Hyponatremia

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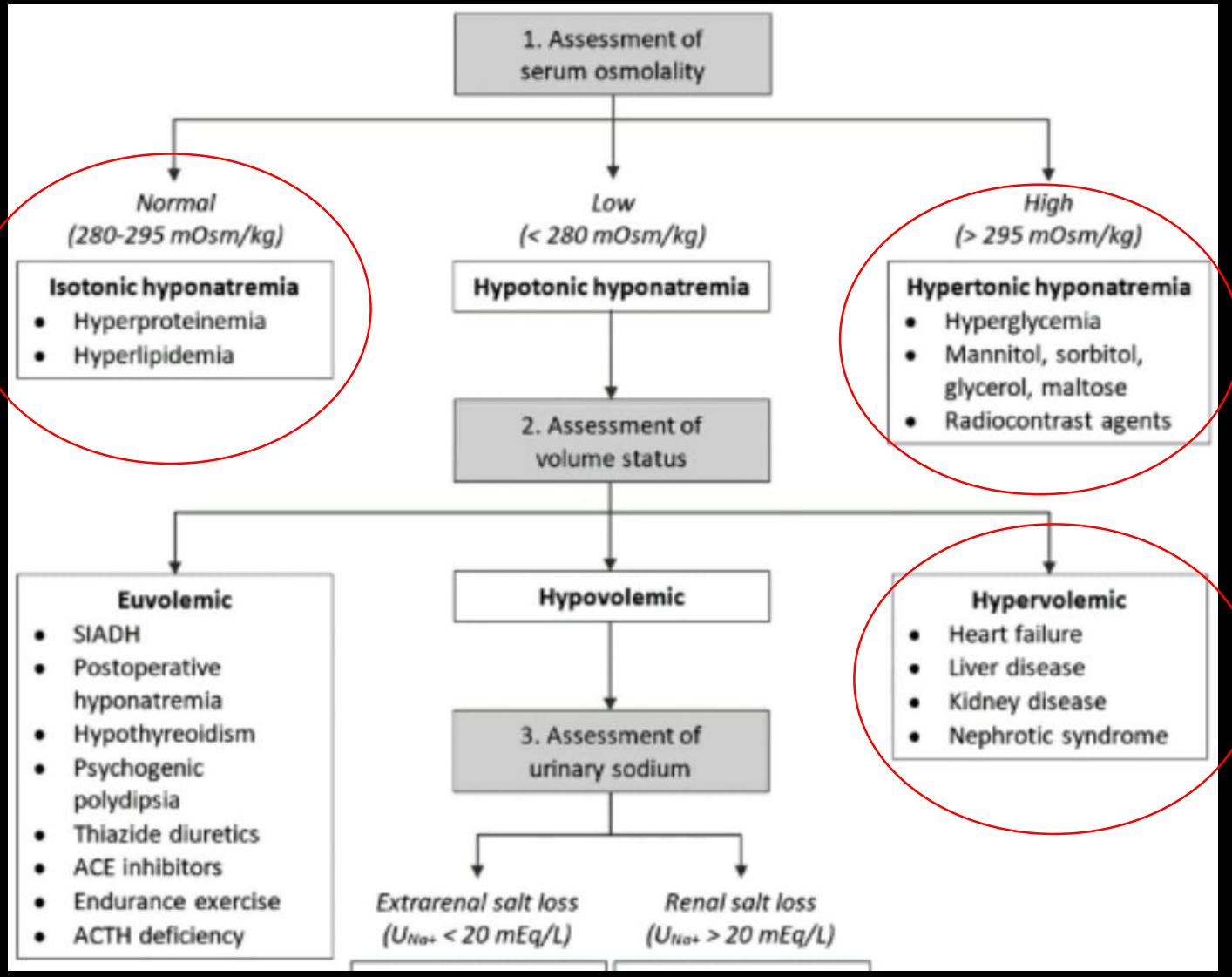
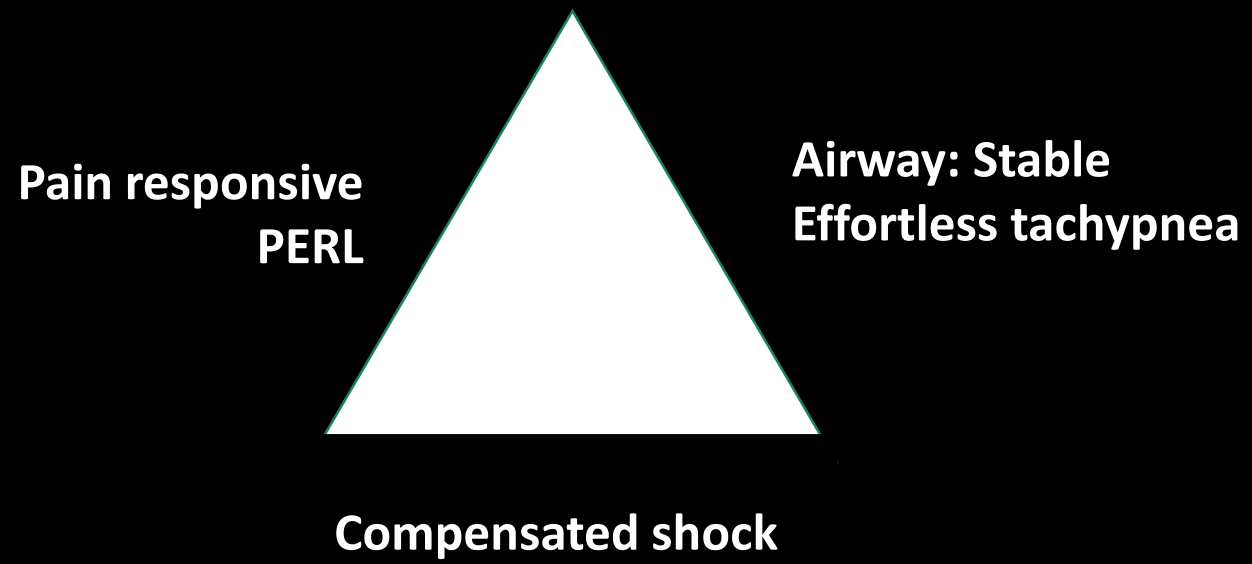


