Electrolyte emergencies

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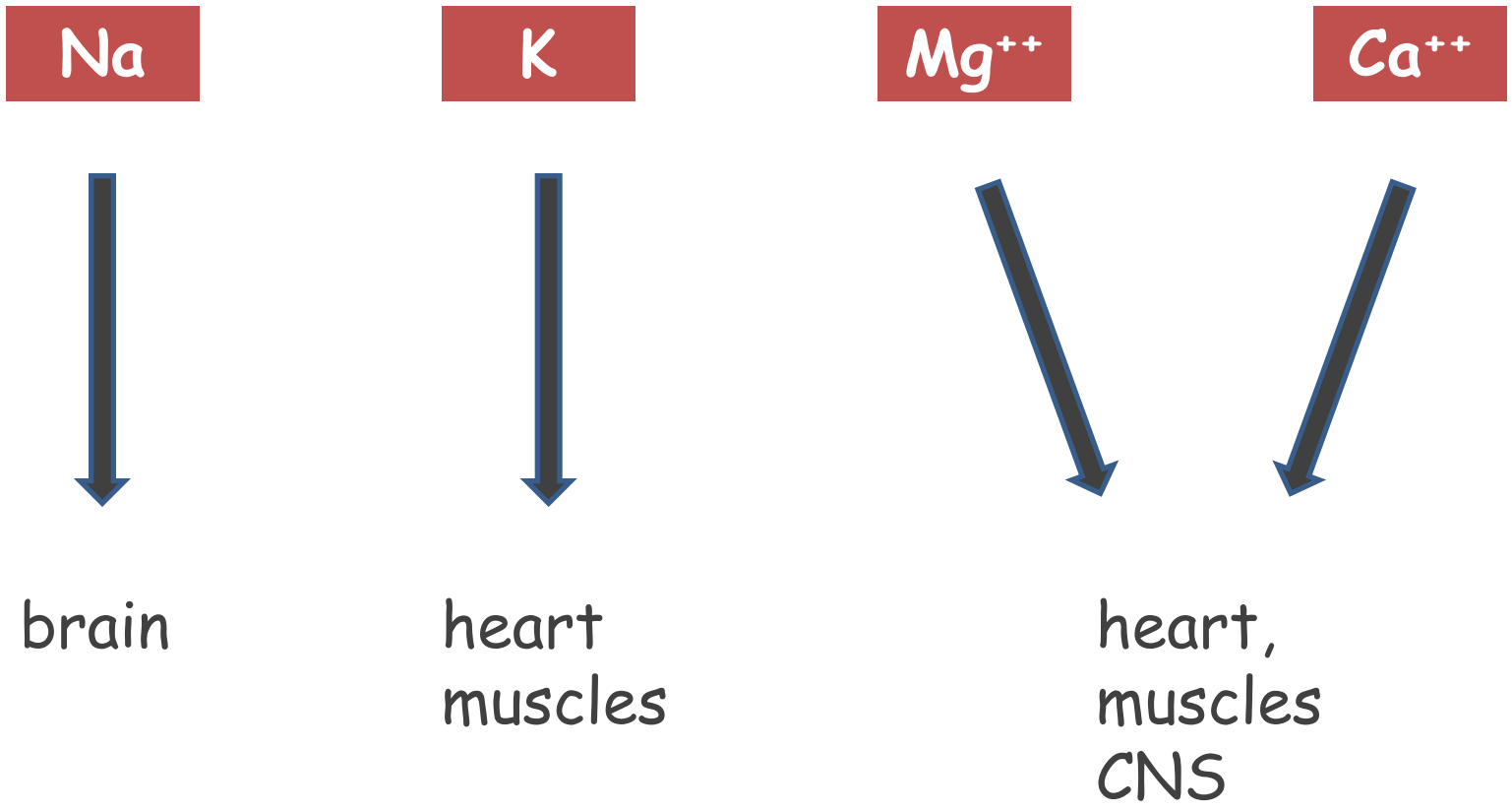
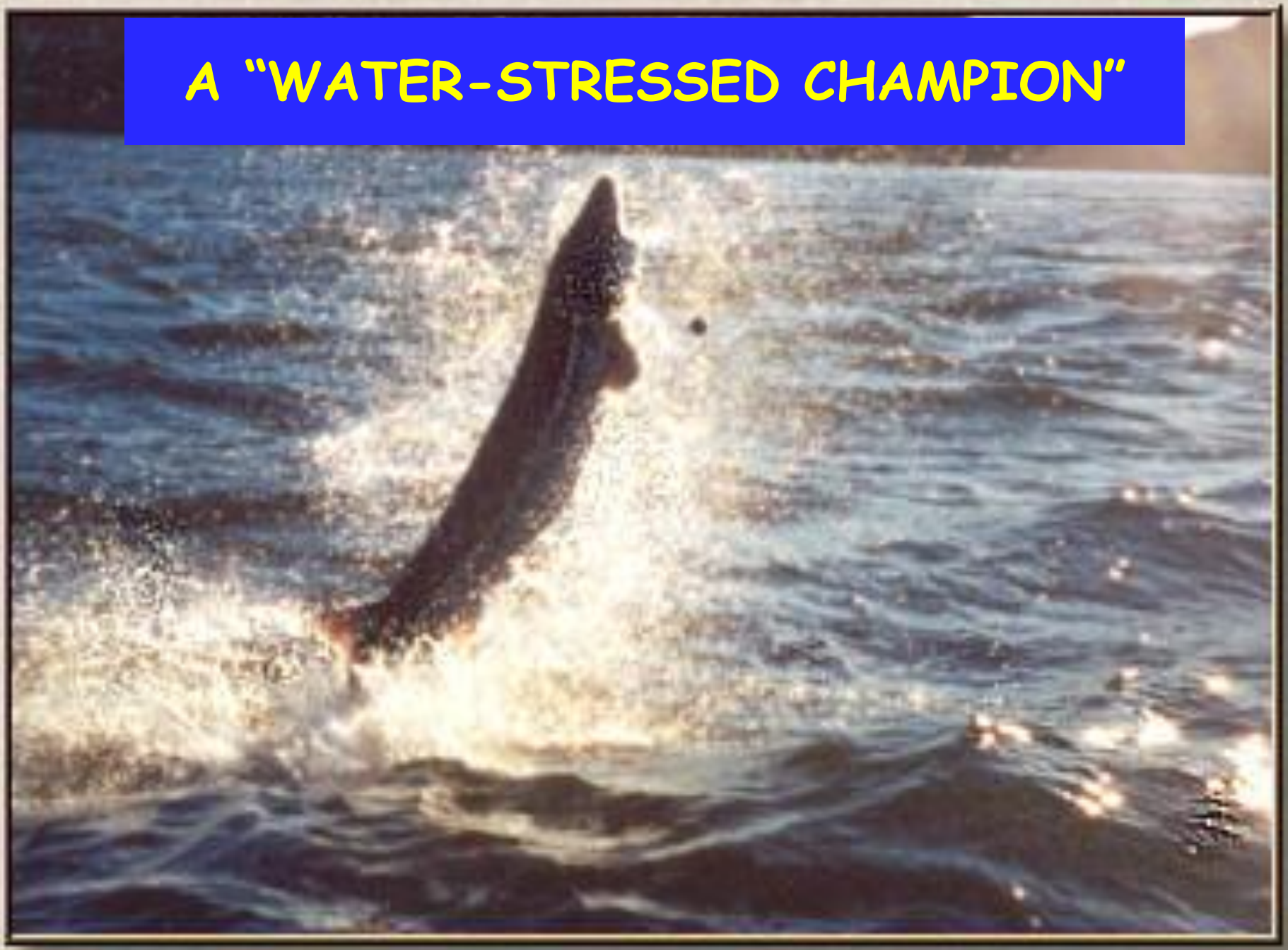
