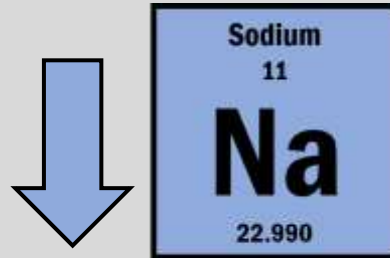


# Hyponatremia

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Serum  $\text{Na}^+$  < 135 mmol/L



# Pathophysiology & Causes

# Hyponatremia - $[\text{Na}^+] < 135 \text{ mmol/L}$

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- $\text{Na}^+$  - Major *extracellular* cation  
Change in  $[\text{Na}^+]$  = Change in water = Change in ECF volume
- Hyponatremia  $\text{H}_2\text{O} > \text{Na}^+$  → Low Serum Osmolality

# Causes - According to ECF volume status

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Hypovolemia

Hypervolemia

Euvolemia

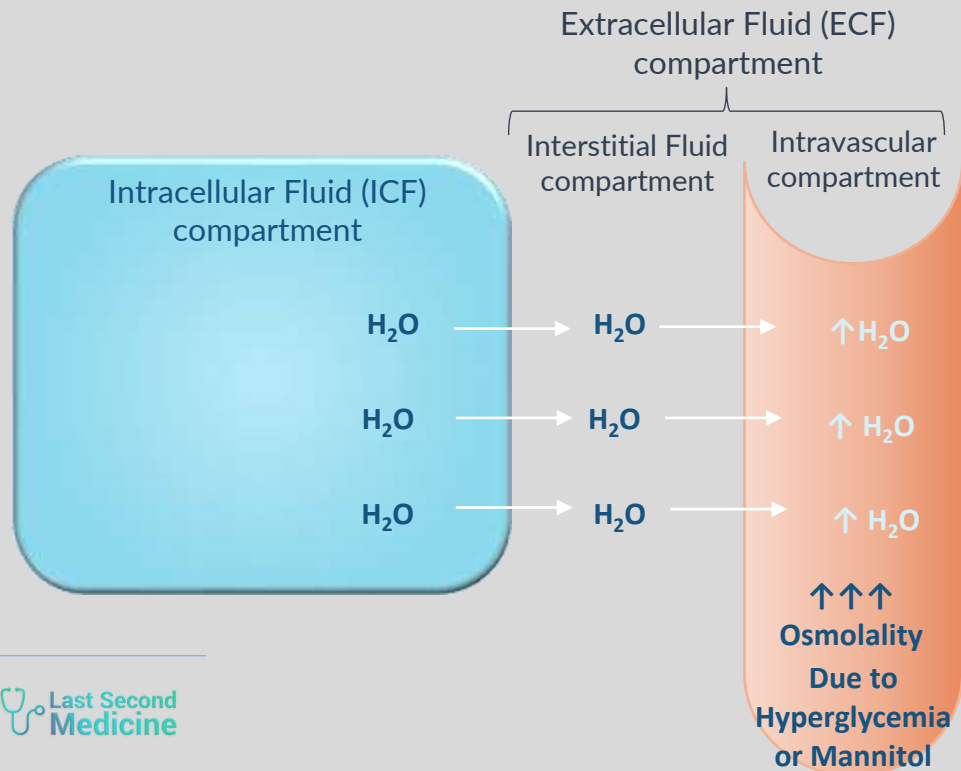
Hyponatremia =  $\text{H}_2\text{O} > \text{Na}^+$  → Low Serum Osmolality

Low  $\text{Na}^+$  in lab result does not always mean patient has Hyponatremia!