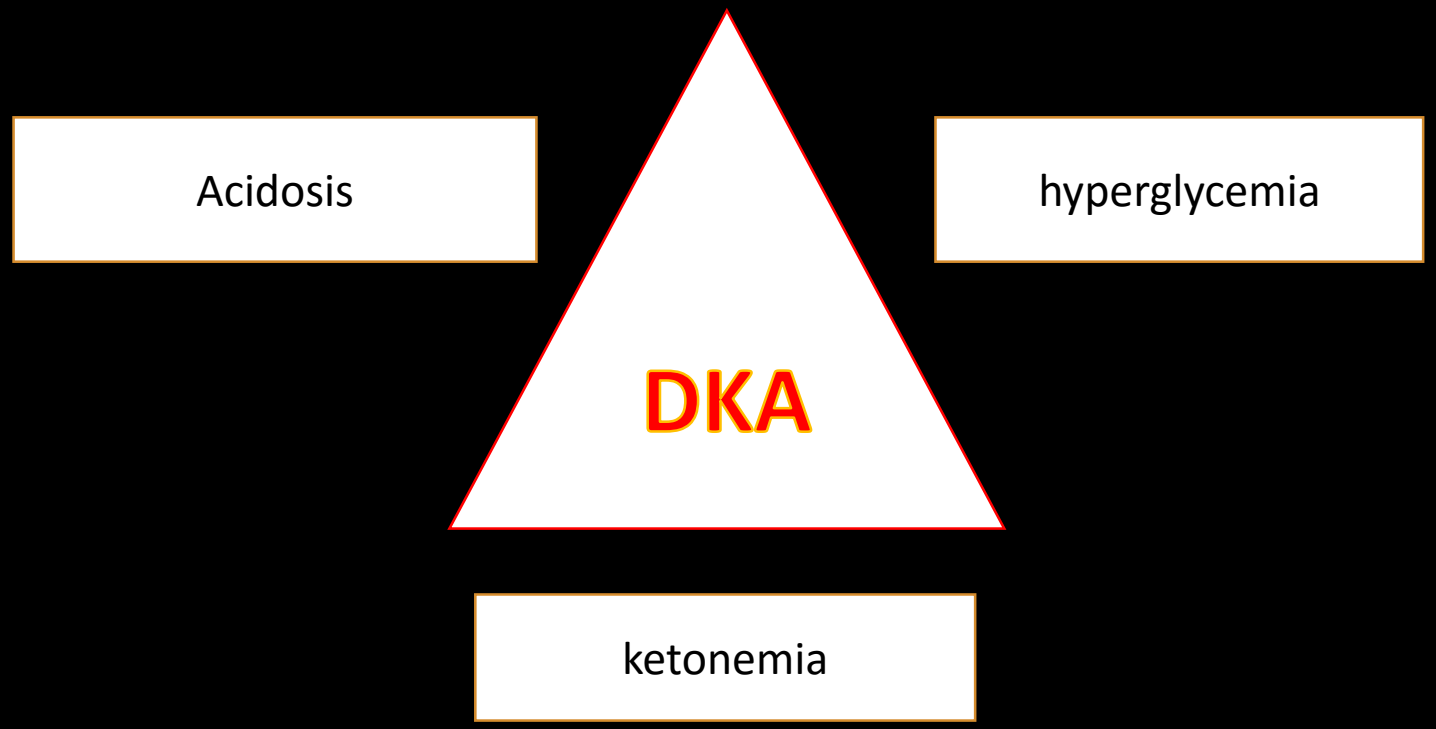
Case scenario 1

- 9 years old boy with H/o unresponsiveness since morning .
- Evaluated for UTI due to frequent micturition
- H/o polyphagia; child has lost 15% body weight.



