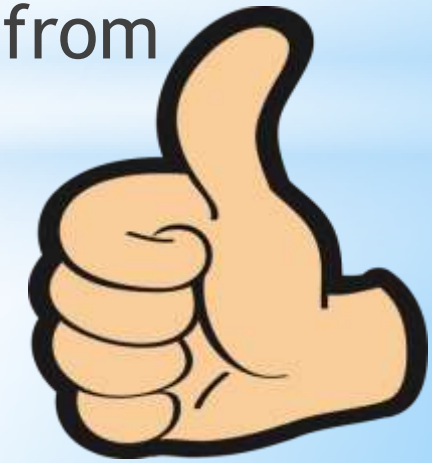
*Hyponatremia

Dr R V Dhakshayani
Associate Professor of Pediatrics
Govt. Chengalpattu Medical College

*Essential facts

- ✓ Hyponatremia develops either by gain of free water or loss of sodium
- ✓ Hyponatremia = low serum osmolarity
- ✓ Underlying cause is USUALLY evident from the clinical setting



Case scenario

- 2 years old male child, weighing 10 kgs.
- Fever, vomiting & loose stools - 2 days
- Vomiting 5-6 episodes, loose stools 8-10 episodes
- Managed as outpatient with ORS; child had not consumed ORS as advised, had been taking mineral water, milk and fruit juices.
- Brought to Emergency Department with lethargy, refusal of feeds and poor oral intake.

Case scenario

- On examination, child is listless, irritable, temperature- 102deg F, skin turgor is reduced
- Child's HR-160/min, RR- 46/min, liver span-N, peripheral pulses -feeble +++/+, cool below ankles, CRT>3sec, BP- 70/40mmHg.

Case scenario

Questions:

1. What is the physiological status of this child?
2. What is the immediate management in the present status?

Primary assessment

- Airway - Stable
- Breathing- RR 46/min; no retractions; lungs – no creps; SpO2 94%
- Circulation- HR 160/min; cool below ankles; pulses +++/+ ; CRT > 3 sec; Liver span 7 cm; BP 70/40 mmHg
- Disability -Verbal responsive; Eyes – MP; EOM – Normal

Effortless tachypnoea/ Hypovolemic shock/ ALOC

Immediate management

* Oxygen through NRM @8L/min
* Secure IV line
* NS – 20ml/kg over 20 minutes - Reassess

Case scenario...contd.

- After the first bolus, his vitals were
- HR-140/min, RR-40/min, +++/++, cool below ankles, CRT<3 sec
- Child continued to have loose stools, skin turgor is reduced & eyes are sunken.

Case scenario

- How will you categorise dehydration based on severity?

Table 75.1 Clinical Evaluation of Dehydration

Mild dehydration (<5% in an infant; <3% in an older child or adult): Normal or increased pulse; decreased urine output; thirsty; normal physical findings

Moderate dehydration (5–10% in an infant; 3–6% in an older child or adult): Tachycardia; little or no urine output; irritable/lethargic; sunken eyes and fontanel; decreased tears; dry mucous membranes; mild delay in elasticity (skin turgor); delayed capillary refill (>1.5 sec); cool and pale

Severe dehydration (>10% in an infant; >6% in an older child or adult): Peripheral pulses either rapid and weak or absent; decreased blood pressure; no urine output; very sunken eyes and fontanel; no tears; parched mucous membranes; delayed elasticity (poor skin turgor); very delayed capillary refill (>3 sec); cold and mottled; limp, depressed consciousness

* Assessment of degree of dehydration

* Pre illness weight-10
* Present weight-9.4
* 600 gm lost after the diarrhoeal episode- 6% dehydration.

Case scenario...Contd.

- CBC–neutrophilic leucocytosis
- Blood glucose – 90mg/dL
- Urea -28mg/dL
- Creatinine- 0.8mg/dL
- Serum electrolytes – Na- 128mEq/L
    - K- 3.5mEq/L
    - HCO3- 18mEq/L

AWD / moderate dehydration/ Hypovolemic hyponatremia

Volume depletion stimulates synthesis of ADH - reduced renal water excretion

Body's mechanism for preventing hyponatremia, renal water excretion, is blocked

Water retention > Na loss = hyponatremia

(diarrhoeal setting)

Case scenario

* What are the sequential steps in the assessment and management of this child?

Neurological symptoms – Yes/No?

*Steps in Assessment

Step 1 – Identify true hyponatremia

Confirm hyponatremia (rule out a lab error if the clinical setting is unlikely) - measure serum osmolarity if available.

Normal or high serum osmolality suggest pseudohyponatremia

*Steps in Assessment

Step 2 – Identify possible mechanism

Determine the volume status of the patient (clinical signs, serial weights if available).	Determine water gain or sodium loss as the predominant mechanism by clinical setting.