## ↑ Serum Osmolality

### Hypertonia

- Leads to osmotic shift of water from ICF to ECF
- Causes – Hyperglycemia *or* IV osmolytes like Mannitol



HOW



## Laboratory Artefacts

### Isotonia

- Due to Hyperlipidemia or Hyperproteinemia
- Aqueous fraction of the serum sample is reduced due to volume occupied by the macromolecules
- Seen only with certain lab assays
- No actual change in water or sodium status -

### Pseudohyponatremia

**Serum osmolality** =  $2 [\text{Na}^+] + \text{Glucose (mmol/L)} + \text{Urea (mmol/L)}$

- Conversion mg/dl to mmol/L → glucose/18 & Urea/2.8

**Normal range** – 275 – 295 mOsm/kg

**< 275 mOsm/kg = Hypotonia**

# Causes - According to ECF volume status

True Hyponatremia

$[\text{Na}^+] < 135 \text{ mmol/L}$

Serum osmolality  $< 275 \text{ mOsm/kg}$

Hypovolemia

Hypervolemia

Euvolemia

Hyponatremia =  $\text{H}_2\text{O} > \text{Na}^+$  → Low Serum Osmolality

# Causes - According to ECF volume status

## Hypovolemia

$\text{Na}^+ \downarrow\downarrow, \text{H}_2\text{O} \downarrow$

- GI losses
  - Vomiting
  - Diarrhea
  - Third spacing of fluids
- Diuretics – Thiazides
- Burns
- Cerebral salt wasting
- Sodium losing nephropathy
- Adrenocortical insufficiency

## Hypervolemia

$\text{Na}^+ \uparrow, \text{H}_2\text{O} \uparrow\uparrow$

## Euvolemia

$\text{Na}^+ \leftrightarrow, \text{H}_2\text{O} \uparrow$

# Causes - According to ECF volume status

## Hypovolemia

$\text{Na}^+ \downarrow\downarrow$  ,  $\text{H}_2\text{O} \downarrow$

### Symptoms

Thirst, Dizziness on standing &  
Weakness

### Signs

Tachycardia, Postural  
hypotension, Prolonged capillary  
refill time, Dry mouth, Reduced  
skin turgor, Reduced urine  
output, Weight loss, Delirium &  
stupor



# Causes - According to ECF volume status

## True Hyponatremia

$[\text{Na}^+] < 135 \text{ mmol/L}$

Serum osmolality  $< 275 \text{ mOsm/kg}$

### Hypovolemia

$\text{Na}^+ \downarrow\downarrow, \text{H}_2\text{O} \downarrow$

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### Hypervolemia

$\text{Na}^+ \uparrow, \text{H}_2\text{O} \uparrow\uparrow$

- Congestive Heart Failure
- Liver cirrhosis
- Nephrotic syndrome
- Chronic kidney disease or Acute Kidney Injury

### Euvolemia

$\text{Na}^+ \leftrightarrow, \text{H}_2\text{O} \uparrow$

- Abnormally high water intake
  - Oral
    - Primary polydipsia
  - Infusion
    - Excessive IV dextrose
    - Post-prostatectomy bladder irrigation with sodium-free fluid
- Syndrome of inappropriate secretion of Antidiuretic hormone (SIADH)
- Hypothyroidism
- Glucocorticoid deficiency
- Tea and toast diet
- Beer potomania