POCT

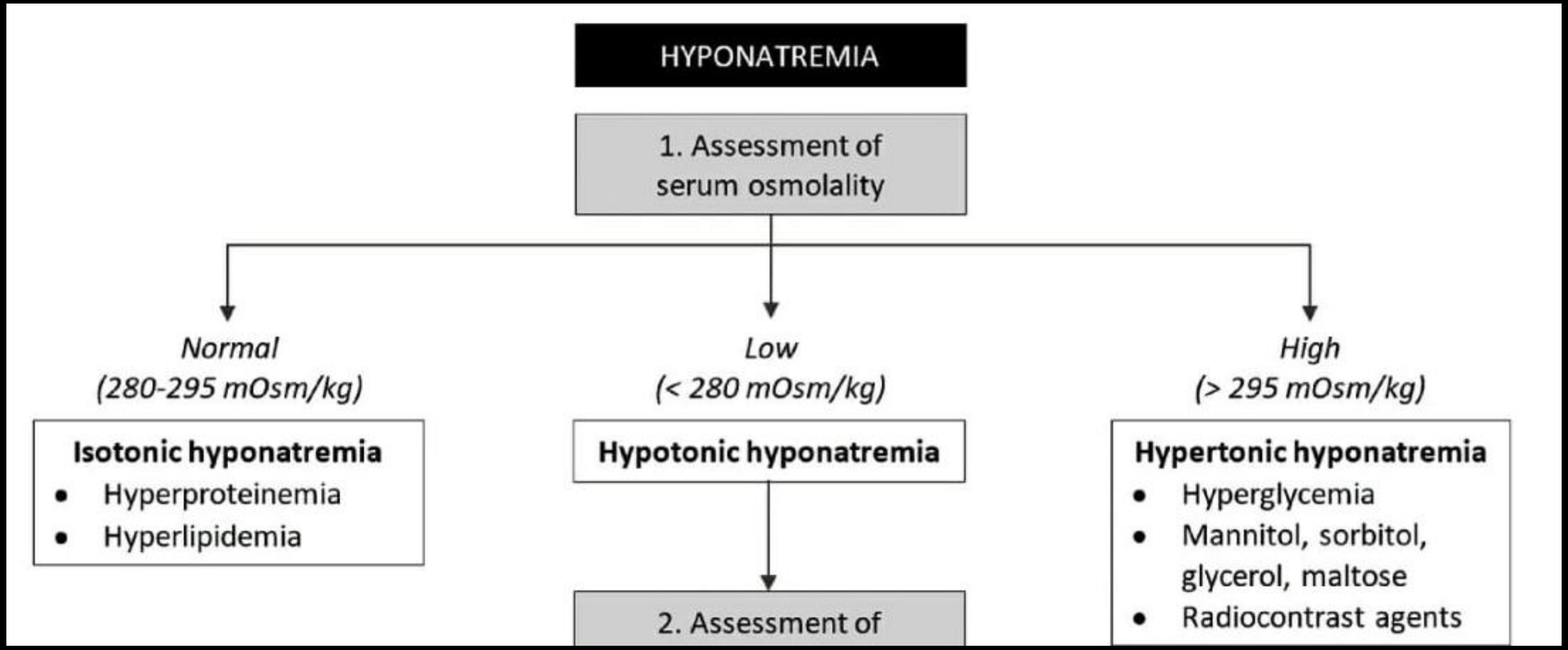
- CBG check showed **444mg/dl**
- VBG showed pH: **6.8**
  Hco3: **4**
  pCo2: **23**
  po2: **68**
- Blood ketones :**5.9**



Serum electrolytes

- S. Sodium: **129 mEq/dl**
- S. Potassium: 4.1mEq/dl
- S. Bicarbonate: 5mEq/dl
- S. Chloride: 98mEq/dl

Is the altered sensorium also due to hyponatremia? Do I need to correct it?



Serum osmolality: 303mOsm/L

Step 1

- Assessment of serum osmolarity

280-295	Isotonic/Iso-osmolar
<280	Hypotonic/Hypo osmolar
>295	Hypertonic/ Hyperosmolar

Step 1

- Assessment of serum osmolarity

280-295	Isotonic
<280	Hypotonic
>295	Hypertonic

- Factitious
- DKA
- Mannitol sorbitol, glycerol

Hypertonic hyponatremia

- High serum osmolarity drives water from intracellular to extracellular space
  - Dilutional hyponatremia.
  - Sodium is lost in the urine during the osmotic diuresis.

Correction factor

- For every 100 mg/dl more than 100 measured blood sugar add 1.6 to the measured serum sodium levels
- sugars more than 500mg/dl add 2.4 Meq/dl for every 100mg/dl more
- In this case, 444-100/100 times 1.6= 4.4*1.6=7.6
  129+7.6=136.6 mEq/dl
- Remember:
  - Total body sodium is normal
  - Hyponatremia even after correction is a risk factor for cerebral edema

Case scenario 2

- 2 years old child while being evaluated for fever and vomiting was found to have a serum sodium of 128mEq/dl. This was an incidental finding. Child was active on examination

- What would you like to ask the lab in this situation?
  - A. Is the value correct. Can you recheck it?
  - B. How does the sample look?
  - C. Which method of testing was used to measure serum sodium?

Step 1

- Assessment of serum osmolarity

280-295	Isotonic
• Pseudohyponatremia • Hyperproteinemia • Hyperlipidemia	
<280	Hypotonic
>295	Hypertonic