Steps in Assessment

- **Step 3- Identify possible etiology**
- If clinical evidence of fluid overload (edema), identify the reason (renal / cardiac / hepatic)
- Evaluation - History / examination/Relevant lab tests to confirm
- If euvolemic, think of SIADH/polydipsia/ endocrine causes
- If hypovolemic, think of fluid loss (GI/renal/third space), diuretics/cerebral salt wasting in appropriate settings

Steps in Assessment

- **Step 4- Trial of treatment under monitoring of electrolytes and fluid status**
- Water restriction in hypervolemic and euvolemic state
- Replacing water / prevent losses in case of hypovolemic state

Case scenario

* How will you categorise hyponatremia based on osmolarity?

*Serum Osmolality

Normal 280-295mOsm/kg	Low <280 mOsm/kg	High >295mOsm/kg
Isotonic hyponatremia	Hypotonic hyponatremia	Hypertonic hyponatremia
Hyperlipidemia Hyperproteinemia	Assess volume status	Hyperglycemia Mannitol,sorbitol glycerol

Hypovolemic Hyponatremia	Euvolemic Hyponatremia	Hypervolemic Hyponatremia
Water (↓) and Na deficit(⇊)	Water excess(↑)	Water (⇈) and Na excess(↑)
1.Extrarenal loss (U Na < 20mmol/L) - Vomiting, diarrhoea 3rd spacing 2. Renal Loss (U Na >20mmol/L)- • RTA, Cerebral salt wasting • DKA • Diuretic therapy, • Adrenal insufficiency	1. Water intoxication Use of 5% Dextrose in post operative period, Psychogenic water drinking, Tap water enema 2.SIADH	1.Renal failure (U Na > 40 mmol/L) others (U Na < 20 mmol/L) 2.Nephrotic syndrome 3.Congestive heart failure 4.Protein energy malnutrition 5.Cirrhosis liver

Case scenario

- Is there a possibility of pseudohyponatremia in this child? If so, what are the conditions that you will consider?

*Pseudohyponatremia

- Hyperlipidemia / hyperproteinemia/ IVIG infusions

  (Flame emission photometry – sodium measured in relation to total serum; solid component rises and gives falsely low sodium values)

- *Modern analyzers / ABG analyzers - ion sensitive electrodes

- *Factitious or translocational hyponatremia- hyperosmolar agents like Mannitol, Glucose, contrast agents etc. cause fluid shifts into ECS because of high osmolality

Case scenario

- What is the further management in this child?

*Steps in assessment

Any neurological symptoms? - No

*1.True or pseudo? - Sample appropriate, glucose (CBG) 90 mg/dL, sample not lipemic- True

*2. Volume status? - Moderately dehydrated, hypovolemic, no shock.

*3. Acute or chronic? - Acute

*4. Urine sodium levels? Not done

(To differentiate renal/non renal losses)

Trial of treatment under monitoring of electrolytes and fluid status

* Correct dehydration, hyponatremia gets corrected by itself
* Clinically monitor, repeat electrolytes after 24 hrs.
* If new symptoms occur, repeat Na at that point.

Table 75.2 Fluid Management of Dehydration

1. Restore intravascular volume
   Isotonic fluid (NS or LR): 20 mL/kg over 20 min
   Repeat as needed
2. Calculate 24 hr fluid needs: maintenance + deficit volume
3. Subtract isotonic fluid already administered from 24 hr fluid needs
4. Administer remaining volume over 24 hr using 5% dextrose NS + 20 mEq/L KCl
5. Replace ongoing losses as they occur

LR, Ringer lactate; NS, normal saline.

Step wise correction of dehydration

- Calculate volume needed: (Two phase dehydration correction)

* Deficit = Here 6% dehydration =60 ml/kg of fluid loss.