# Clinical Features

# Clinical Features

## True Hyponatremia

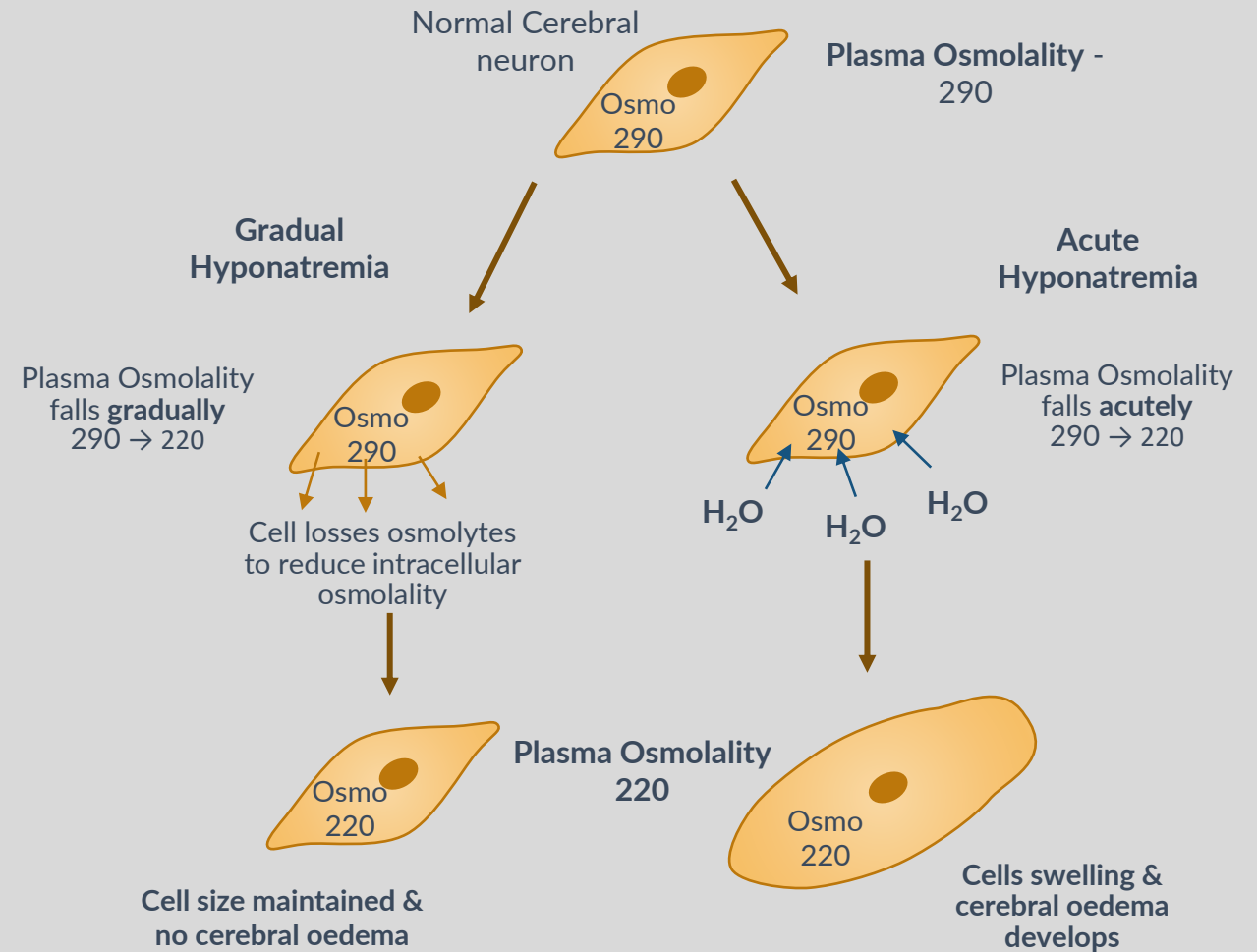
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Serum osmolality  $< 275 \text{ mOsm/kg}$

- Asymptomatic – when mild
- Profound disturbances of cerebral function
- Symptoms depend on the **speed** at which it develops & its **severity**

### 1. Speed of development of Hyponatremia

- **Acute**  $< 48$  hours
- **Chronic**  $> 48$  hours



Chronic Hyponatremia  $> 48\text{h}$

Acute Hyponatremia  $< 48\text{h}$

# Clinical Features

- Asymptomatic – when mild
- Profound disturbances of cerebral function
- Symptoms depend on the **speed** at which it develops & its **severity**