Isotonic hyponatremia

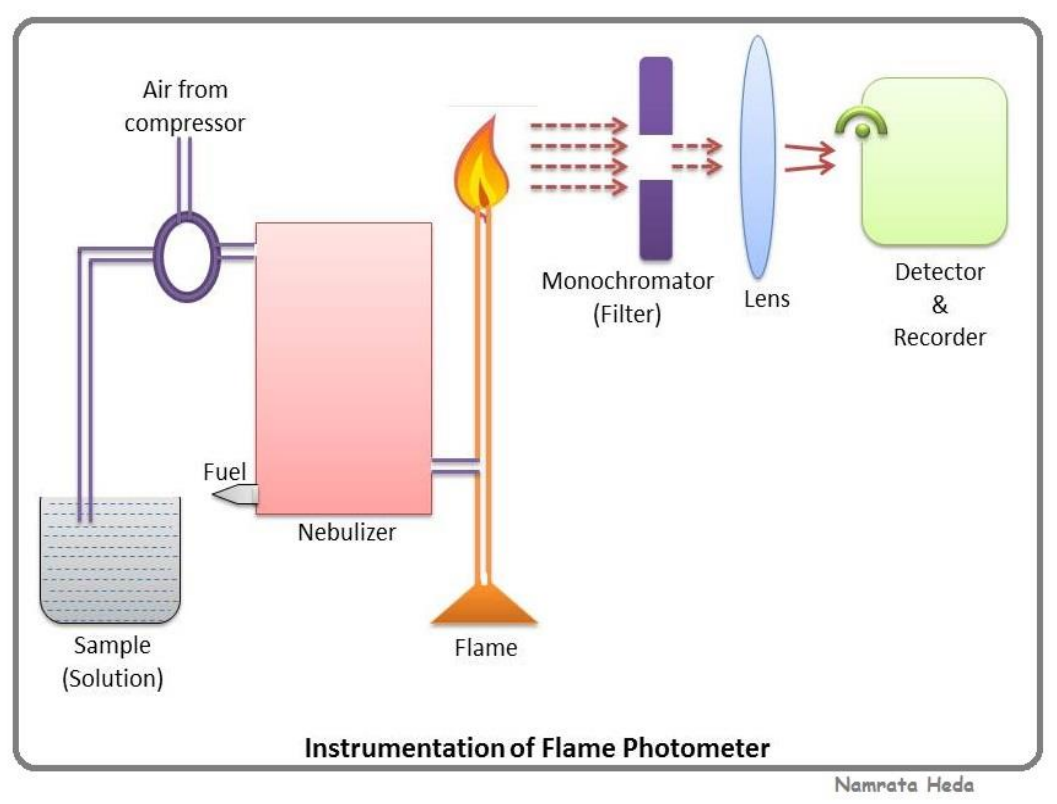
- Redistributive
- Dilution of ECFV due to lipids/proteins

Principle

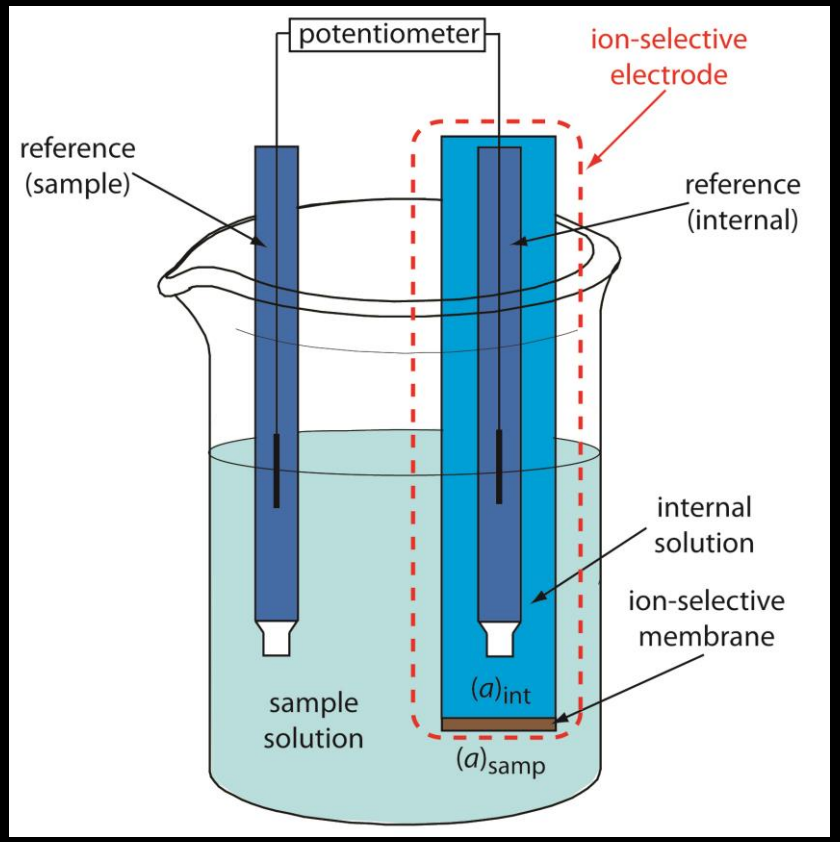
- 93% of plasma is water, and 7% composed of solutes
- To measure the serum sodium level
  - dilute the serum sample necessitating a correction factor of 0.93.
- Indirect methods : accurate and valid under standard physiologic conditions.
- presence of an abnormally excessive level of additional solute,
  - the ratio of solid to water in plasma is altered unpredictably leading to inaccurate reading when measured indirectly.