* % dehydration × weight = 60×10=600 ml

* Deficit + Maintenance =600 + 1000 =1600 mL

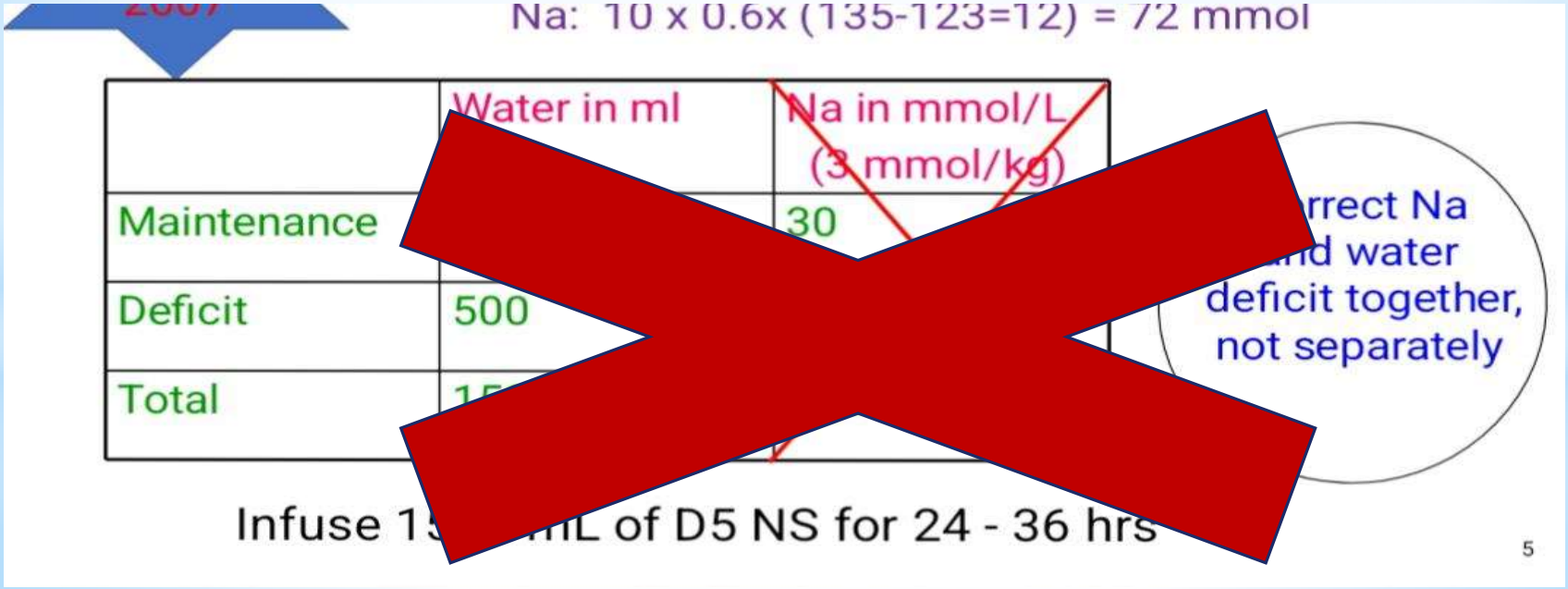
- Replace as D5 NS with appropriate maintenance K

- Give half of total fluid (800ml) in 8 hrs and second half (800ml) in the next 16 hrs .

Ongoing losses to be replaced ml per ml.

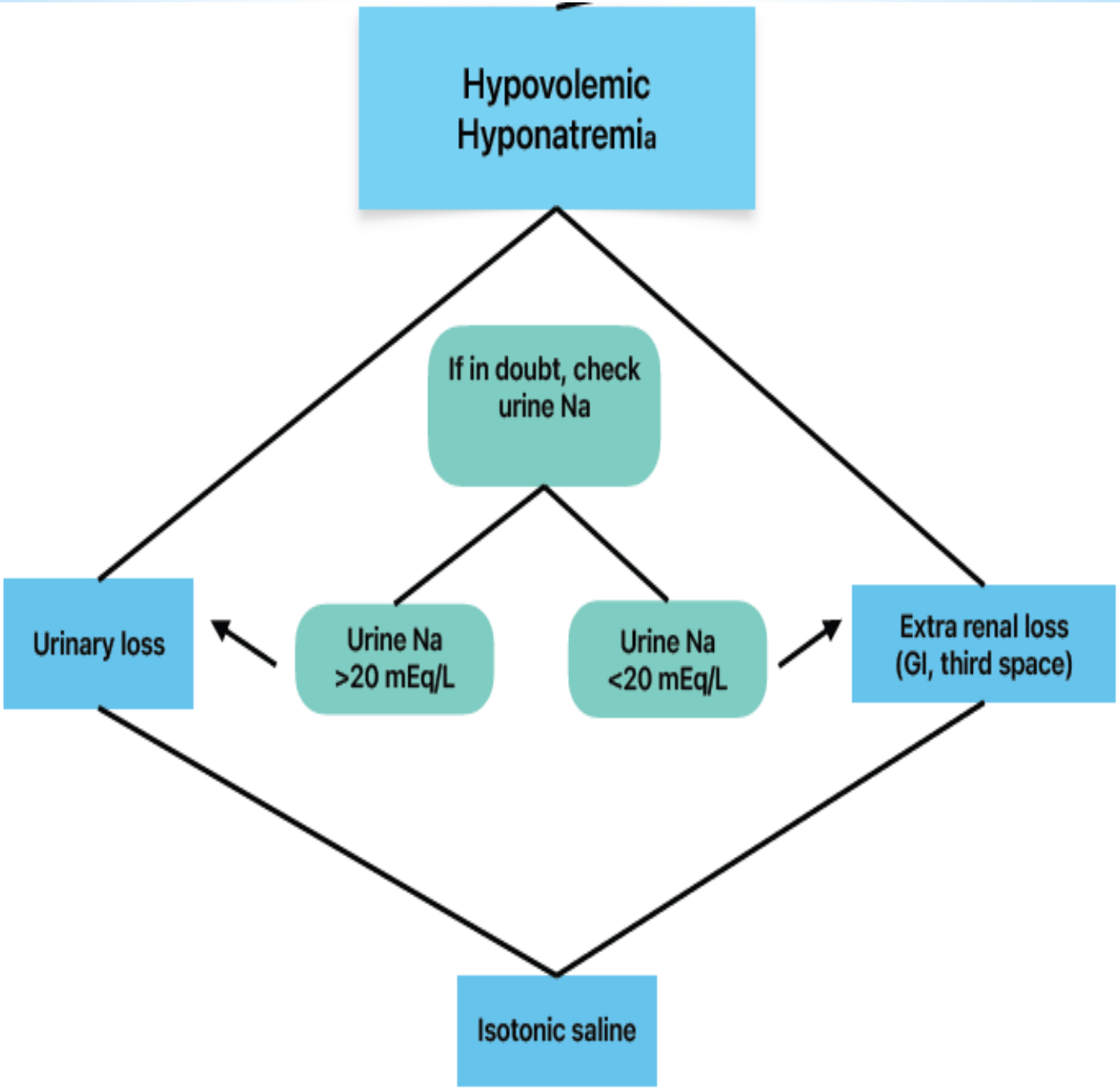
Add KCl if hypokalemic & once the urine output is well established.

