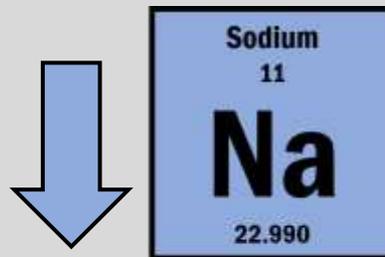


Hyponatremia

Serum Na⁺ < 135 mmol/L



Pathophysiology & Causes

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

- 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

Hypovolemia

Hypervolemia

Euvolemia

Hyponatremia = $H_2O > Na^+$ → Low Serum Osmolality

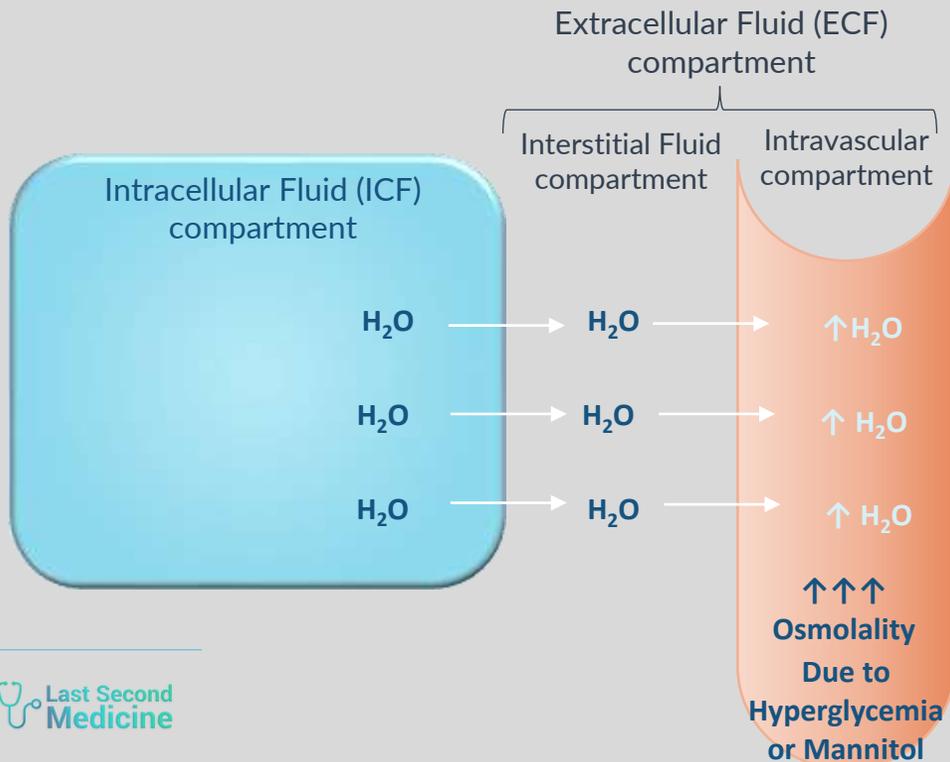
Low Na⁺ in lab result does not always mean patient has Hyponatremia!



↑ Serum Osmolality

Hypertonia

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



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 [Na⁺] + Glucose (mmol/L) + 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

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

- GI losses
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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

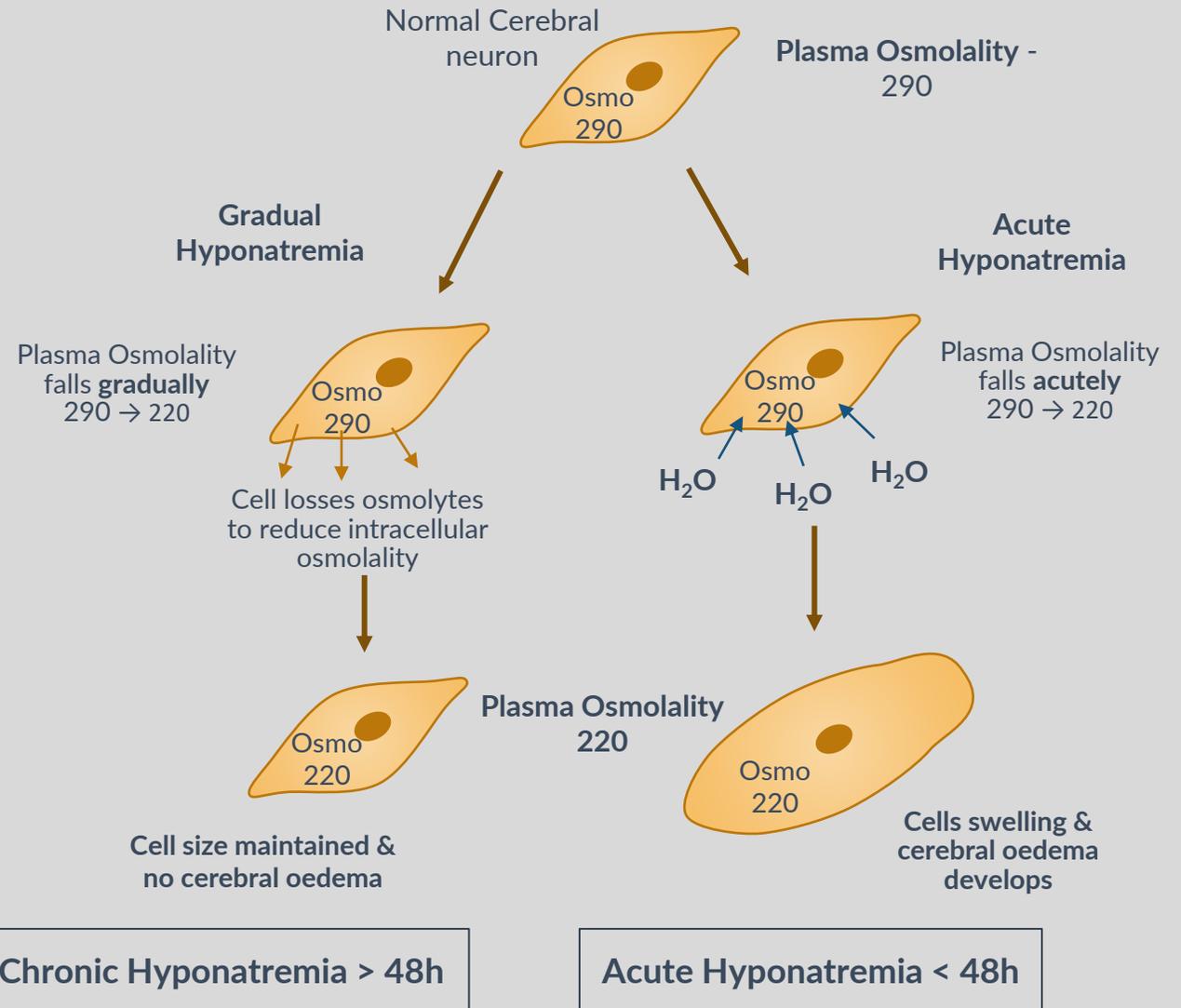
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Serum osmolality $< 275 \text{ mOsm/kg}$

