



Namaste
 مرحبا
 Bem Vindo
 Selamat Datang
Willkommen
 Welcome
 Bienvenidos
 أهلا وسهلا
Welcome
 Bem Vindo
 Croeso
 Namaste
مرحبا
 Welcome
 Welkom
أهلا وسهلا
 Selamat Datang
Bienvenue
 Welcome
 Willkommen
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 Καλώς ήρθατε

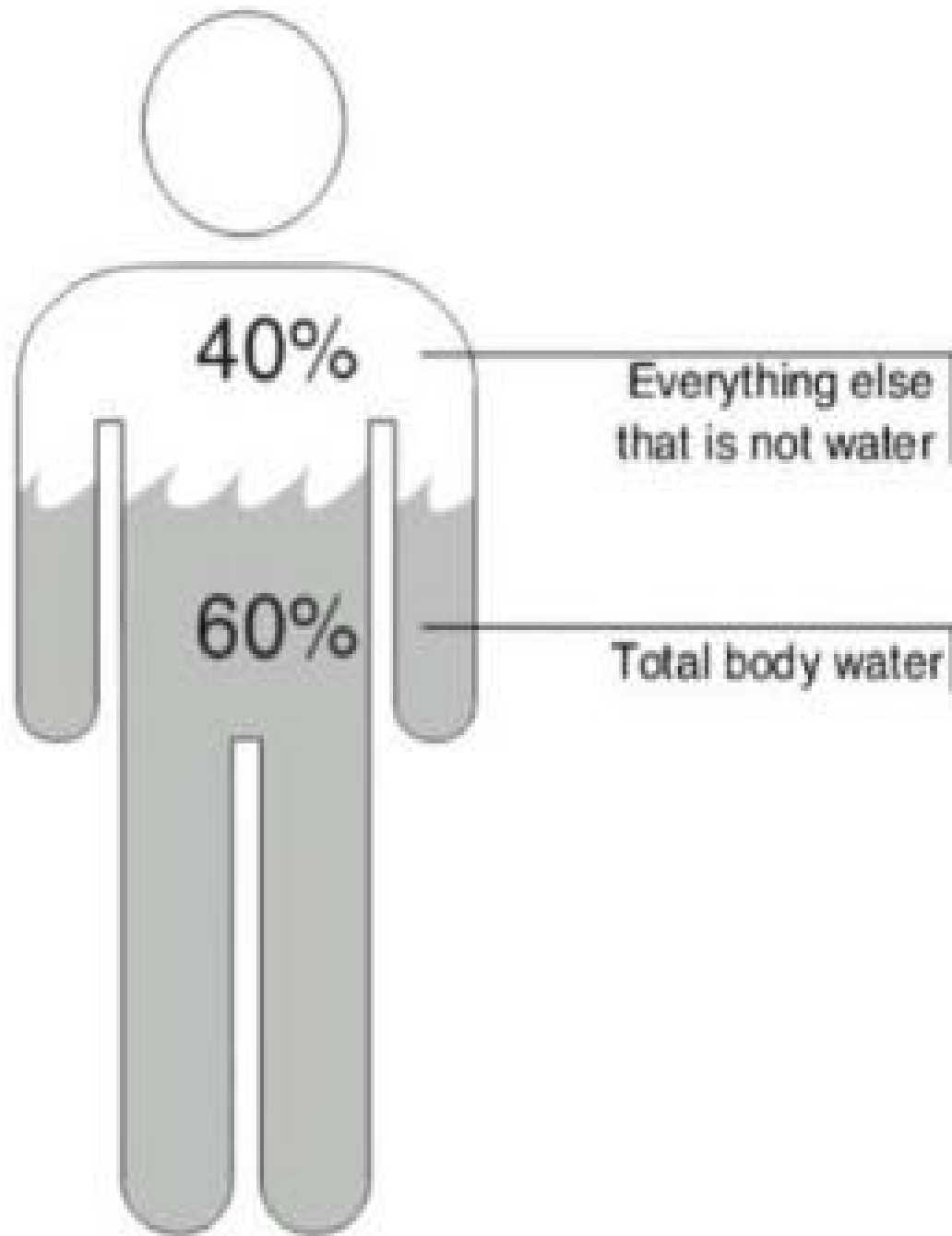


The Blue Marble

December 7, 1972; Apollo 17, 29,000 km from earth

71% of Earth surface is water





	TBW	ECF
16 W	90%	2/3
Preterm	80%	
Term	75%	1/2
Infant	70%	
Child	60%	1/3
Male	60%	
Female	55%	
Elderly	50%	