## 1. Speed of development of Hyponatremia

- **Acute**  $< 48$  hours
- **Chronic**  $> 48$  hours

## 2. Level of hyponatremia & Severity of symptoms

	<u>Serum <math>[\text{Na}^+]</math></u>	<u>Symptoms</u>
- <b>Mild</b>	- 130 – 135 mmol/l	Asymptomatic
- <b>Moderate</b>	- 125 – 129 mmol/l	Nausea, Delirium, Headache
- <b>Severe</b>	- $< 125$ mmol/l	Vomiting, Somnolence, Seizures, Coma, Cardiac arrest

# Diagnostic Approach

# Diagnostic Approach

## True Hyponatremia

$[\text{Na}^+] < 135 \text{ mmol/L}$

Serum osmolality  $< 275 \text{ mOsm/kg}$

Hyponatremia

Calculate Osmolality

$< 275 \text{ mOsm/kg}$

No

Consider causes of Hypertonic & Isotonic hyponatremia

Yes

Check Volume Status

Hypovolemia

Hypervolemia

Euvolemia

Urinary  
 $\text{Na}^+$

$> 30 \text{ mmol/L}$

$< 30 \text{ mmol/L}$

$> 30 \text{ mmol/L}$

$< 30 \text{ mmol/L}$

Urine  
osmolality

$< 100 \text{ mOsm/kg}$

$> 100 \text{ mOsm/kg}$

Renal causes

- Diuretics
- Cerebral salt wasting
- Sodium losing nephropathy
- Adrenocortical insufficiency

Extra-Renal  
causes

- Vomiting
- Diarrhea
- 3<sup>rd</sup> spacing
- Burns
- Pancreatitis

Renal causes

- Acute or Chronic Renal Failure

Extra-Renal  
causes

- CHF
- Liver cirrhosis
- Nephrotic Syndrome

- Primary polydipsia
- Reset Osmostat

- SIADH
- Tea & Toast diet
- Beer potomania
- Hypothyroidism

# Management

# Management

True Hyponatremia

$[\text{Na}^+] < 135 \text{ mmol/L}$

Serum osmolality  $< 275 \text{ mOsm/kg}$

## Na<sup>+</sup> Correction

### Acute

$< 48 \text{ h}$  & signs of cerebral oedema

Rapid correction with 3% Saline

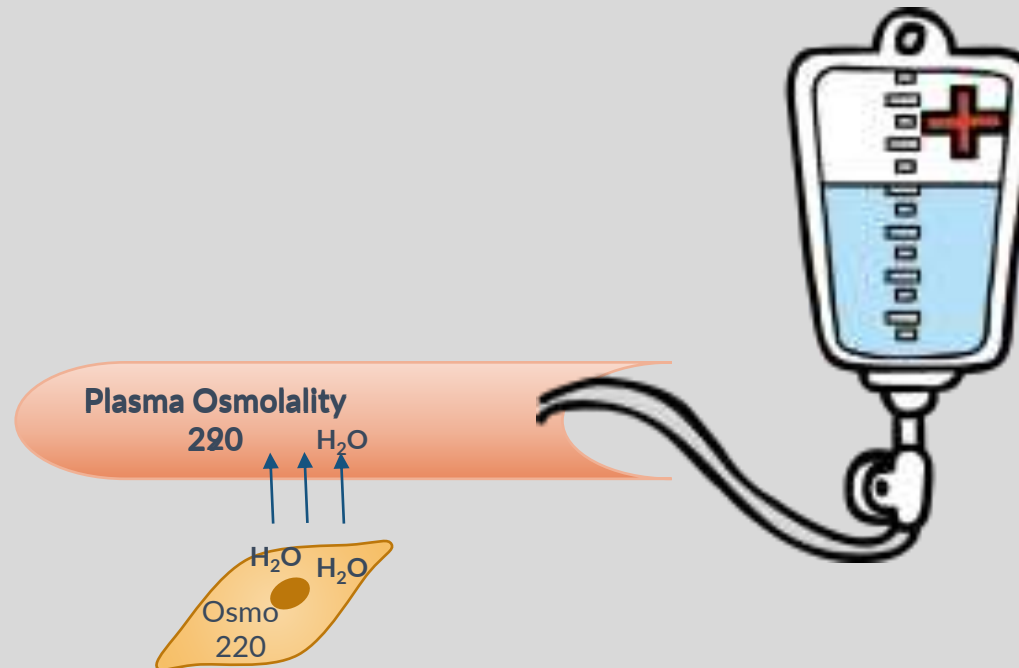
150 mL over 20 minutes, which may be repeated once or twice over the initial hours of observation, depending on the neurological response and rise in plasma sodium