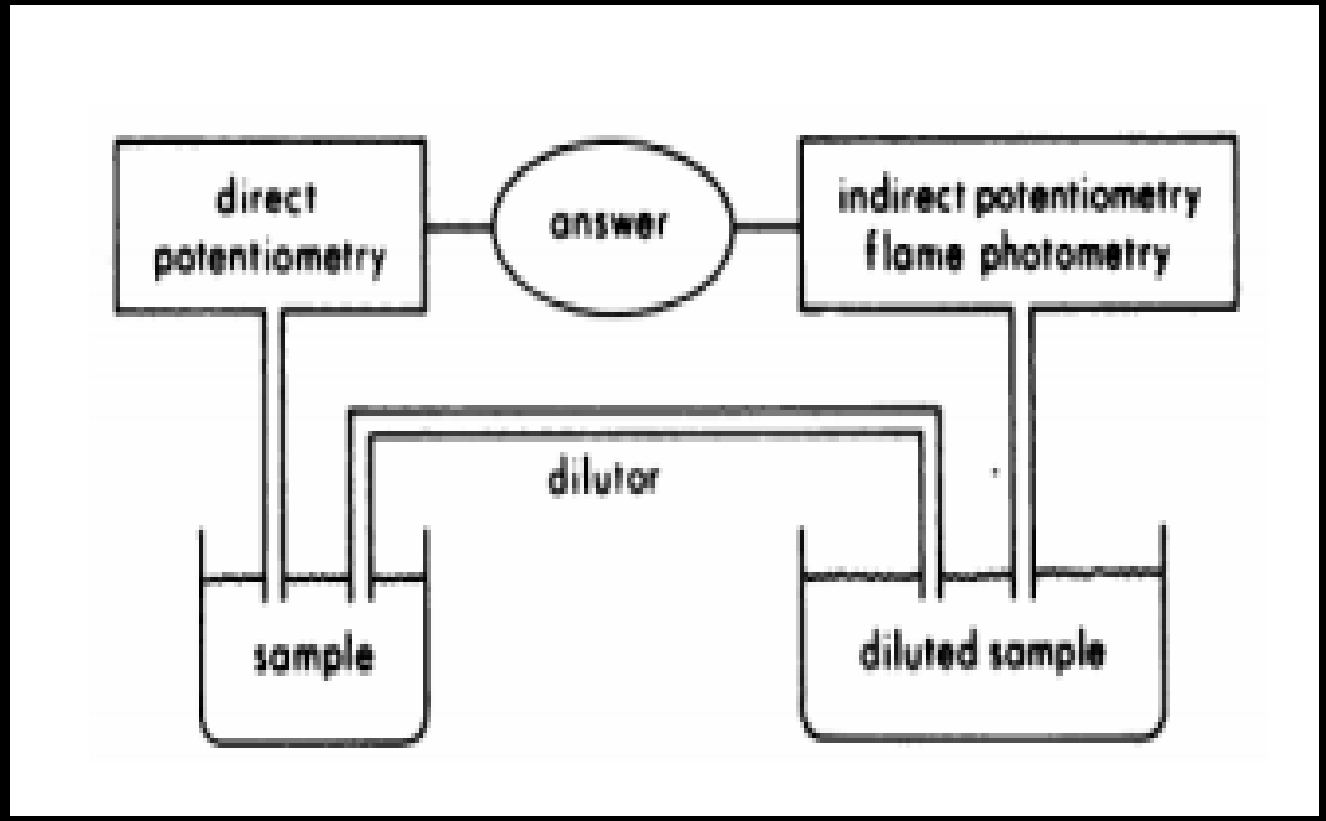
Methods of sodium estimation

Flame emission spectrophotometry



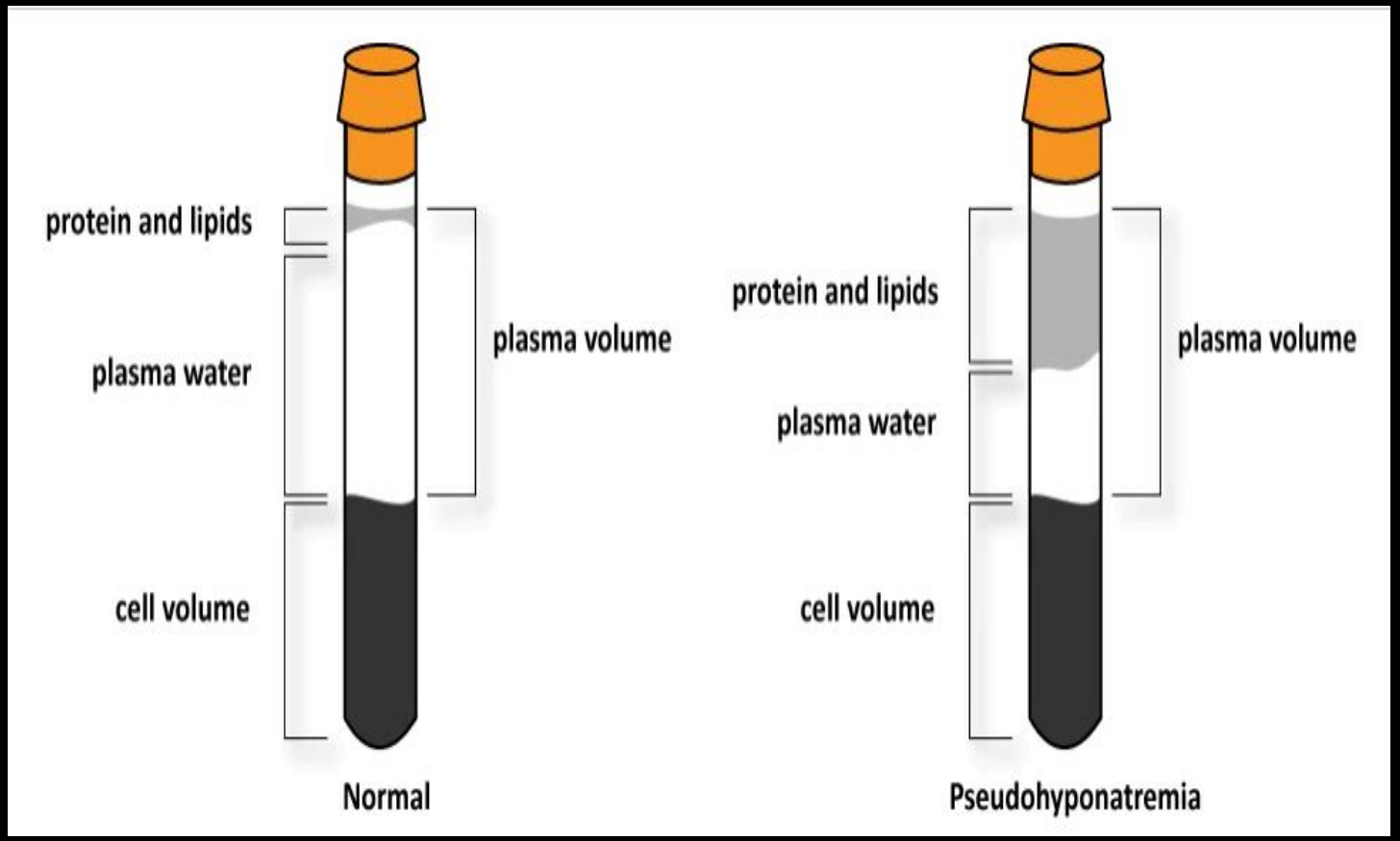
Indirect ion-selective electrode potentiometry





