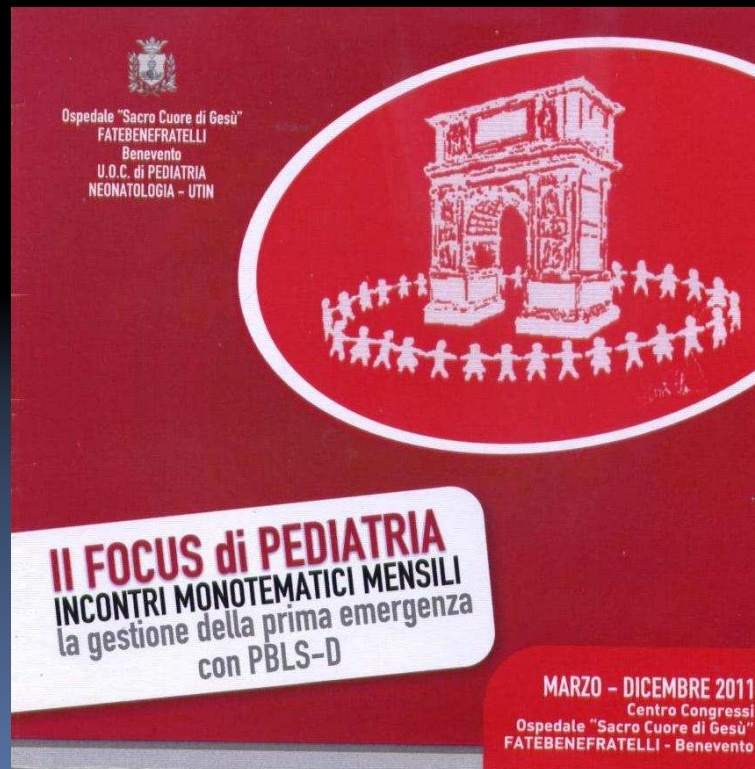


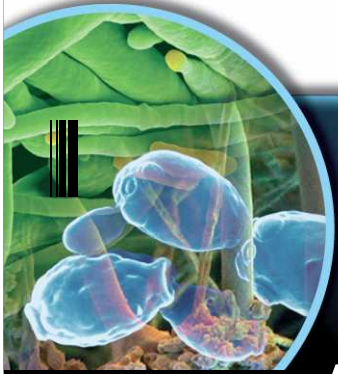
Policlinico
Gemelli
IMPEGNO PER L'ECCELLENZA.

Disidratazione in età pediatrica



Orazio Genovese

Terapia Intensiva Pediatrica
Università Cattolica del Sacro Cuore - Roma

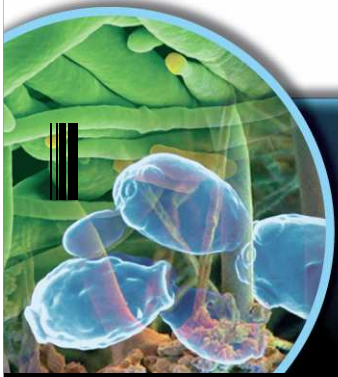


Disidratazione

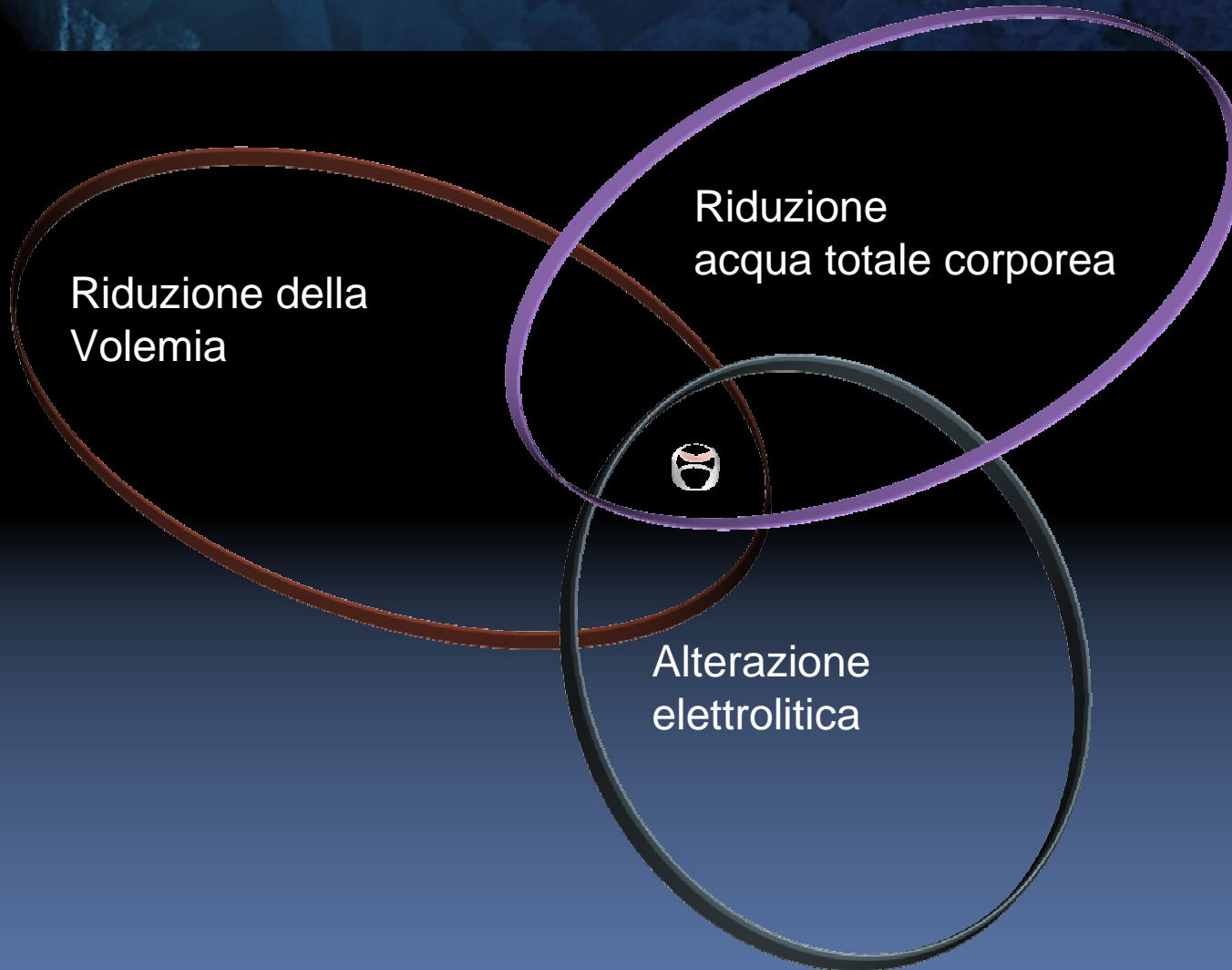


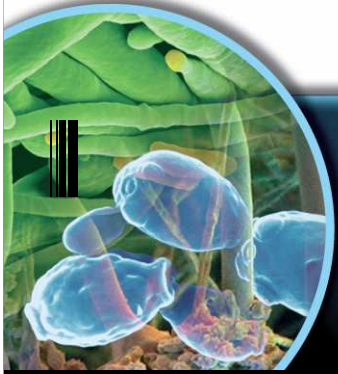
- Alterazione di fluidi corporei causato da deplezione idrica.
 - Perdita di Acqua + soluti





Disidratazione





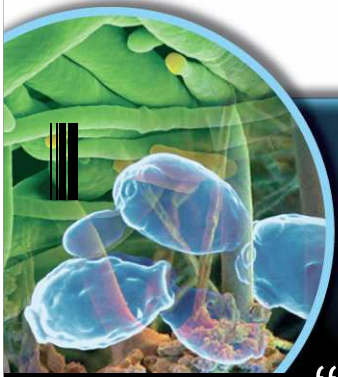
Compostion fluids

AVERAGE COMPOSITION OF DIARRHEA

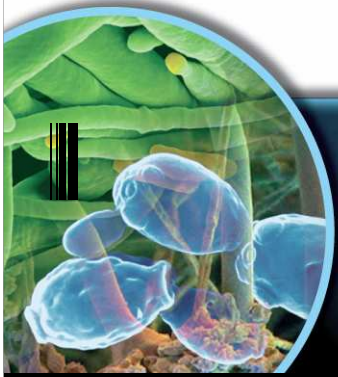
Sodium:	55 mEq/L
Potassium:	25 mEq/L
Bicarbonate:	15 mEq/L