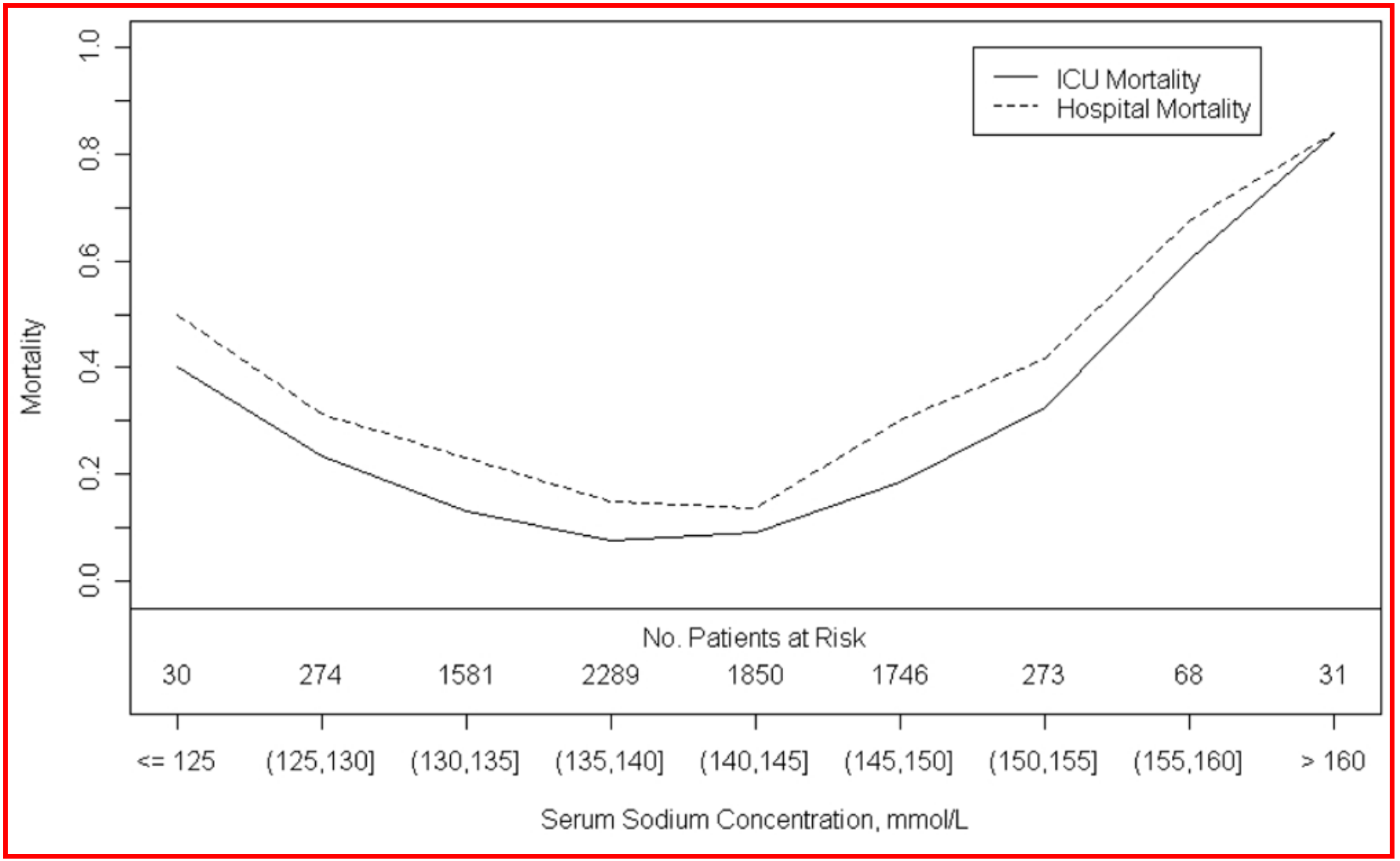
OUTLINE



