Hyponatermia [Dr. Hussein's Seminar]

Tl;dr: nL electrolytes' values > Measured vs Calculated Serum osmolarity > Fluids > Hypo/hypernatremia > Closing questions

The principles:

1- Learning normal electrolytes' values is crucial to knowing what an isotonic IV fluid is.

- nL sodium levels: 140 mEq/L
- nL chloride levels: 105 mEq/L
- nL glucose leves: 100 mEq/L
- nL BUN: 15 mEq/L

2- Serum osmolarity:

- Calculated: 2Na + Glucose/20 + BUN/3
- Measured: Here we are measuring the total number of Osmoles in given serum. It normally should be equal to the calculated serum osmolarity with a **small osmolar gap of -14 to +10** of un-calculated osmoles.
  - Knowing there can be abnormal osmolar gap is crucial. Serum's osmolarity can be normal but the patient is facing hyponatermia namely because of excess other osmoles.
- Let us plug in the values of sodium, glucose and blood urea nitrogen to calculate normal serum osmolarity.
  - 140*2 + 100/20 + 15/3 = 280 + 5 + 5 = **290 mEq/L**

3- Fluids

- For **Hepatorenal syndrome** you use the [Fluid] ***IV albumin*** and this is, according to doctor, the only case in which you begin with colloids.

- The most common fluid used in clinical practice is: **Normal Saline**
  - *or* 0.9% NaCl. In any other case/question (step2/etc) other than hepatorenal syndrome, the 1# choice is nL saline.
  - Its osmolarity is the sum of its individual osmoles resulting in 308 a bit more than the serum osmolarity but we will assume normal saline is isotonic.
  - However you must be careful because administering more than 5L of normal saline would risk the patient having hyperchloraemic metabolic acidosis

- For surgery, they absolutely love Ringer's lactate. It is closer to serum's osmolarity constituents than normal saline.

- Bicarbonate solution which can be used in cases of acidosis like: NaHCO3 50 mmol/L -> 100 mEq/L (Na + HCO3 50 mEq/L each)

- D5W's (Dextrose 5% in water) <u>osmolarity is ignored and assumed to be zero</u> and when mixed with any other fluid, you take the other fluid's osmolarity as the total solution's osmolarity.
  - Ex: 75 mEq/L NaHCO3 + D5W = 150 mEq/L
  - D5W + 3 ampules of NaHCO3 = 300 mEq/L
  - D5W + [Any fluid *X*] = The osmolarity of Fluid *X*

Fluid composition	NS	LR	Plasmalyte
Na (mEq/L)	154	130	140
Cl (mEq/L)	154	109	98
K (mEq/L)	-	4	5
Ca (mEq/L)	-	2.7	-
Mg (mEq/L)	-	-	3
Buffer (mEq/L)	None	Lactate 28	Gluconate 23 Acetate 27
pH	5	6.5	7.4
SID	0	28	50
Price/L	$1.30	$1.66	$7.12

4- Hyponatermia

- *The bigger picture*:
  - 0. Patient came with symptoms of low sodium (N/V, headache, spasms etc)
  - A. Calculate **Serum osmolarity**
  - B. Compare the calculated to Measured serum osmolarity
  - C. Is it Iso-osmolar? Hyper-osmolar? Hypo-osmolar?
  - D. If Hypotonic, is it True hyponatermia or Pseudo hyponatermia?
  - E. If true then assess volume status.
  - F. If euvolemic then measure urine osmolarity and urine sodium concentration.

- Step 1; Serum osmolarity.
  - You don't start with volume. You need to have the calculated and measures serum osmolarity compared to ensure no osmolar gap.
  - 3 Possibilities:
    - Iso-osmolar
      - Keywords: DDx: **Multiple myeloma *or Severe Hyperlipidemia***
      - It is a pseudohyponatremia, a product of laboratory artefacts. The calculated osmoles will be elevated but measured will be normal. This is due to fats and proteins.

    - **Hyper-osmolar**
      - The measured is high.
      - *Here, other "stuff" accounts for osmotic activity other than sodium.*
      - *In principle, for every **100mg/dL** of glucose above 100 adjust by factor of 2.*
        - *Ex: Meaning if blood glucose is 300 and Sodium is 125 then (125+(2*2)) = 129 mEq/L.*
        - If the corrected sodium is within normal ranges this suggests hyponatermia is due to the elevated osmotic compound alone and if even after the correction still low suggests another additional cause.
      - ***Give differential diagnosis of possible osmotic-culprits:***
        - Hyperglycemia
          - Glucose increases the ECF compartment's osmolarity shifting the water from cells to ECF thus a <u>true</u> *dilutional hyponatermia.*
          - There is no osmolar gap because glucose is calculated.
        - Mannitol:
          - Key words: Neurosurgery. Anaesthesia.
          - Similar to glucose would increase the ECF osmolarity causing a shift of water and thus a dilutional hyponatermia but different to glucose, it is not calculated and thus would appear as <u>an osmolar gap</u>.
          - Example: Intracerebral haemorrhage patient on mannitol. Sodium is low ~128 mEq/L. Serum osmolarity is calculated to a 256 mOs/L. The measured osmolarity is 330 mOs/L.
          - Rx: **Supportive. Give normal saline.**
        - Glycine
          - Key words: Prostatic surgery. Transurethral