AVERAGE COMPOSITION OF GASTRIC FLUID

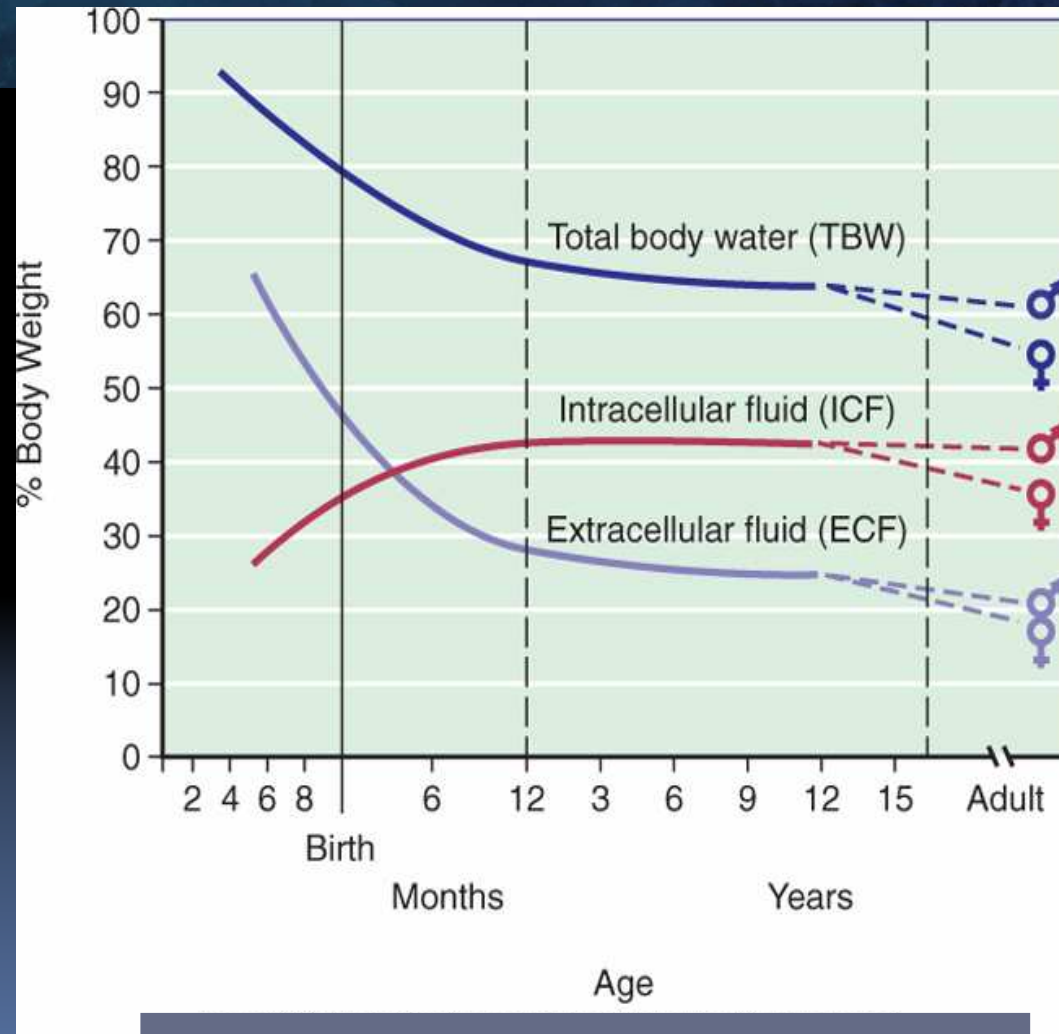
- Sodium: 60 mEq/L
- Potassium: 10 mEq/L
- Chloride: 90 mEq/L



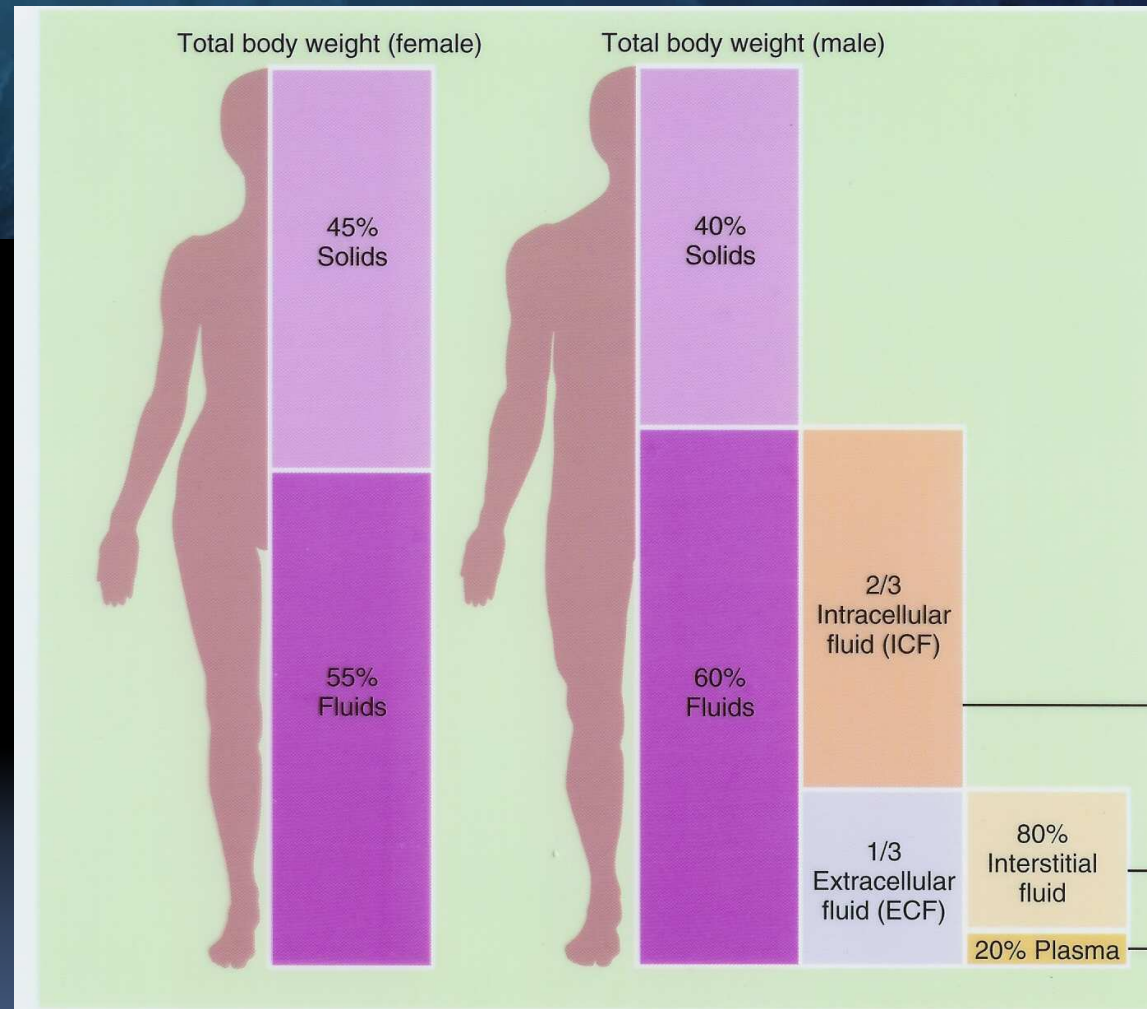
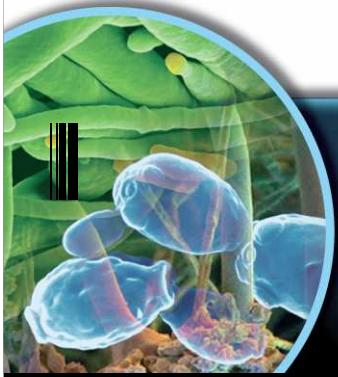
- “**Volume depletion** denotes lessening of the total intravascular plasma, whereas **dehydration** denotes loss of plasma-free water disproportionate to the loss of sodium.
- The distinction is important because volume depletion can exist with or without dehydration, and dehydration can exist with or without volume depletion.”

