



# **Riddle Of Sodium Disorders in Newborn**

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# Agenda

**Na physiology in NB and physiological natriuresis**

**Hyponatremia in NB (approach & management)**

**Hypernatremia in NB (approach & management)**



# Adult kidney

(GFR 100 ml/min/1.73 m<sup>2</sup>)



144 L/DAY PRIMARY FILTRATE

(Na 140 meq/L)

20,000 meq Na

# Body fluid distribution

HAPPY

# Loss of TBW (ECF)

*Pathophysiology*

↑ ANP >>> renal Na & H<sub>2</sub>O excretion

Poor response of principle cells to ADH

Renal immaturity (Na-K ATPase)



**IWL**

Evaporation through skin

~ ½ of IWL in term infants\*

H<sub>2</sub>O loss ∝ 1/gestational age

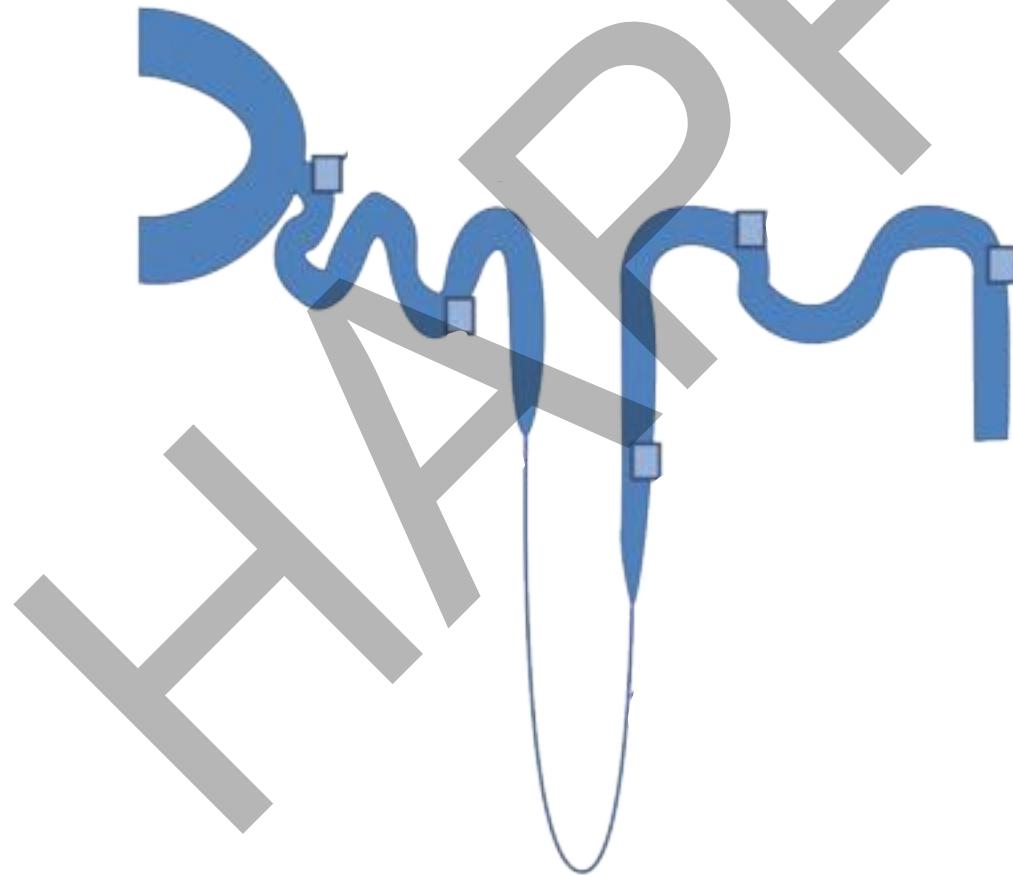


# Na physiology in NB

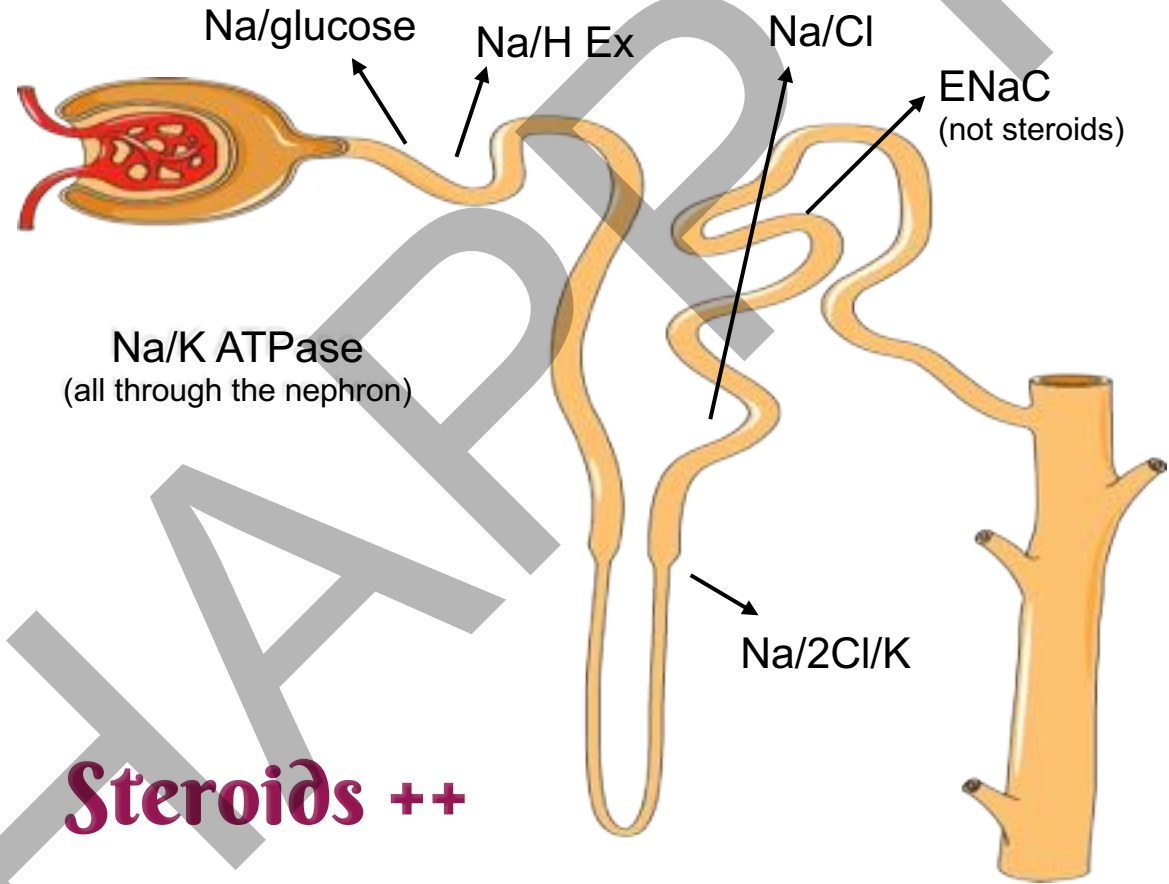
Daily intake = 2-3 meq/kg/d

1/2

1/3



# Changes after birth



**Steroids ++**

# Sodium

## Early Natriuresis

### Why It is important?

- It's an adaptation to extrauterine life
- To eliminate excess ECW. and Na

### Pathophysiology

- $\uparrow$  ANP  $\ggg$  renal Na & H<sub>2</sub>O excretion.
- Renal immaturity (Na-K ATPase)

### Progress

2w

- $\downarrow$  ANP
- Na- K ATPase activity is similar irrespective to gestational age



# Hyponatremia

## Early hyponatremia

(0-6 days)