* Older method of correcting the Na deficit is not required.
Correct dehydration/volume with isotonic fluids & hyponatremia will get corrected by itself.



Osmolarity of Commonly used IV Fluids

Solution	Osmolarity (mOsmol/L)	Sodium content (mequiv/L)	Osmolality (compared to plasma)	Tonicity (with reference to cell membrane)
Sodium chloride 0.9%	308	154	Isosmolar	Isotonic
Sodium chloride 0.45%	154	77	Hyposmolar	Hypotonic
Sodium chloride 0.45% with glucose 5%	432	75	Hyperosmolar	Hypotonic
Glucose 5%	278	–	Isosmolar	Hypotonic
Glucose 10%	555	–	Hyperosmolar	Hypotonic
Sodium chloride 0.9% with glucose 5%	586	150	Hyperosmolar	Isotonic
Sodium chloride 0.45% with glucose 2.5%	293	75	Isosmolar	Hypotonic
Sodium chloride 0.18% with glucose 4%	284	31	Isosmolar	Hypotonic
RL	278	131	Isosmolar	Isotonic
4.5% human albumin solution	275	100-160	Isosmolar	Isotonic


Hypovolemic Hyponatremia
If in doubt, check urine Na
Urinary loss
Urine Na >20 mEq/L
Urine Na <20 mEq/L
Extra renal loss (GI, third space)
Isotonic saline

Scenario 2

* The same child was managed in a district hospital. Initial sodium was 124. As the child developed an episode of seizure, it was referred to a tertiary care centre where serum Na was 116 mEq/L on arrival.
* How will you manage this child now?

*Steps in assessment

Any neurological symptoms? - Yes

*1.True or pseudo? - Sample appropriate, glucose (CBG) 90 mg/dL, sample not lipemic- True

*2. Volume status? - Moderately dehydrated, hypovolemic, no shock.

*3. Acute or chronic? - Acute

*4. Urine sodium levels? Not done

(To differentiate renal/non renal losses)

Trial of treatment under monitoring of electrolytes and fluid status

Management

* Target is to increase serum Na by 5 mEq/L to bring down the cerebral edema
- Which fluid? **3% saline 5 mL/kg or NS 20 mL/kg ?**
- 10 kg child, 3% saline 5 ml/kg= 50 ml (1 ml- 0.5 mEq of Na; 50 mL = 25 mEq of Na)

* NS 20 ml/ kg = 200 ml(100 ml= 15.4 mEq of Na; 200 ml = 30mEq)
* Both 5ml/kg of 3% saline & 20ml/kg of NS provide around 25-30 mEq of Na.
* NS bolus (20ml/ kg)is preferred as it corrects hypovolemia as well as sodium deficit.
* 3% saline may not be the right choice if child is volume depleted.

Take home messages

- The initial goal in treating hyponatremia in patients with diarrhoeal diseases is restoration of intra-vascular volume with isotonic fluids.
- NS 20 ml/ kg bolus is preferred over 3% saline in volume depleted hyponatremic patients with neurological symptoms.

*Thank you