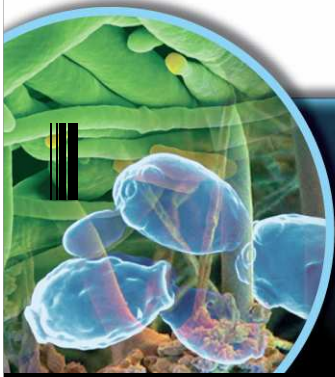


Distribuzione dei fluidi



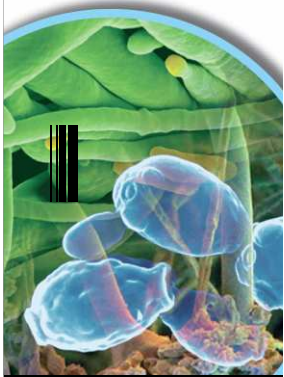
Winters RW *The Body Fluids in Pediatrics*. Boston, Little, Brown,



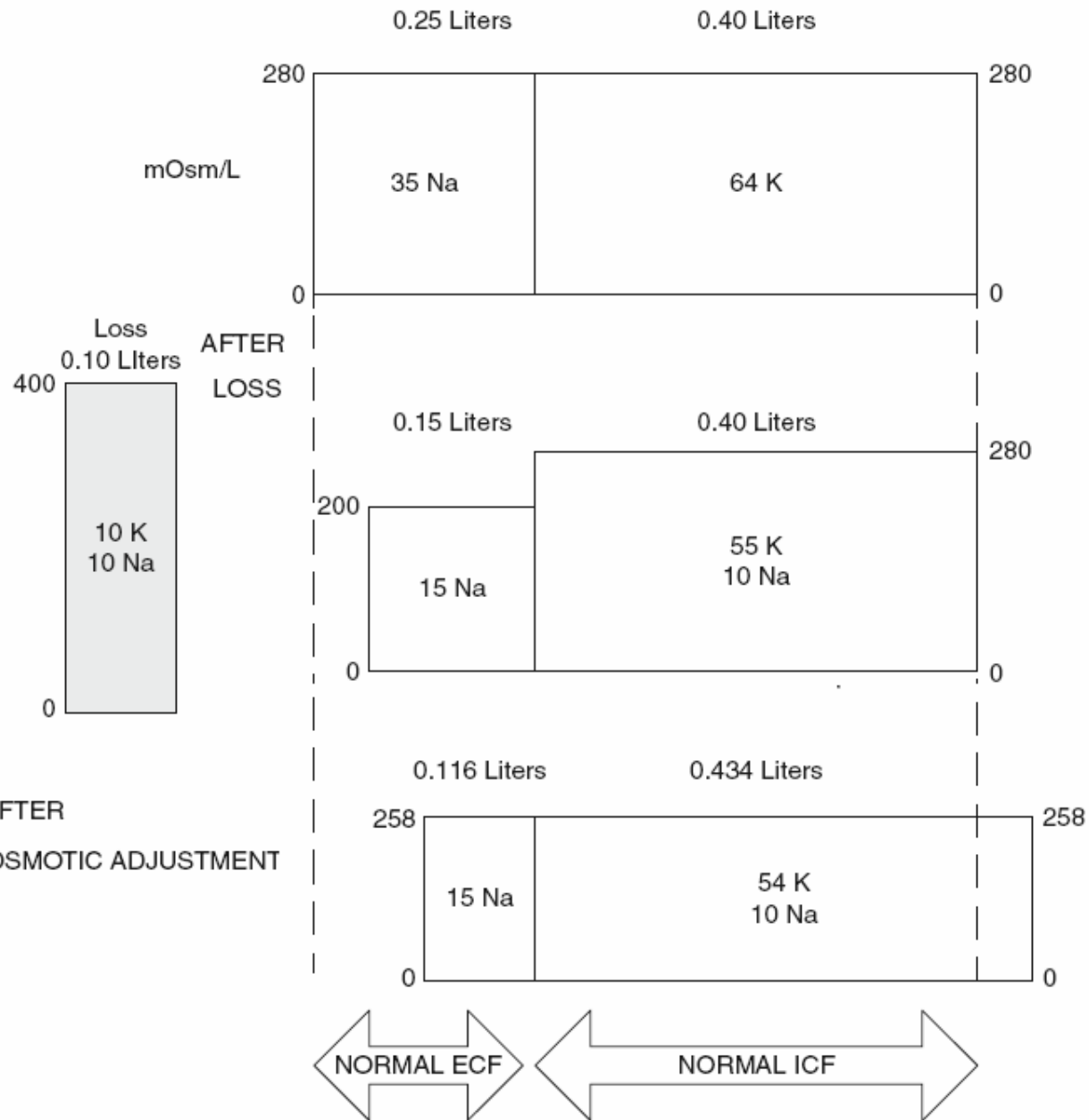


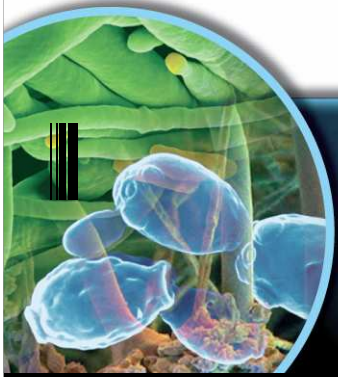
and anions in the intracellular space and the plasma, expressed in mEq/L.

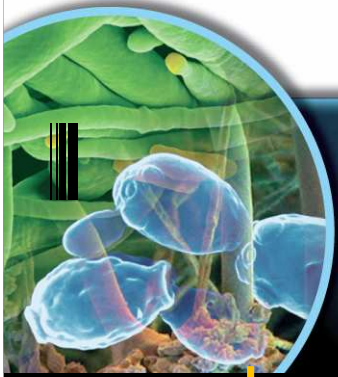
PLASMA		INTRACELLULAR	
Cations	Anions	Cations	Anions
Na ⁺ (140)	Cl ⁻ (104)	K ⁺ (140)	Phos ⁻ (107)
K ⁺ (4)	HCO ₃ ⁻ (24)		Prot ⁻ (40)
	Prot ⁻ (14)		
	Other (6)		
Ca ⁺ (2.5)	Phos ⁻ (2)	Na ⁺ (13)	HCO ₃ ⁻ (10)
Mg ⁺ (1.1)		Mg ⁺ (7)	Cl ⁻ (3)



NORMAL



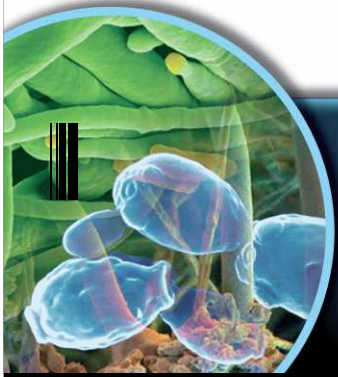




Deplezione VOLEMICA

Loss of isotonic fluid from the extracellular fluid

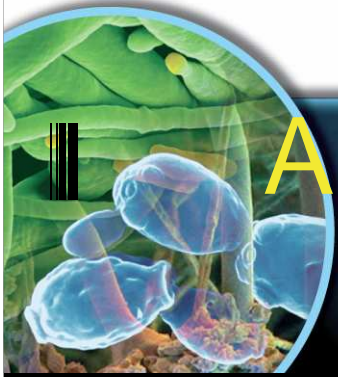
- Exceeding net intake.
 - gastrointestinal tract
 - skin
 - Lungs
 - urine
- Not exceeding net intake.
 - acute sequestration in the body in a "third space" (Septic shock, GI obstruction, crush injury, bleeding, acute pancreatitis, capillary leak syndrome,)