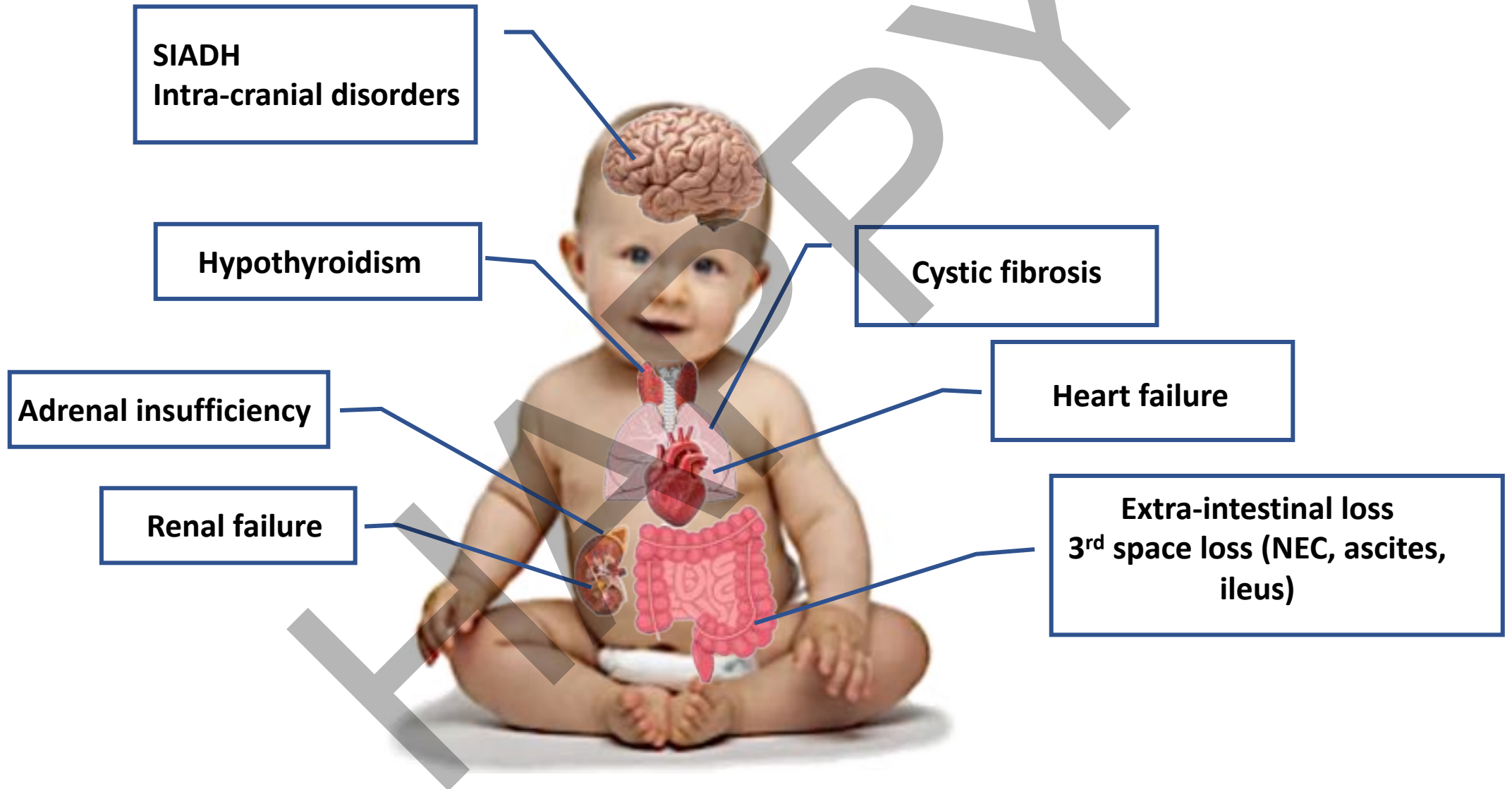
- Defined when serum Na < 128 meq/L
- Most often reflects excess TBW with normal total body Na
- SIADH and ↑ maternal free water intake (the commonest)

## Late hyponatremia

(7-28 days)

- Defined when serum Na < 135 meq/L
- Excessive renal Na losses and ↓ Na intake (the commonest)

# Diseases associated with hyponatremia



**Plasma Osmolality**

> 280 mOsm/kg

< 280 mOsm/kg

- Hyperglycemia
- Mannitol
- Pseudohyponatremia (hyperlipidemia, hyperproteinemia)

