or hypertensive patient
- Cortisol deficiency (flulike sx’s, etc.: check ACTH stimulation test)
- Renal causes
- Potassium-sparing diuretics