Common Causes of Dehydration

- **Most common Causes of Dehydration**
 - Gastroenteritis
 - Febrile illness
 - Stomatitis/pharyngitis
 - Diabetic ketoacidosis

- **Life-Threatening Causes of Dehydration**
 - Gastroenteritis (especially infants)
 - Heat prostration
 - Diabetic ketoacidosis
 - Gastrointestinal obstruction (Pyloric stenosis)
 - Burns over 25% of body surface area
 - Cystic fibrosis
 - Thyrotoxicosis Diabetes insipidus
 - Congenital adrenal hyperplasia
 - Child abuse



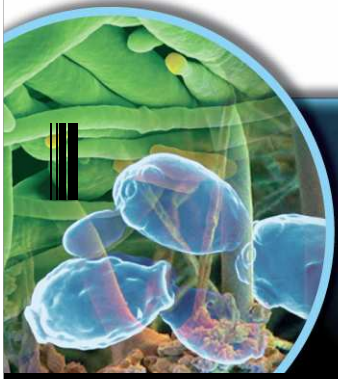
Approccio clinico nell'urgenza

Classico

- Anamnesi fisiologia
- Anamnesi patologica
- Esame obiettivo sistematico
- Esami laboratoristici e strumentali
- Diagnosi
- Terapia

Operativo

- Valutazione parametri vitali
- Stabilizzazione delle funzioni vitali
- Esame obiettivo "testa-piedi" ed esami essenziali
- Stabilizzazione e correzione delle alterazioni

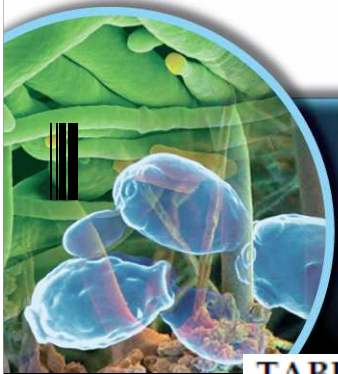


Clinical Evaluation of Dehydration

	Mild	Moderate	Severe
Lattante	<5%	5-10%	>10%
Bambino/adulto	<3%	3-6%	>6%



Steiner MJ. Is this child dehydrated?
JAMA. Jun 9 2004



Validity and Reliability of Clinical Signs in the Diagnosis of Dehydration in Children

Marc H. Gorelick, MD, MS*§; Kathy N. Shaw, MD, MS*§; and Kathleen O. Murphy, RN, MSN†

TABLE 2. Diagnostic Performance of 10 Individual Clinical Findings

Clinical Finding	Prevalence	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value	Negative Predictive Value	Kaplan's κ†
Decreased skin elasticity	0.14	0.35 (0.23, 0.49)	0.97 (0.92, 0.99)	0.57	0.93	0.55
Capillary refill >2 sec	0.19	0.48 (0.35, 0.61)	0.96 (0.90, 0.99)	0.57	0.94	0.65
General appearance	0.26	0.59 (0.46, 0.71)	0.91 (0.84, 0.95)	0.42	0.95	0.61
Absent tears	0.30	0.67 (0.53, 0.78)	0.89 (0.82, 0.94)	0.40	0.96	0.75
Abnormal respirations	0.20	0.43 (0.30, 0.56)	0.86 (0.78, 0.91)	0.37	0.94	0.40
Dry mucous membranes	0.42	0.80 (0.67, 0.89)	0.78 (0.70, 0.85)	0.29	0.99	0.59
Sunken eyes	0.31	0.60 (0.47, 0.72)	0.84 (0.76, 0.90)	0.29	0.95	0.50
Abnormal radial pulse	0.24	0.43 (0.30, 0.56)	0.86 (0.78, 0.91)	0.25	0.93	0.59
Tachycardia (HR>150)	0.24	0.46 (0.32, 0.61)	0.79 (0.72, 0.87)	0.20	0.93	measu
Decreased urine output	0.59	0.85 (0.73, 0.93)	0.53 (0.44, 0.62)	0.17	0.97	0.75

ARTICLE

Validation of the Clinical Dehydration Scale for Children With Acute Gastroenteritis

Ran D. Goldman, MD^{a,b}, Jeremy N. Friedman, MB, ChB, FRCPC^{c,d}, Patricia C. Parkin, MD, FRCPC^{c,d}

TABLE 2 Associations for Dehydration Severity Categories

Variable	No Dehydration (n = 117)	Some Dehydration (n = 84)	Moderate/Severe Dehydration (n = 5)	P
Child information				
Age, mean ± SD, mo	20.7 ± 13.6	24.1 ± 15.9	34.2 ± 21.2	.06
Male, n (%)	58 (50)	43 (51)	2 (40)	.88
Primary validation hypotheses				
LOS, mean ± SD, min	245 ± 181	397 ± 302	501 ± 389	<.001
Oral rehydration, n (%)	100 (85)	73 (87)	3 (60)	.22
Intravenous rehydration, n (%)	17 (15)	41 (49)	4 (80)	.001
pH of <7.32 (N = 59), n (%)	2 (14)	14 (34)	1 (25)	.36
Bicarbonate level of <18 mEq/L (N = 59), n (%)	4 (29)	16 (39)	3 (75)	.22
Secondary validation hypotheses				
No. of vomiting episodes in past 7 d, median (interquartile range)	7 (9)	11 (9)	32 (27.5)	Mann-Whitney test, <.00 (none to some), .01 (some to moderate/ severe)
No. of diarrhea episodes in past 7 d, median (interquartile range)	7 (17.5)	6 (13)	28 (23.5)	Mann-Whitney test, .41 (none to some), .02 (some to moderate/ severe)

Single P values for primary validation hypotheses are from a single analysis of variance test.

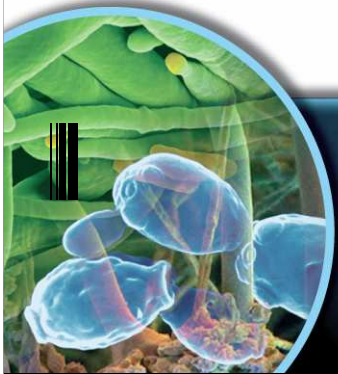


Gradi di disidratazione WHO

TABLE 1. Symptoms associated with dehydration

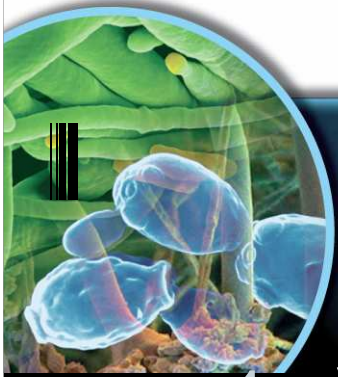
Symptom	Minimal or no dehydration (<3% loss of body weight)	Mild to moderate dehydration (3%–9% loss of body weight)	Severe dehydration (>9% loss of body weight)
Mental status	Well; alert	Normal, fatigued or restless, irritable	Apathetic, lethargic, unconscious
Thirst	Drinks normally; might refuse liquids	Thirsty; eager to drink	Drinks poorly; unable to drink
Heart rate	Normal	Normal to increased	Tachycardia, with bradycardia in most severe cases
Quality of pulses	Normal	Normal to decreased	Weak, thready, or impalpable
Breathing	Normal	Normal; fast	Deep
Eyes	Normal	Slightly sunken	Deeply sunken
Tears	Present	Decreased	Absent
Mouth and tongue	Moist	Dry	Parched
Skin fold	Instant recoil	Recoil in <2 seconds	Recoil in >2 seconds
Capillary refill	Normal	Prolonged	Prolonged; minimal
Extremities	Warm	Cool	Cold; mottled; cyanotic
Urine output	Normal to decreased	Decreased	Minimal

Sources: Adapted from Duggan C, Santosham M, Glass RI. The management of acute diarrhea in children: oral rehydration, maintenance, and nutritional therapy. *MMWR* 1992;41 (No. RR-16): 1–20; and World Health Organization. The treatment of diarrhoea: a manual for physicians and other senior health workers. Geneva, Switzerland: World Health Organization, 1995. Available at http://www.who.int/child-adolescent-health/New_Publications/CHILD_HEALTH/WHO.CDR.95.3.htm.