**Urine Osmolality**

>100 mOsm/kg

<100 mOsm/kg

- Water intoxication in infant

**Hypovolemia**

Yes

No

**Urine Na, FeNa**

Urine Na >30 meq/l, FeNa > 0.5

Urine Na < 30 meq/l, FeNa < 0.5

- Diuretics
- Salt losing nephropathy
- Cerebral salt wasting

- Extrarenal losses
- Edematous conditions

Urine Na > 30 meq/l, FeNa > 0.5

- SIADH
- Renal insufficiency
- Hypothyroidism
- PPV
- Glucocorticoid deficiency

# Hyponatremia ttt

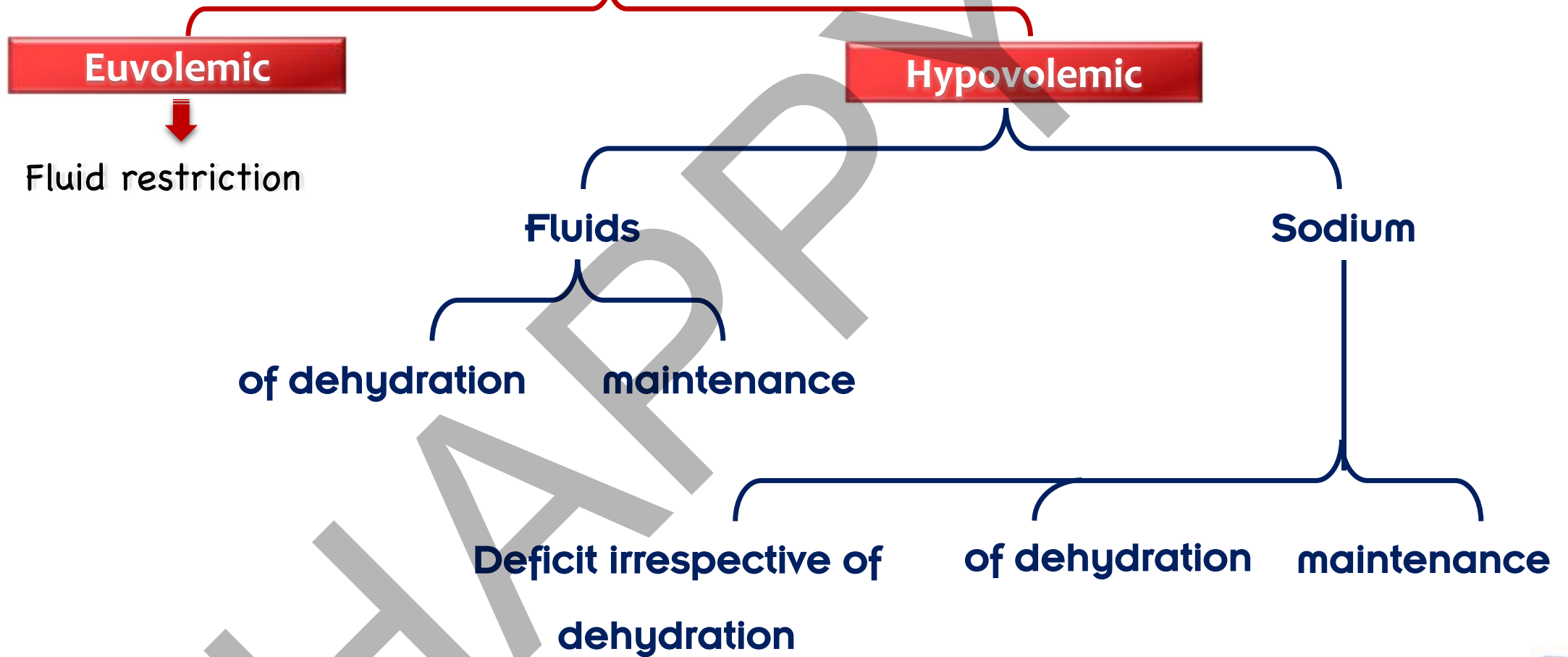
## Symptomatic hyponatremia

- Hyponatremic encephalopathy should be suspected with any sharp decline of serum Na (Na < 120 meq/L)
- Manifestations of cerebral edema may be obscure in NB
- Vomiting, seizures, weakness, respiratory distress>>> herniation (dilated pupil & decorticate posture)