القومي لمكافحة الجفاف



MARINO'S
**The ICU
Book**
FOURTH EDITION

Paul L. Marino

Wolters Kluwer | Lippincott
Williams & Wilkins



Blood volume saves lives

Total vs intravascular

Oedema is not a good predictor of intravascular volume in acute/critical illness

- **Hypo-oncotic (underfill) oedema**
- **Capillary leak & SIRS**



Am J Kidney Dis. 2010 Feb;55(2):316-25.

Fluid overload and mortality in children receiving continuous renal replacement therapy: the prospective pediatric continuous renal replacement therapy registry.

Sutherland SM¹, Zappitelli M, Alexander SR, Chua AN, Brophy PD, Bunchman TE, Hackbarth R, Somers MJ, Baum M, Symons JM, Flores FX, Benfield M, Askenazi D, Chand D, Fortenberry JD, Mahan JD, McBryde K, Blowey D, Goldstein SL.

297 children from 13 centers across the United States participating in the Prospective Pediatric CRRT Registry.

RESULTS:

- **31% had >20% fluid overload**
 - **O.R. to mortality 8.5 even after CRRT**
 - **1% overload → 3% higher mortality**
-
- **FO is an established risk factor for adverse outcomes in adults, children, term and premature neonates**



6-10% is the intervention threshold

Impact in neonates

Inadequate fluid	Excess fluid
Hypovolemia	PDA
Hyperosmolality	HF
Thermal intolerance	IVH
Metabolic derangements	NEC
AKI	BPD
Circulatory collapse	

Normal balance

- **Water intake = Water output**
(Homeostasis)

-Thirst

-Urine concentration



FLUID BALANCE:

INTAKE:

- Metabolism
- Water
- Food
- Medications, transfusions, etc
- IV Fluids

OUTPUT:

- Insensible loss
- Urine
- Sweat, Stool
- Abnormal loss
GI, surgical, ...

FLUID BALANCE: intervention

- **Intake**

Fluid prescription

- **Urine output**

Diuretics

Fluid removal (UF)

- **Control of environmental losses**

Neonatal facts

- **Children are not small adults or big neonates either**
- **Extremely LBW care is an entirely new discipline**

1. Neonates are tiny Preterms can get incredibly tiny



2. Higher water requirements/ Kg

- **Small size → ↑ S.A./ vol. ratio**
- **Higher skin permeability**
- **Relatively high insensible loss**
1/3 resp. & 2/3 skin
- **Relatively high ECF**

However;

- **Babies are born with 10% excess water, mostly extracellular (more in ELBW)**
- ➔ **Physiological wt loss (days-1wk)**
- **Fluid needs are initially LOW, no Na**
- **Compensated by high RAAS activity**

How big is a newborn's stomach?



Day 1

size of a cherry

5-7 mL

1- 1.4 teaspoons



Day 2

size of a walnut

22-27 mL

0.75-1 oz



One week

size of an apricot

45-60 mL

1.5- 2 oz



One month

size of large egg

80-150 mL

2.5- 5 oz

3. Early intake normally parallels need **BUT NOTE**

Balance should be initially NEGATIVE

- **Preterms: \uparrow losses + \downarrow stores so need support to maintain \geq intrauterine rates**
- **IUGR: lower glycogen stores**
- **IDM: hypoglycemia risk**
- **Stress (asphyxia, RD, MV, ...) \rightarrow water retention and high ADH**
- **Limited ability to excrete large/ rapid Na/water loads**

Fluid response to critical illness

Initial resuscitation	Most volume responsive (how much)
Fluid retention	Restriction usually needed
Recovery	Normal or increased needs

4. Relation to nutrition

100-140 Cal/Kg/d

- **Gap in small PT → PN**
- **Milk is not all water !!**
- **Weight is not a good growth marker?**
 - 20g could be a void, dressing, ..
 - Weight includes water, fat & organs
 - Length, HC & body composition