Quando ricoverare?

- Shock
- Severe dehydration (>9% of body weight)
- Neurological abnormalities
- Intractable or bilious vomiting
- ORS treatment failure
- Lack of adequate care at home
- and/or there are social or logistical concerns
- Suspected surgical condition



Approccio

1. Valutazione rapida dei parametri vitali
2. Correzione dello stato di shock e ripristino della volemia
3. Stima del deficit (quantitativa e qualitativa)
4. Calcolo dei fluidi da somministrare
5. Valutazione dell'appropriatezza



Contents lists available at ScienceDirect

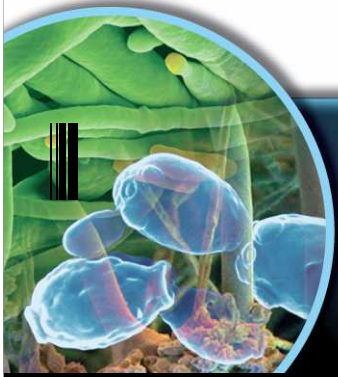
Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation



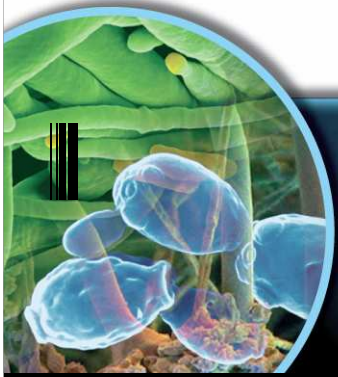
European Resuscitation Council Guidelines for Resuscitation 2010 Section 6. Paediatric life support

- Linee-guida PALS compromissione funzioni vitali
 - A: airway
 - B: breathing
 - C: circulation
 - D: disability



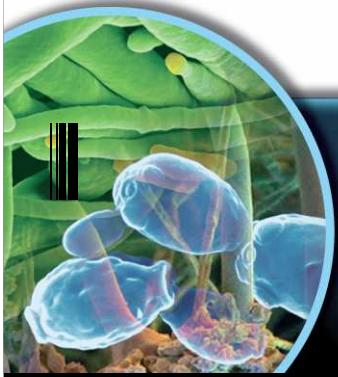
A: Valutazione dello stato di coscienza

- Bambino vigile e reattivo
- Stanco, Irritabile
- Apatico, Soporoso
- Coma



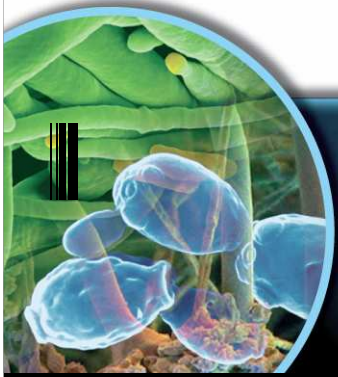
B: Respirazione

- Alterazione del pattern respiratorio
- Polipnea, dispnea,
- Respiro irregolare, Bradipnea,



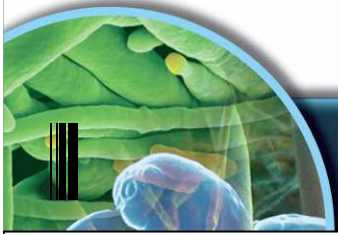
Valutazione del Circolo

- Polso Centrale
- Polsi periferici
- Frequenza cardiaca
- Perfusione periferica
 - Tempo di refill
 - Temperatura Corporea
 - Colorito cutaneo
- Pressione Arteriosa Sistolica



Refill Capillare <2''





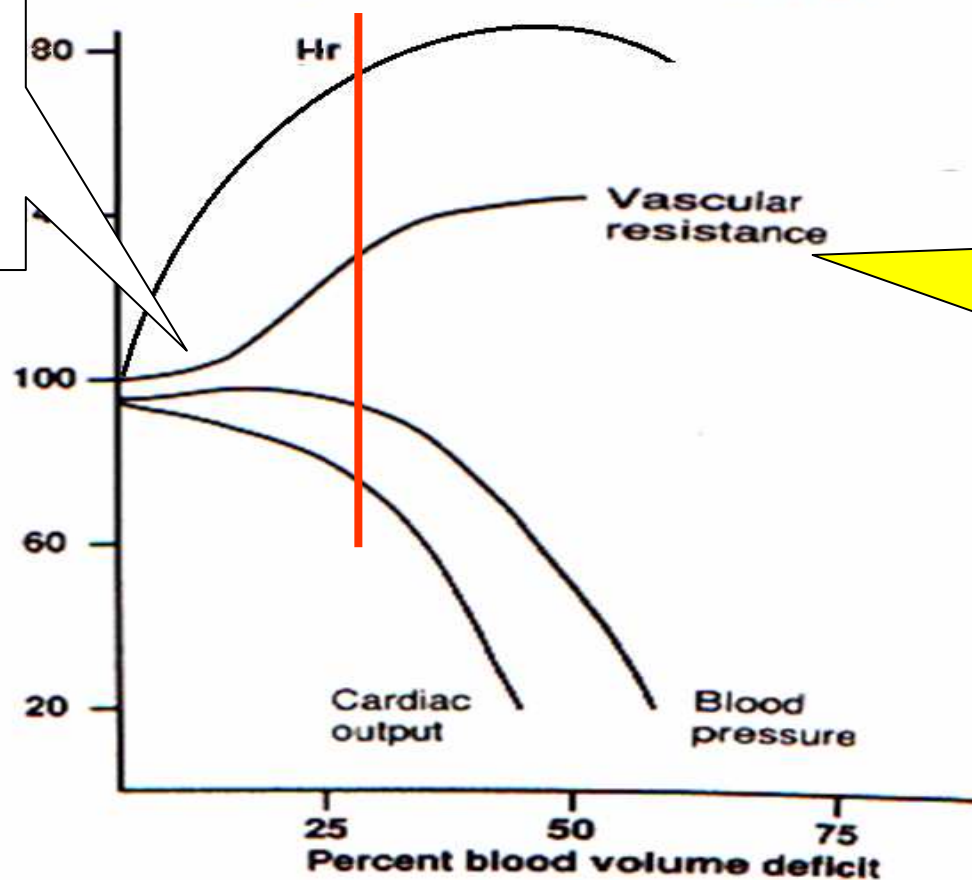
Risposta emodinamica

Shock compensato

Segni clinici modesti

Pressione normale

Efficacia terapia



Shock scompensato

Insufficienza multiorgano

IIPOTENSIONE

Minore risposta a terapia



Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

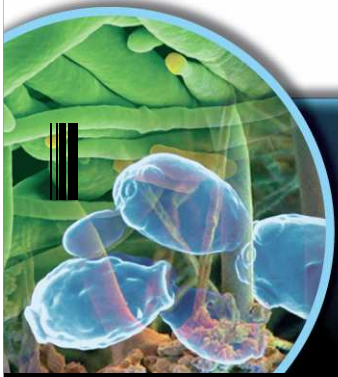
IIPOTENSIONE in età pediatrica

60 mm Hg in neonati a termine (0 - 28 giorni)

70 mm Hg in lattanti (1 - 12 mesi)

70 mm Hg +2 età (in anni) in bambini da 1 a 10 anni

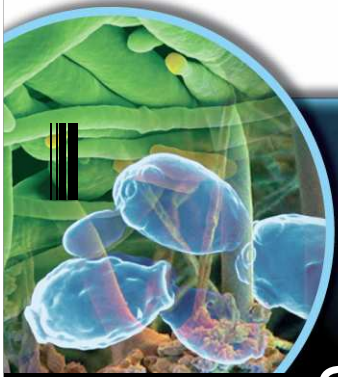
90 mm Hg in bambini > 10 anni di età



D: valutazione neurologica

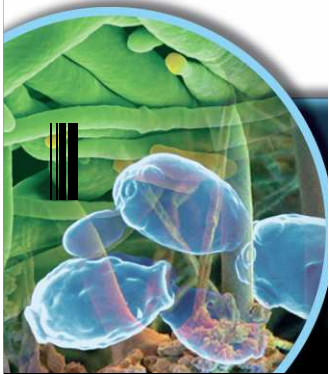
- Disabilità neurologica:
 - Irritabilità, letargia, coma
 - Convulsioni





E: altri segni

- Stima del calo ponderale
- Turgore della cute
- Idratazione delle mucose
- Occhi
- Output urinario
- Lacrimazione



Journal of Pediatric Gastroenterology and Nutrition
46:S81–S184 © 2008 by European Society for Pediatric Gastroenterology, Hepatology, and Nutrition and
North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition

European Society for Paediatric Gastroenterology, Hepatology,
and Nutrition/European Society for Paediatric Infectious Diseases
Evidence-based Guidelines for the Management of Acute
Gastroenteritis in Children in Europe

- The best measure of dehydration is the **percentage loss of body weight** (Vb, D).
- Classification into subgroups with no or minimal dehydration, mild or moderate dehydration, and severe dehydration is an essential basis for appropriate treatment (I, A).