- Direct measures ion activity (moles ion/kg solvent)
- Indirect measures concentration (moles ion/L)

In pseudohyponatremia



The sample is lipemic

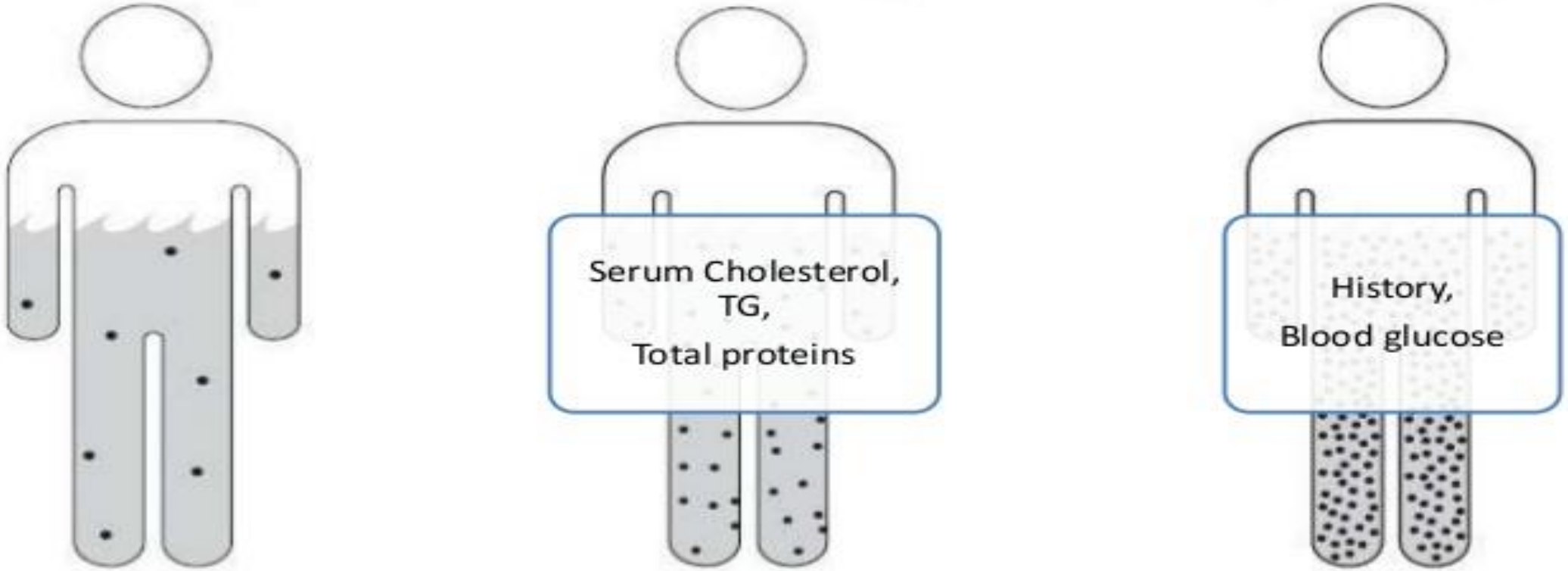
Work up showed that this child had hypertriglyceridemia