60-80 mL/Kg in (near) term

50-120 mL/Kg/d

Max 120-150 mL/kg/d (end of wk1)

	Initial	D3-7
34w +	60-70	90-150
28-33w	60-70	90-130
	80-120	100-130
24-27w	90-130	100-140

In closed incubator without phototherapy

- **Initially Na-free**
- **Increase rate if**
 - Na \geq 145mmol/L; or
 - Urine $<$ 0.5mL/kg/h (& check balance)
- **Add Na (3-5mmol/Kg – 2-4mmol/100mL)**
 - Na $<$ 145mmol/L; and
 - Diuresis
- **Then add K when $<$ 5mmol/L (1-2mmol/100mL)**

IDM

- **Will need higher volume to maintain GIR**
- **Na & K expected to fall within 24h (check earlier)**

Stress

Asphyxia, TTN, RD, MV

- **Generally LOWER requirements first few days**
- **Asphyxia on cooling ? Start normal & monitor overload**
- **PDA may also need diuretics**

Increased requirements

- **Shock**
- **Insensible losses increased:**
 - Open warmer
 - Photo (-40%)
- **Abnormal losses as GI surgery or drainage:**
 - Replace saline-K
- **Inappropriate polyuria**

AKI

- **Correct hypovolemia**
- **Maintenance based on actual urine output**
- **-ve target for overload**
± diuretics or UF

Insensible Water Loss according to Birth Weight on Day 5

BIRTH WEIGHT	IWL (ml/Kg/day)
<1000 gm	60-80
1000-1500 gm	40-60
>1500 gm	20

Lower values (12mL/Kg/d) reported in term neonates in neutral thermal environment & RH 50%

- **Transepithelial (skin) losses**

↑ warmer (>2x) photo (60%) ↓ wrapping (50%+)

General principles apply



والبحر بحر والجبال رواسخ
والنور نور والظلام عماء
والحر ضد البرد قول صادق
والصيف صيف والشتاء شتاء

General principles apply

- **Who needs (not) to receive volume?**
- **What are the maintenance requirements?**
- **What is the current fluid status?**
- **What is the treatment goal?**

Fluid assessment

- **Proper clinical evaluation**
- **Weight changes**
- **Tracking of I/O**
- **Serum Na & Urea**
- **Ultrasound**
- **Body composition analysis**

Tracking

2 Kg, D7, 130 mL/Kg/d

Urine 2 mL/Kg/d

- Insensible = 50mL
- Urine = 96mL
- GI = 0
- Surgical = 0
- Total out = 146mL

260-146

+104 mL

**300mL in 3 d
(15% FO)**

MANAGEMENT DILEMMA

Assessment of fluid status in neonatal dialysis: the need for new tools

Noureddin Nourbakhsh^{1,2} · Nadine Benador^{1,2} 

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B type natriuretic peptide ++
Pro BNP (longer half life & renal clearance)

Fluid assessment: Neonatal challenges

- **Weight accuracy**
- **Weight gain confounding**
- **Unplanned intakes/ outputs**
- **Insensible highly variable**
- **Accurate urine collection**
- **BCA for neonates**

The main Conclusions

- Dehydration and overload are both serious
- **Effect size is greater in neonates**
- Initial balance normally –ve
- **Protocols guide start, accurate monitoring & adjustment are needed**
- **ACT ON changing needs**
- **General fluid balance principles apply**



Q1. Which of the following is LOWER in preterms compared to term neonates?

A	Body surface area relative to body size
B	Extracellular fraction of total body water
C	Insensible water loss/m² body surface area
D	Glomerular filtration rate /m² body surface area

Q2. Water requirements **DECREASE** in neonates who are

A	mechanically ventilated
B	nursed in open warmers (servos)
C	receiving phototherapy
D	undergoing abdominal surgery

Q3. Which is true regarding neonatal sodium?

A	Requirements are 3-5mmol/Kg during the first day of life
B	Fluids should be restricted if serum level exceeds 145mmol/L
C	Levels are expected to rapidly increase in infants of diabetics on high GIR
D	Factitious hyponatremia may follow IVIG administration