Journal of Pediatric Gastroenterology and Nutrition
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North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition

European Society for Paediatric Gastroenterology, Hepatology, and Nutrition/European Society for Paediatric Infectious Diseases Evidence-based Guidelines for the Management of Acute Gastroenteritis in Children in Europe

- The best 3 individual signs for assessment of dehydration are (IIC):
 - **Prolonged Capillary refill time**
 - **Abnormal skin turgor**
 - **Abnormal respiratory pattern**



Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

- “Use an isotonic crystalloid solution (eg, lactated Ringer’s solution or normal saline) as the initial fluid for the treatment of shock (IA). There is no added benefit in using colloid (eg, albumin) during the early phase of resuscitation”.

- 20mL/kg in 20’

- Reinfondere (max 1L) o 40% ECF

- Ripristino volemia

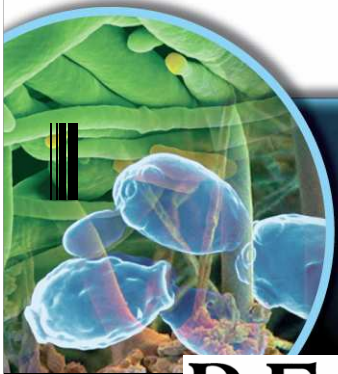
- FC, PA, refill, reattività e diuresi

- Segni di overload

Kleinman M, Circulation ,2010;122;S876-S908

Finfer S, N Engl J Med. 2004;350:2247–2256

AAVV BMJ. 1998;317:235–240.



Idratazione orale

PEDIATRICS®

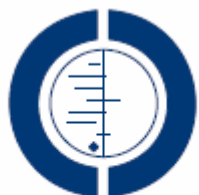
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

TABLE 2. Successful Rehydration at 4 Hours, Including Individual Components of Successful Rehydration

Variable	ORT	IVF	Difference (95% CI)*
Successful rehydration	55.6% (20/36)	56.8% (21/37)	-1.2% (-24.0% to 21.6%)
Resolution of moderate dehydration (score <2)	90.6% (29/32)	82.9% (29/35)	7.8% (-8.3% to 23.8%)
Production of urine	88.2% (30/34)	85.7% (30/35)	2.5% (-13.3% to 18.4%)
Weight gain	82.8% (24/29)	100% (31/31)	-17.2% (-31.0 to -3.5%)
Absence of severe emesis (<5 mL/kg)	100% (33/33)	100% (33/33)	0%

TABLE 3. Secondary Outcome Measures

Variable	ORT (n = 36)	IVF (n = 37)	Difference (95% CI)*
Mean time to initiate therapy, min†	19.9 + 13.4 (n = 35)	41.2 + 29.4 (n = 35)	21.2 (10.3 to 32.1)
Improved dehydration score at 2 h	78.8% (26/33)	80% (28/35)	-1.2% (-20.5% to 18%)
Hospitalization rate (24-h observation unit)	30.6% (11/36)	48.7% (18/37)	-18.1% (-40.1% to 4.0%)
Parental preference for same therapy next time	61.3% (19/31)	51.4% (18/35)	9.9% (-14 to 33.7)
72-h ED revisits‡	9.1% (3/33)	8.3% (3/36)	0.8% (-12.6% to 14.1%)



THE COCHRANE
COLLABORATION®

Oral versus intravenous rehydration for treating dehydration due to gastroenteritis in children (Review)

Hartling L, Bellemare S, Wiebe N, Russell KF, Klassen TP, Craig WR

reported for the ORT group (WMD -1.20 days, 95% CI -2.38 to -0.02 days; 526 participants, 6 trials). Phlebitis occurred more often in the IVT group (NNT 50, 95% CI 25 to 100) and paralytic ileus more often in the ORT group (NNT 33, 95% CI 20 to 100, fixed-effect model), but there was no significant difference between ORT using the low osmolarity solutions recommended by the World Health Organization and IVT (729 participants, 6 trials).

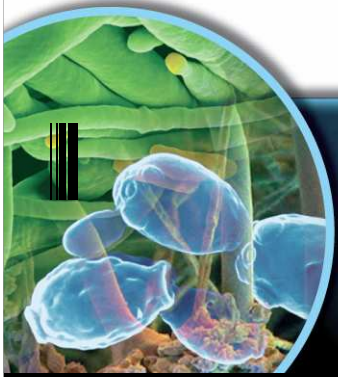


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European Society for Paediatric Gastroenterology, Hepatology,
 and Nutrition/European Society for Paediatric Infectious Diseases
 Evidence-based Guidelines for the Management of Acute
 Gastroenteritis in Children in Europe

Reidratazione orale raccomandata (IA)

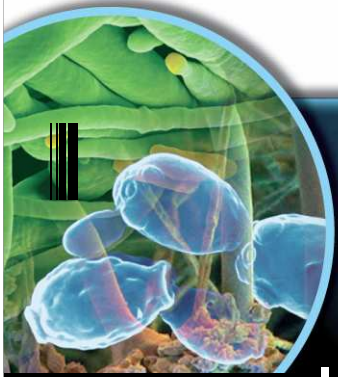
Grado	Lieve	Moderata	Severa
Paziente stabile	OS		EV
Assunzione Liquidi inappropriata	OS/SNG		EV
Complicanze	Ipernatremia/iponatremia severa, compromissione SNC		



Esami di laboratorio?

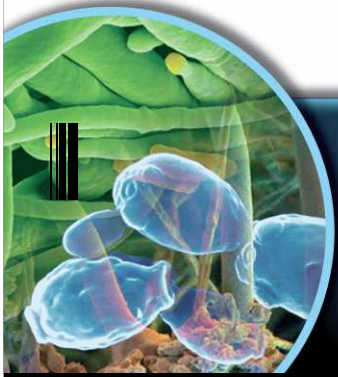
- Disidratazione severa
- Sintomatologia neurologica
- Terapia EV

- Laboratorio
 - NaHCO_3
 - CO_2
 - BUN
 - Na/K
 - Ht
 - PS Urinario



Tipi di disidratazione

- Iponatremica
- Normonatremica
- Ipernatremica



Reidratazione EV in 24 ore per $130 < Na < 150$

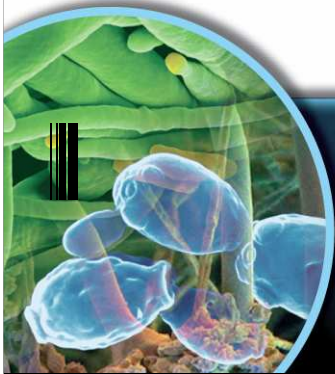
- Bolo iniziale (20ml/kg)
- Mantenimento /24h
- Reintegro perdite

Bambino 15 kg e peso attuale 13.5 kg
Disidratazione severa (-1.5Kg) = 10 %
Sottrarre bolo iniziale di 300 mL

$$\frac{1500\text{mL} + 1250\text{mL} - 300\text{mL}}{24\text{h}}$$

$$\frac{2450\text{mL}}{24\text{h}}$$

$$100\text{mL/h}$$



Quali Fluidi?