True vs Pseudo - Hyponatremia

True hyponatremia
low osmolality

Pseudohyponatremia
normal osmolality

Translocational
high osmolality

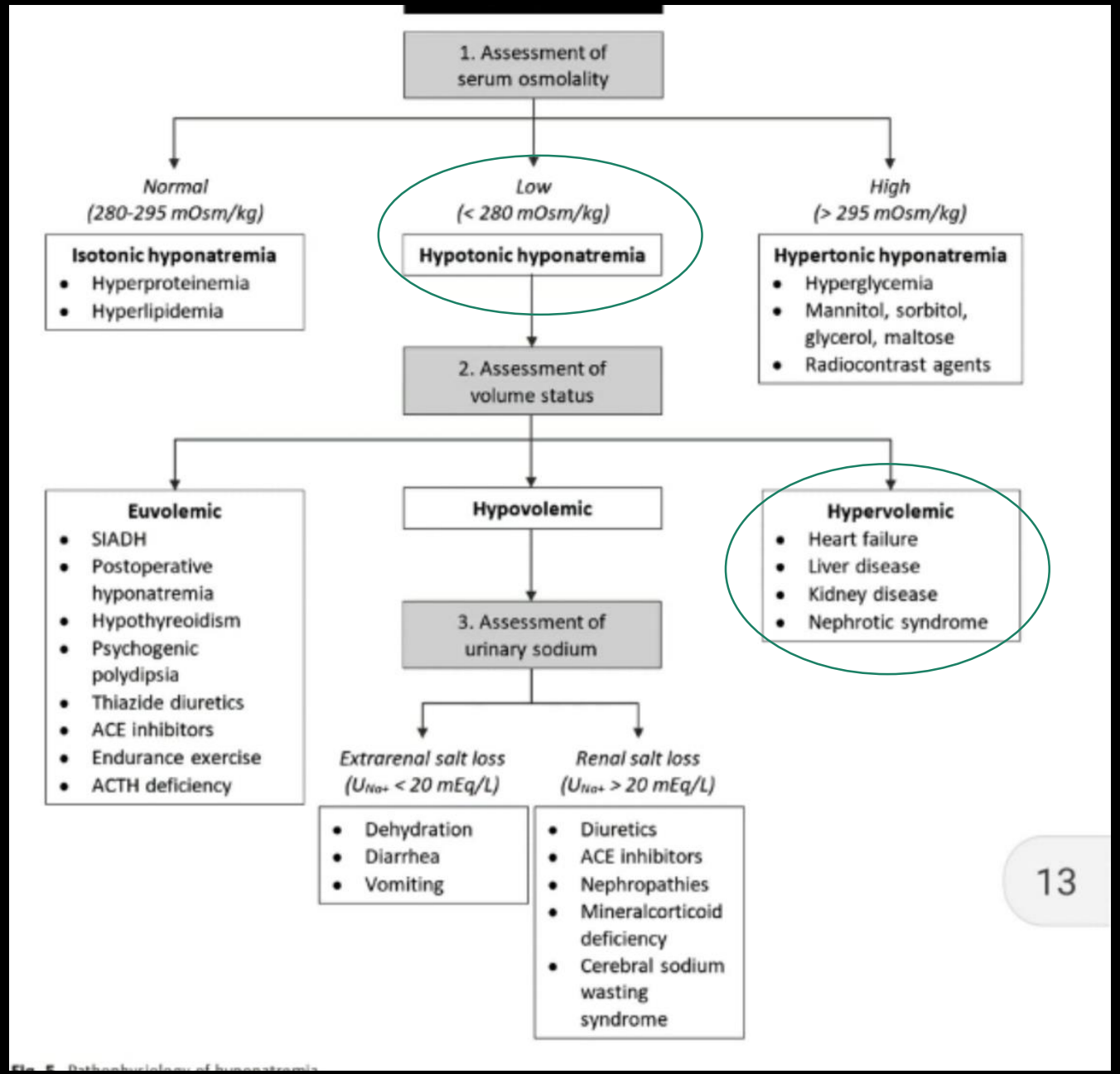


Goce Spasovski et al, Nephrol Dial Transplant (2014) 29 (Suppl. 2): ii1–ii39

Case scenario 3

- A 21-month-old boy was brought with Increasing breathing difficulty He was a known child with congenital heart disease in cardiac failure. He is on digoxin for the same. He has mild pedal edema; His weight increased before presentation, and his blood test results showed hyponatremia (116 mEq/L), low plasma osmolarity (241 mOsm/L), and high urine osmolarity (435 mOsm/L).

Serum osmolarity: 241



Pedal edema
Increase in weight

Hypervolemic hyponatremia

- Nephrotic syndrome- decreased plasma oncotic pressure
- Cirrhosis- systemic arterial vasodilatation and renal hypoperfusion
- Congestive heart failure- low cardiac output and reduced systemic blood pressure
- Third spacing due to dengue- capillary leak into pleural, peritoneal spaces
-
- Renal failure- inability to excrete free water load