A "WATER-STRESSED CHAMPION"



Mortality and Dysnatremias



Critical Care 2008, 12:R162

CELL VOLUME REGULATION

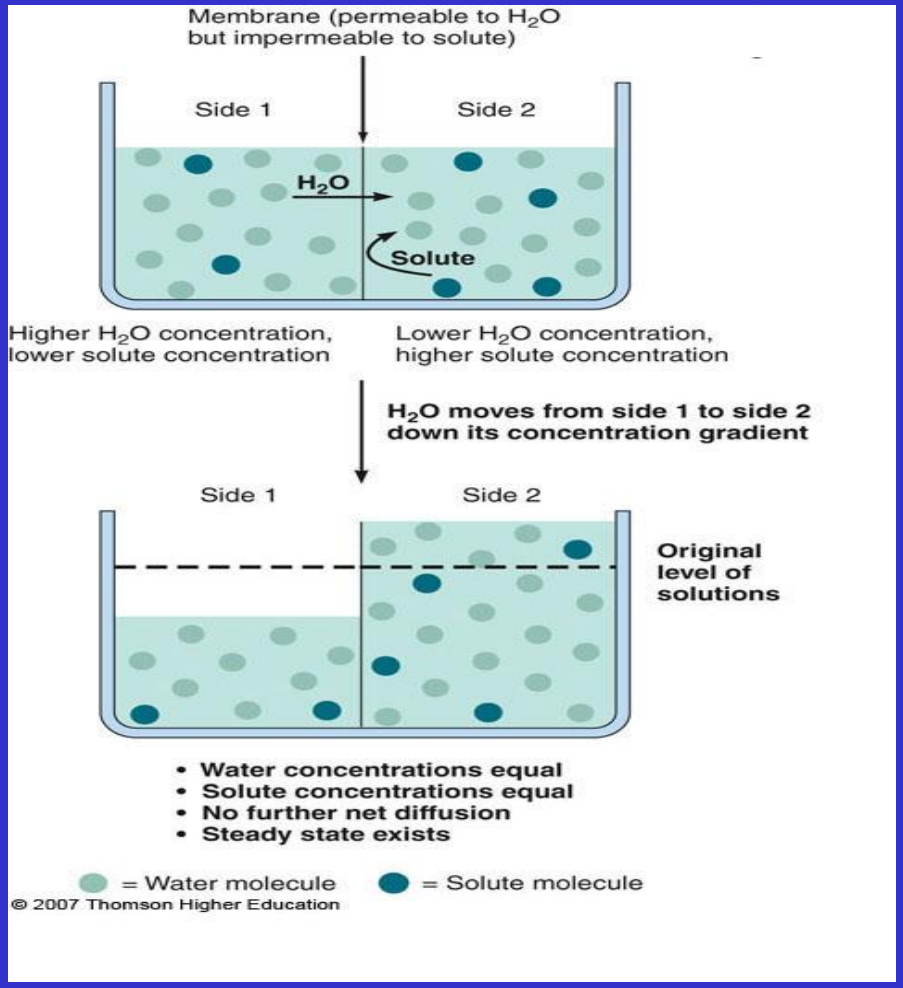
“ The Na pump spends energy from ATP hydrolysis……..”

…. ATP DEPLETION = SICK CELL ?

MORE ATTENTION FOR TONICITY

- TONICITY IS EFFECTIVE OSMOLALITY
- Δ 1 mOsm/kg = Δ 19.3 mmHg (Hydrostatic pressure)