Table 1 Constituent formulation of intravenous and oral solutions

Solution	Osmolality, mOsm/l	Glucose, mmol/l	Na, mEq/l	Cl, mEq/l	HCO ₃ , mEq/l	K, mEq/l
Intravenous solutions						
Ringer's	280	–	130	110	25	4
0.9% saline	308	–	154	154	–	–
D ₅ 0.45% saline	454	300	77	77	–	–
D ₅ 0.22% saline	377	300	38	38	–	–
Darrow's	–	–	122	104	53	35
Butler's	456	300	46	40	20	35
Oral solution						
WHO-ORS	330	110	90	80	30	20
Low-Na ORS	270	110	60	50	30	20
Pedialyte	270	140	45	35	30	20

ORS, oral rehydration solution; WHO, World Health Organization.



Hyperchloraemic acidosis in patients given rapid isotonic saline infusions

Michael Eisenhut

Arch Dis Child 2007 92: 560

SF o glucosalina?



(0,9% NaCl =154mEq/L

PEDIATRICS®

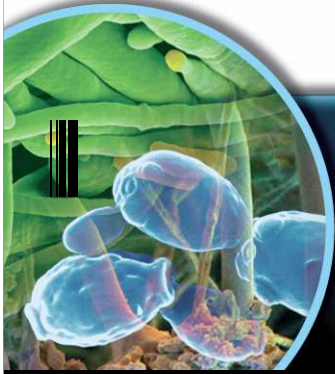
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Livelli elevati di ADH

Acute Hyponatremia Related to Intravenous Fluid Administration in Hospitalized Children: An Observational Study
Ewout J. Hoom, Denis Geary, Maryanne Robb, Mitchell L. Halperin and Desmond Bohn
Pediatrics 2004;113:1279-1284



SG5% + NaCl 40-48mEq/L



Disidratazione normo- iponatremica

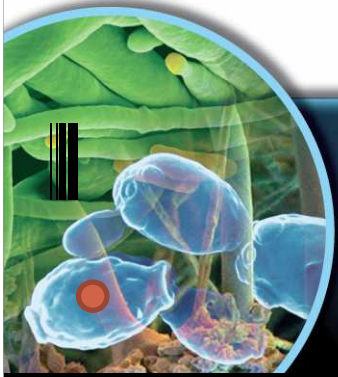
REVIEW

Fluid therapy for children: facts, fashions and questions

Malcolm A Holliday, Patricio E Ray, Aaron L Friedman

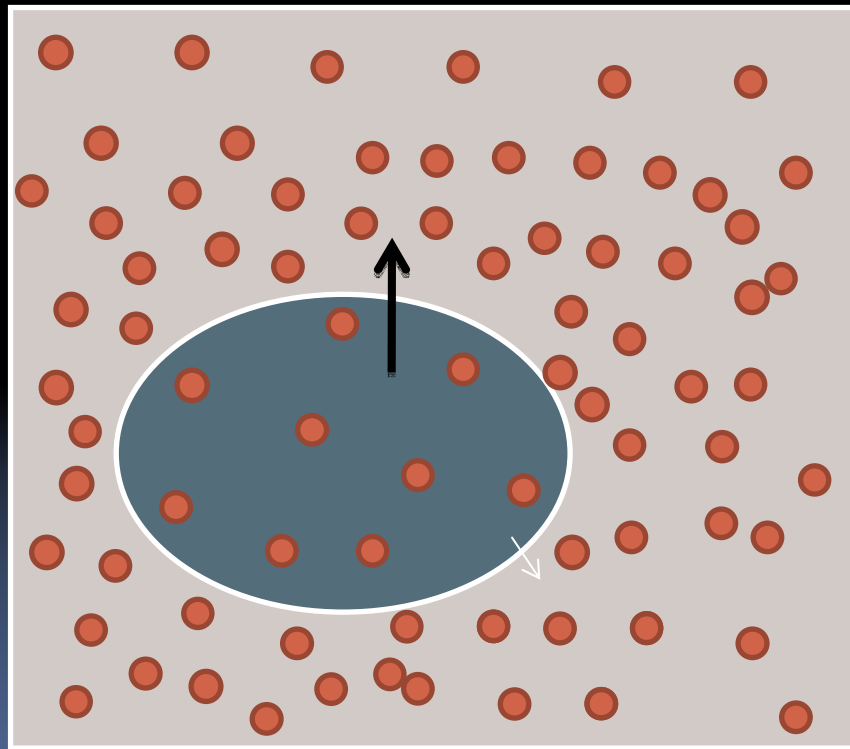
Arch Dis Child 2007;**92**:546–550. doi: 10.1136/adc.2006.106377

- Velocità di reidratazione : 4-6h
- Polielettrolitica Bilanciata (SER)
- con Na 80-130mEq/L e tamponata (bicarbonato, lattato o acetato)