Pathophysiology

Increased total body water+ decreased effective circulatory volume

Increased ADH

Increased RAA axis

Fluid retention

Increased sodium reabsorption
Increased urinary potassium loss

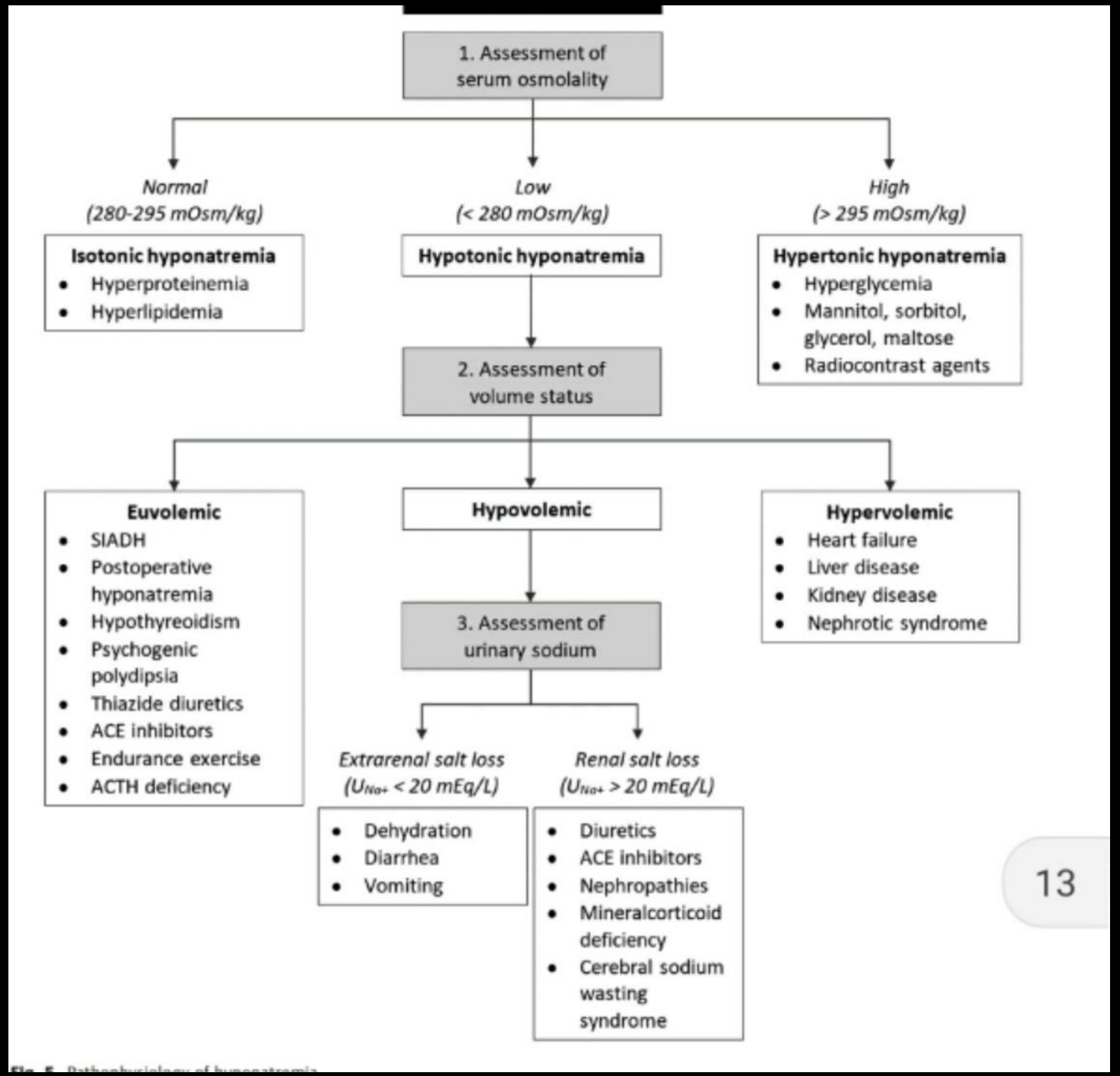
- Measure urine sodium levels
- Urine sodium <20:
- Urine sodium>20: renal failure

Management

- Fluid restriction: less than 24hours u.o and insensible losses
- ± frusemide: hypotonic urine.
  - Remember serum potassium .
  - Loop diuretics only after correction of ECV
- Sodium administration depending on acuity and symptoms of hyponatremia
- Goal is to increase serum sodium by 4-6mEq/day
  - Avoid osmotic demyelination syndrome
- Serum albumin must be measured and corrected

Management contd.

- Vaptans: vasopressin receptor antagonists
  - Cause aquaresis resulting in correction of osmolality and serum sodium levels
  - Without activation of RAAS
  - Only in resistant hyponatremia to isotonic /hypertonic fluids
  - Evidence is limited in children
  - Tolvaptan and conivaptan is used in children
  - Needs close monitoring


1. Assessment of serum osmolality
Normal (280-295 mOsm/kg)
Low (< 280 mOsm/kg)
High (> 295 mOsm/kg)
Isotonic hyponatremia
Hyperproteinemia
Hyperlipidemia
Hypotonic hyponatremia
Hypertonic hyponatremia
Hyperglycemia
Mannitol, sorbitol, glycerol, maltose
Radiocontrast agents
2. Assessment of volume status
Euvolemic
SIADH
Postoperative hyponatremia
Hypothyreoidism
Psychogenic polydipsia
Thiazide diuretics
ACE inhibitors
Endurance exercise
ACTH deficiency
Hypovolemic
Hypervolemic
Heart failure
Liver disease
Kidney disease
Nephrotic syndrome
3. Assessment of urinary sodium
Extrarenal salt loss (U_{Na+} < 20 mEq/L)
Renal salt loss (U_{Na+} > 20 mEq/L)
Dehydration
Diarrhea
Vomiting
Diuretics
ACE inhibitors
Nephropathies
Mineralcorticoid deficiency
Cerebral sodium wasting syndrome

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- **Thank you**