## Symptomatic hyponatremia ttt

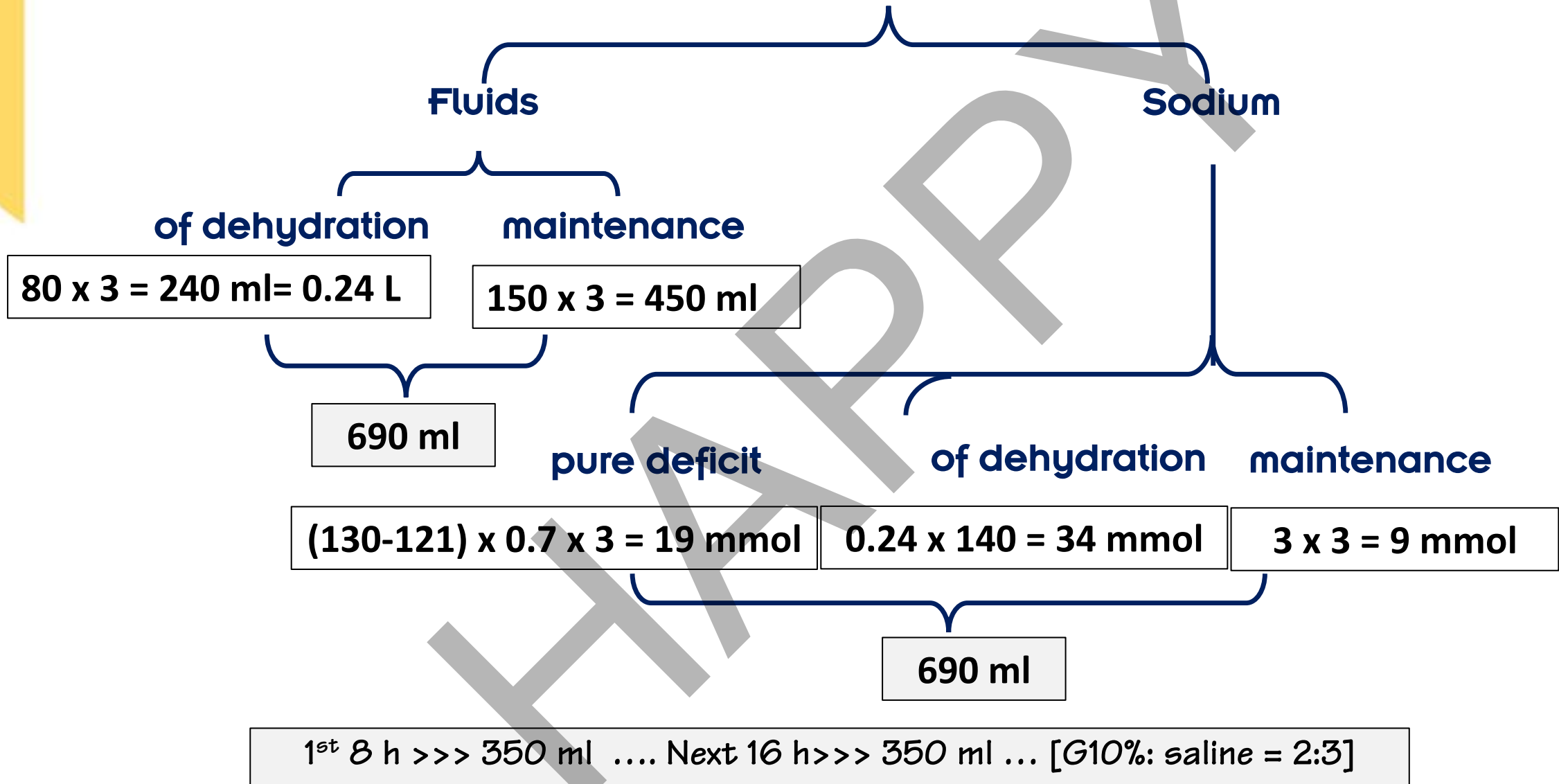
- 2-3 ml/kg bolus 3% NaCl over 10 min.
- Repeated once or twice
- **Goal:** Na rise 5-6 meq/L over 2 hours
- No more 3% NaCl, if:
  - a. Symptoms-free
  - b. Na rise 5 meq/L within 2h (or 10meq/L over 5h)

# Asymptomatic hyponatremia



$$\text{Deficit} = (\text{expected} - \text{observed}) \times 0.7(\text{fraction of TBW}) \times \text{Wt.} = \text{mmol}$$