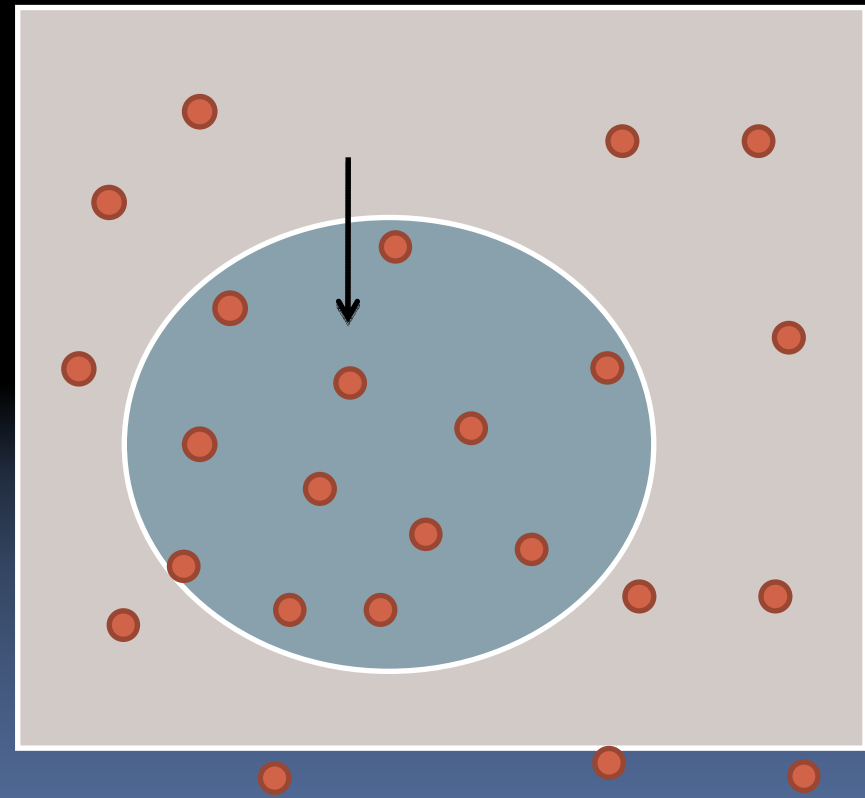


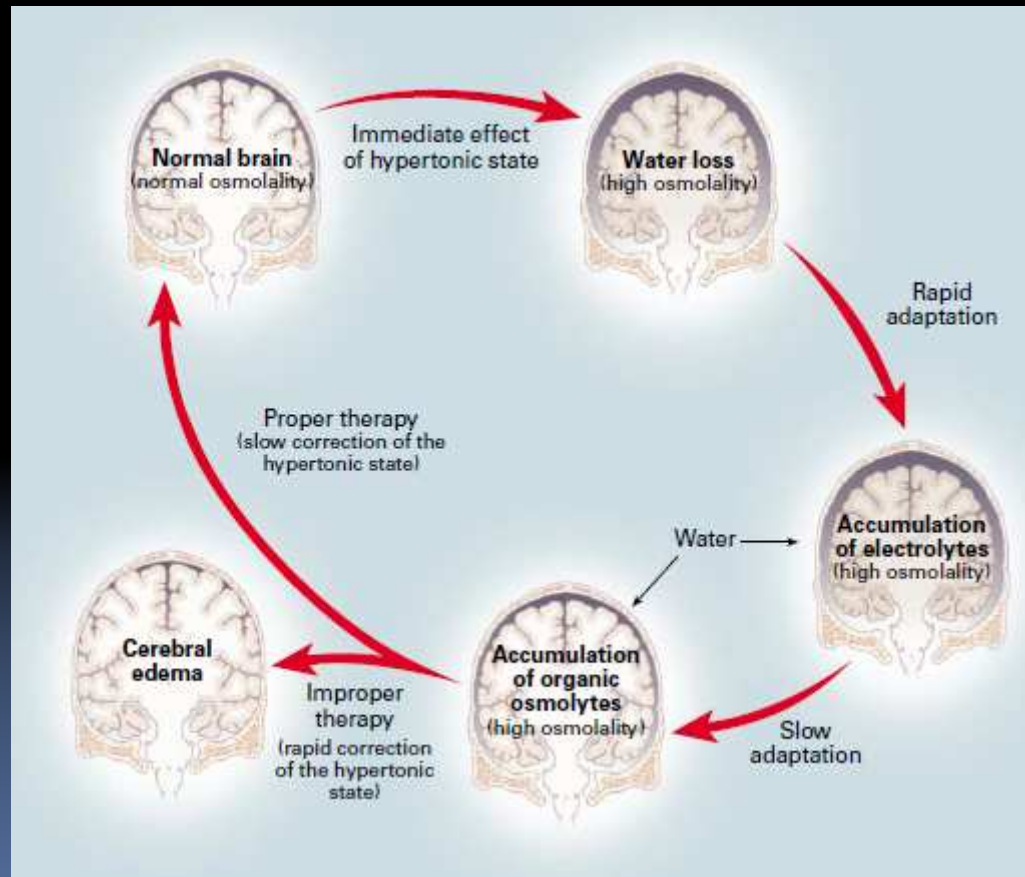
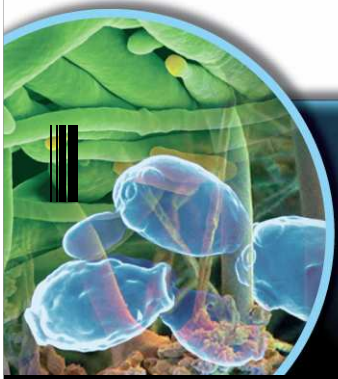
Attenzione al $[\text{Na}^+]$

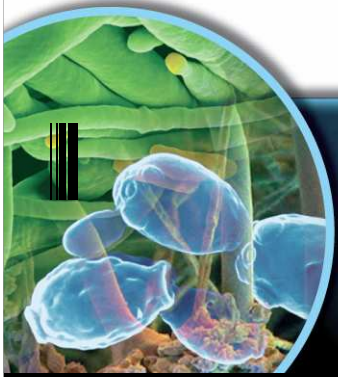
$\text{Na}^+ > 150\text{mEq/L}$



$\text{Na}^+ < 130\text{mEq/L}$

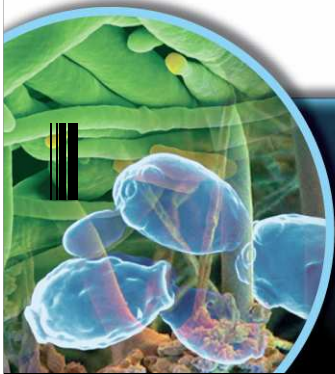






Correzione della'ipo-ipernatremia

- **Velocità max= 0,5 mEq/L/hr
= 12 mEq/L/die**
- Aggiunta di NaCl 3% in infusione
- Aggiunta di acqua libera



Stima della correzione

Deficit di acqua Libera:

$$\text{Total H}_2\text{O deficit (L)} = \left[\frac{\text{Na}^+ \text{ misurato}}{\text{Na}^+ \text{ dsiderato}} \times (\text{TBW}) \right] - \text{TBW}$$

TBW= Total Body Water

www.medcalc.com

Entità della Correzione (Adroque Madias) per sapere di quanto varia la natremia in seguito all'infusione di un volume x di fluido

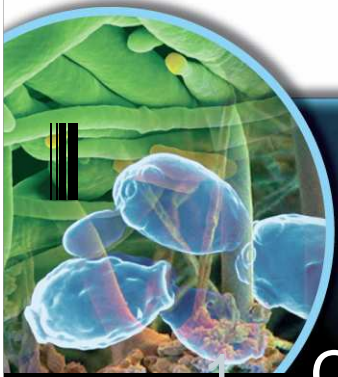
$$\frac{[\text{Na}_{\text{fluido}} - \text{Na}_{\text{Plasma}}] \text{ volume Fluido}}{\text{TBW} + \text{Volume fluido}}$$

Es : Bolo da 500 in b di 10 kg con Na=165mEq/L (TBW=7L)

$(0-165) \times 0.5 / 7L + 0.5L = 11\text{mEq/L}$ se SG5%

$(77-165) \times 0.5 / 7L + 0.5L = 5.8\text{mEq/L}$ se SG5/0.45% NaCl o ½ NS

$(154-165) \times 0.5 / 7L + 0.5L = 0.7\text{mEq/L}$ se SF



Correzione

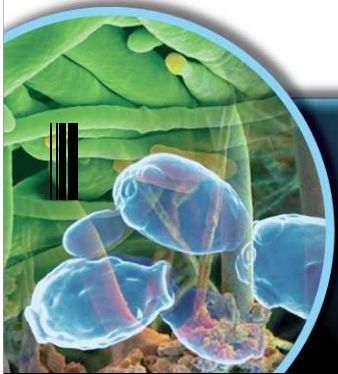
1. Calcolare il deficit di acqua libera da sommare alla fluido di mantenimento per riportare il $[Na^+]$ al valore desiderato (e incluso nel calcolo del deficit)

$$\text{Total H}_2\text{O deficit (L)} = \text{total body water} \times \left(1 - \frac{\text{desired Na}^+}{\text{serum Na}^+} \right)$$

2. Calcolare il tempo in cui effettuare la correzione

$$\text{Time of infusion (hr)} = \frac{\text{serum Na}^+ - \text{desired Na}^+}{0.5}$$

3. Sommare il volume di acqua libera (SG 5%) da infondere al mantenimento necessario per le ore calcolate
4. Dividere il volume totale per le ore calcolate



Es. B. 7Kg
=165mEq/L

deficit= 10%

Na⁺ misurato

Na⁺ desiderato =145mEq/L

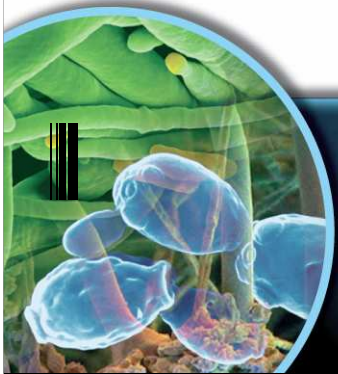
1. Calcolo del deficit di liquidi tot e FW

1. Tempo in cui effettuare la correzione
2. Sommare il volume di acqua libera (SG 5%) da infondere al mantenimento necessario per le ore calcolate
3. Dividere il volume totale per le ore calcolate

- 700 mL di deficit
- 580 mL di FW
- 120 NS o S

- 20mEq/0.5 = 40 ore
- (preferiamo 48 ore)

- 7000mL/die x 2= 1400 mL
- 1400ml +700 ml=2100 ml
-
- 2100/48 = 43,75mL/h



Doppia fluidoterapia

0.45%NaCl
o SER

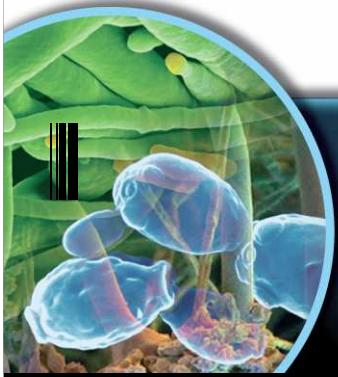
700 ml +
120=
820ml/24h



SG5%

580mL/48h
Vel= 12 cc/h

Controlla natremia ogni 2-4h!!



everything will be okay
in the end.

if it's not okay,
it's not the end.

(unknown)