- 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



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 [Na⁺]</u>	<u>Symptoms</u>
- Mild	- 130 – 135 mmol/l	Asymptomatic
- Moderate	- 125 – 129 mmol/l	Nausea, Delirium, Headache
- Severe	- <125 mmol/l	Vomiting, Somnolence, Seizures, Coma, Cardiac arrest

Diagnostic Approach

Diagnostic Approach

True Hyponatremia

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

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 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
- 3rd 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⁺ Correction

Acute

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

Rapid correction with 3% Saline

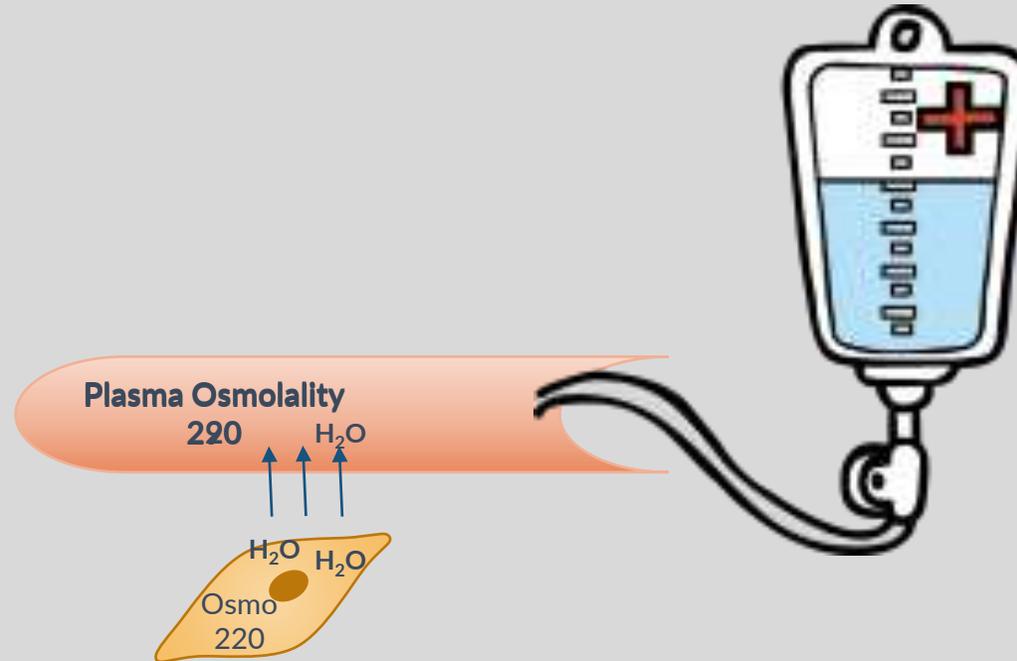
150 mL over 20 minutes, which may be repeated once or twice over the initial hours of observation, depending on the neurological response and rise in plasma sodium

Chronic

Rapid correction is hazardous

Treatment of underlying cause

Hypertonic saline



Management

True Hyponatremia

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Na⁺ Correction

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Chronic

Rapid correction is hazardous

'Central pontine myelinolysis'

Rate of correction - 10 mmol/24h

Treatment of underlying cause

Hypertonic saline



Plasma Osmolality
220

H₂O
H₂O H₂O

Osmo
290

Management

True Hyponatremia

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Na⁺ Correction

Acute

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Chronic

Rapid correction is hazardous

'Central pontine myelinolysis'

Rate of correction - 10 mmol/24h

Treatment of underlying cause

Hypovolemia

- Controlling source of Na⁺ loss
- IV saline, if clinically indicated

Euvolemia

- Fluid restriction - 600–1000 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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