3 Kg NB, D7, moderate dehydration, asymptomatic with serum Na 121 meq/L



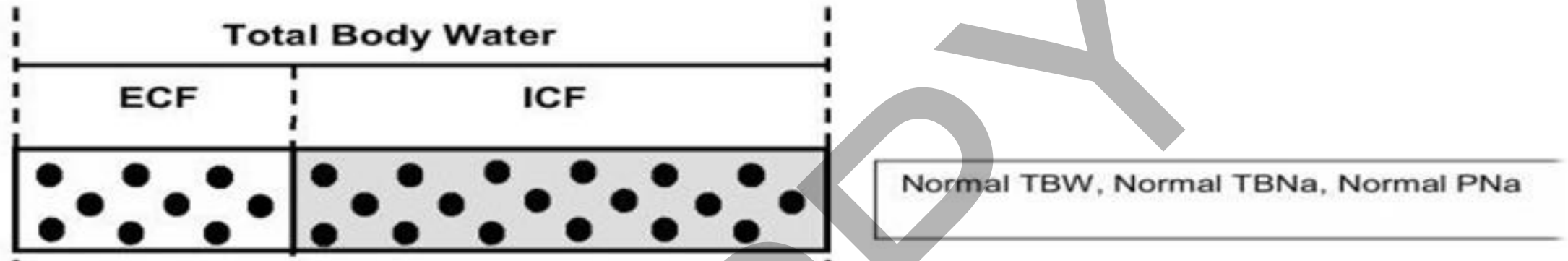
# Hypernatremia

- Defined when serum Na > 150 meq/L
- Most often in preterm and LBW infants
- Insufficient breast-milk feeding accounts for > 15% of causes

Disorder of total body water rather than plasma Na concentration



# Hypernatremia



HAPPY

# Hypernatremia

## Hypovolemic

TBW ↓ ↓  
TB Na ↓

U Na > 20 meq/L  
Renal losses

- Diuretics
- Renal diseases

U Na < 10 meq/L  
Extra-renal losses

- GE
- Burns

## Euvolemic

TBW ↓  
TB Na ---

U Na Variable

- Diabetes insipidus
  - Central
  - Nephrogenic
- Increase insensible loss
  - Ineffective breast feeding
  - Phototherapy

## Hypervolemic

TBW ↑  
TB Na ↑ ↑

U Na normal or ↑

- Hyperaldosteronism
- Cushing \$
- Na HCO<sub>3</sub> excessive intake



# Correction of Hyponatremia

## Emergency phase

Shock >> prompt response

*use of 0.9% NaCl 20ml/kg  
over 30 min*

## Rehydration phase

Calculate

Free water deficit (in L) =  
[[**current Na/145**]-1] x TBW  
x B.Wt.

+

Maintenance fluid = Total  
fluid over 48 hours

## Notes

- Rate: not > 0.5 meq/l /h
- Correction over 48-72 h
- Consider dialysis if Na > 180-200 meq/l

3 Kg NB, D7, moderate dehydration, asymptomatic with serum Na 170 meq/L,  
History revealed GE

$$\text{Free H}_2\text{O deficit} = [(\text{current Na}/145)-1] \times \text{TBW} \times \text{B.Wt.}$$
$$[(170/145)-1] \times 0.7 \times 3 = 0.36 \text{ L} = 360 \text{ ml}$$

- Maintenance fluid over 48 hours =  $150 \times 3 \times 2 = 900 \text{ ml}$
- Total fluid = 1260 ml over 48 hours

Na

$$\text{. Maintenance} = 2 \times 3 = 6 \text{ meq/d} = 12 \text{ meq/48 h}$$

$$\text{. Deficit} = 0.36 \times 140 \times 0.6 = 30 \text{ meq}$$

K

$$\text{- Maintenance} = 2 \times 3 = 6 \text{ meq/d} = 12 \text{ meq/48 h}$$

$$\text{- Deficit} = 0.36 \times 120 \times 0.4 = 18 \text{ meq}$$

	Water	Na	K
Maintenance /48h			
Water deficit			
Na deficit			
K deficit			
Total			

**Rate of infusion = 26 ml/h (630 ml over 24 h)**

**630 ml fluids /day should contain Na 21meq Na and 15 meq K (~ Na 33 meq/L and K 24 meq/L)**

**Type of fluids = G10% : isotonic saline = 3:1 (add 12ml K ~ 24 meq/L)**

**Monitor serum Na every 6-8 hours**

# CONCLUSION

- **Physiological natriuresis is an important step for adaptation in extra-uterine life.**
- **Symptomatic hyponatremia should be corrected promptly**
- **Hypernatremia is a disorder of total body water rather than plasma Na concentration**

**1. Which of the following Na channels NOT activated by steroids in NB?**

- a) Na/H exchange**
- b) Na/K/2Cl cotransport**
- c) Epithelial Na channels**
- d) Na/K ATPase**

**2. The most common cause of euvolemic hyponatremia in NB is:**

- a) SIADH (syndrome of inappropriate secretion of ADH)**
- b) Salt losing nephropathy**
- c) Renal insufficiency**
- d) Extra-renal losses**



**3. The most common cause of euvolemic hypernatremia in NB is:**

- a) Phototherapy**
- b) Diabetes insipidus**
- c) Renal diseases**
- d) Insufficient breast feeding**



thank you!

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