### Chronic

Rapid correction is hazardous

## Treatment of underlying cause

Hypertonic saline





# Management

True Hyponatremia

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## Na<sup>+</sup> Correction

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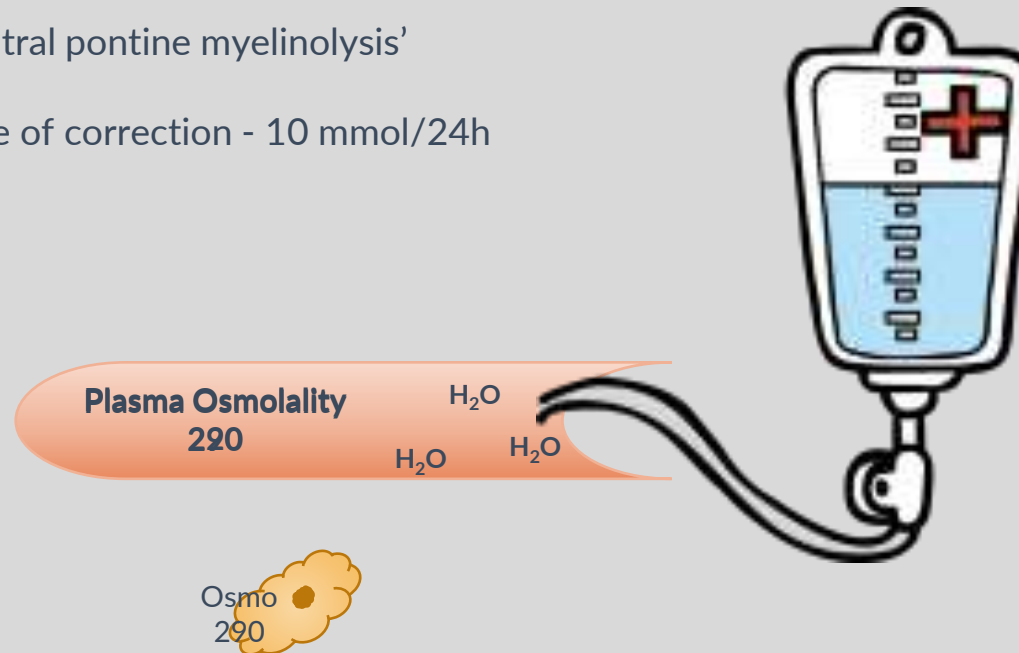
Rapid correction is hazardous

'Central pontine myelinolysis'

Rate of correction -  $10 \text{ mmol/24h}$

## Treatment of underlying cause

Hypertonic saline



# Management

## True Hyponatremia

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### Na<sup>+</sup> Correction

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Rapid correction is hazardous

'Central pontine myelinolysis'

Rate of correction -  $10 \text{ mmol/24h}$

### Treatment of underlying cause

#### Hypovolemia

- Controlling source of  $\text{Na}^+$  loss
- IV saline, if clinically indicated

#### Euvoemia

- Fluid restriction -  $600\text{--}1000 \text{ mL/24 hours}$
- SIADH
  - Withdrawal of precipitating stimulus
  - Oral urea therapy
  - Oral vasopressin receptor antagonists - Tolvaptan

#### Hypervolemia

- Treatment of underlying cause
- Diuretics
- Fluid restriction
- Potassium sparing diuretics

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