resection of the prostate.
        - Glycine and mannitol won't cause anion gap acidosis.
        - Rx: **Supportive. Give normal saline.**

- Hypo-osmolar
    - The measured and calculated is low.
    - Next step is assessment of volume status!
    - Hyper-volemic
        - Key words: Edema, JVP, etc.
        - Etiologies leading to generalised edema. (CHF, Cirrhosis/ Kidney Gn or End-stage CKD/ malabsorption hypoalbuminemia)
        - Cirrhosis and **Glomerulonephritis** can have a hypoalbuminemia [Hypo-osmolar] -> Thus, low intravascular volume. And the first compensatory mechanism of body is RAAS activation -> +ADH release -> Free water retention (Poor prognostic sign) -> Hyponatermia.
        - Rx: Diuretics.
    - Hypovolemic
        - Keywords: BP low, orthostatic pressure.
        - Rx: Give fluids IV.
    - Euvolemic
        - We are left with **RATS to rule out**. Rule out each disease one at a time.
        - **R**enal tubular acidosis (U/A), **A**ddison's disease(ACTH/ Cortisol), **T**hyroid disease(TSH) and **SIADH.**
        - You here think: *What would the kidney do with this water/sodium? If high water then it should dump it and dilute the urine and vice versa!*
        - Here you need to get **urine osmolarity and urine sodium.**
        - **SIADH** is a diagnosis of exclusion, you don't see *euvolemic hyponatermia and jump in; Oh SIADH!*
            - Keywords: Brain tumour, infarction, SSRIs, Stress (**Marathon, exercise**), Paraneoplastic (Lung cancer pulmonary etc)
            - DDx: DM/Central DI/Nephro DI/ Psychogenic polydipsia/ Beet potomania
- ***EMERGENCY*** Acute vs chronic; Acute hyponatermia is more dangerous in that it can cause acute hypo-osmolar state, water moves fro intravascular spaces to cells and eventually our most feared complication brain's herniation and thus…. **DEATH.**
    - If for instance it was a mannitol induced:

Closing questions:
1- 18 yo unconscious. Na: 124, Calculated Serum osmolarity 320 mOs/L, measures is 325 mOs/L. Determine the hyponatermia's type.
A. Serum osmolarity is high.
B. nL osmolar gap.
Thus, hyperosmolar hyponatermia. Order Blood sugars; 800 mg/dl. 124+(7*2) = 138 thus roughly nL corrected sodium levels correct for osmotic compound causing all of this.

2- 71yo s/p, TUPR, Na 128, serum osmolarity 265 and measured is 330 mOs/L. Determine the hyponatermia's type.
Hyperosmolar.
*Glycine

3- 71y anemia, back pain, Na 128, SO 292 mOs/L, measured 288 mos/L. Determine the etiology.
MM till proven otherwise.

3- 45y man taking SSRI, Na 126, SO 260 mOs/L, measured is 264 mOs/L. Next step?
Volume -> Euvolemic.
*You need to rule out
*Hypothyroidism
*Adrenal insufficiency
*ACTH/Adrenal cortisol
Next step? Urine osmolarity.
Urine Na 8 mEq/L
Urine osmolarity 50 mEq/L
*Doesn't make sense for even a SIADH, Na should be high where here it isn't.

Notice the increase in urine osmolarit is not that high, Water intoxication is likely.

4- 18yo mathon runner collapsed, Na 118.
*Emergency, acute hypo-osmolar state, you don't have time for further tests.
****Thus!** You manage with? 3% saline 100 ml over 10-15 minutes x3 times you save a life. You increased the tonicity to make water go back to the intravascular.

5- 60 yo, Na 128, SO = 262 mOs/L and equals the measured. Euvolemic.
Urine osmolarity = 400 mOs/L and Urine Na = 8 mEq/L
*This is not SIADH again because of low urina Na.
*Then, ***think simply**,* Notice the very large urine osmolarity. Pre-renal/ **Dehydration!**
*If Na was 48 for ex and after ruling out other ddxs then SIADH.