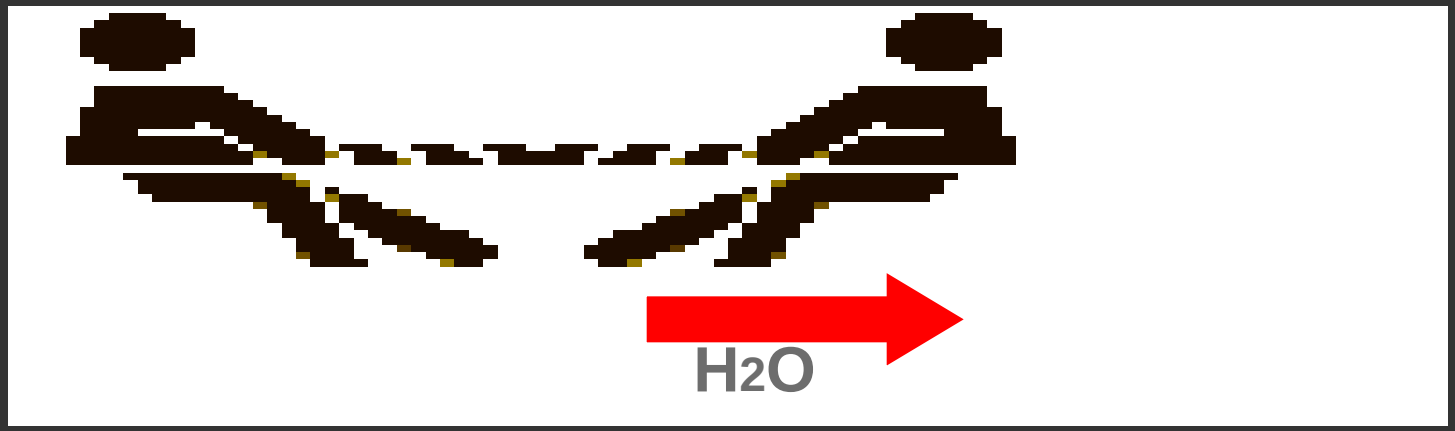
DONNAN EQUILIBRIUM

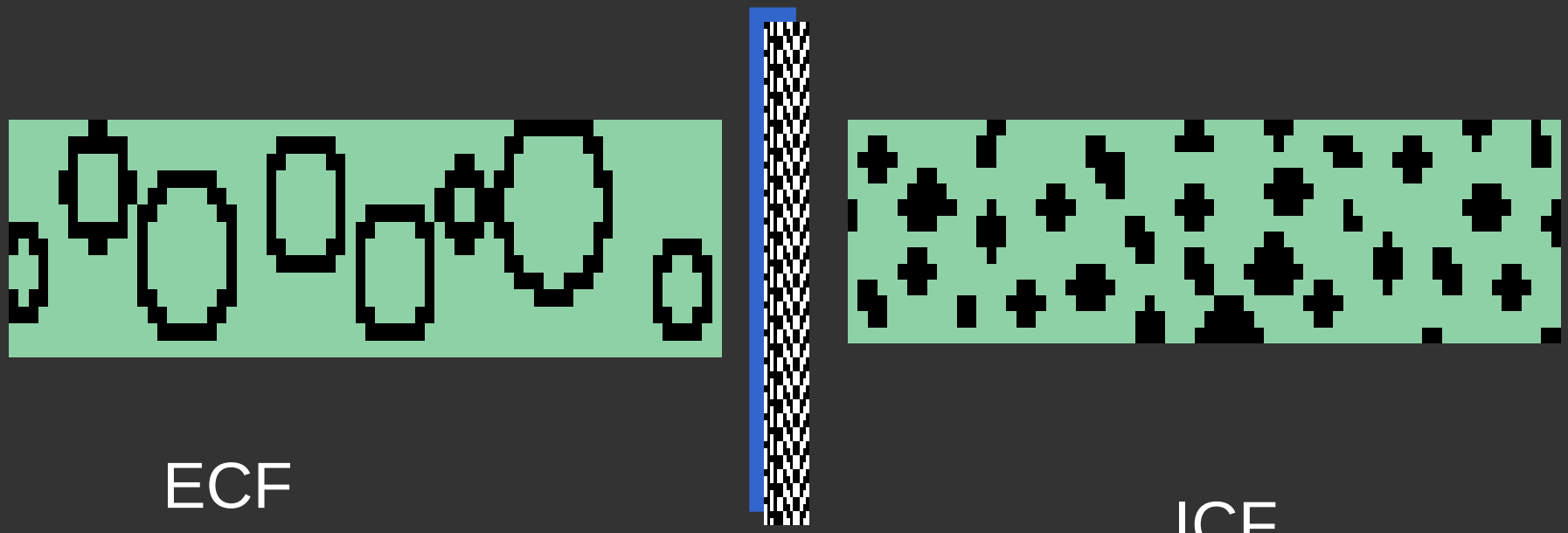


CAUSES OF DYSOSMOLALITY

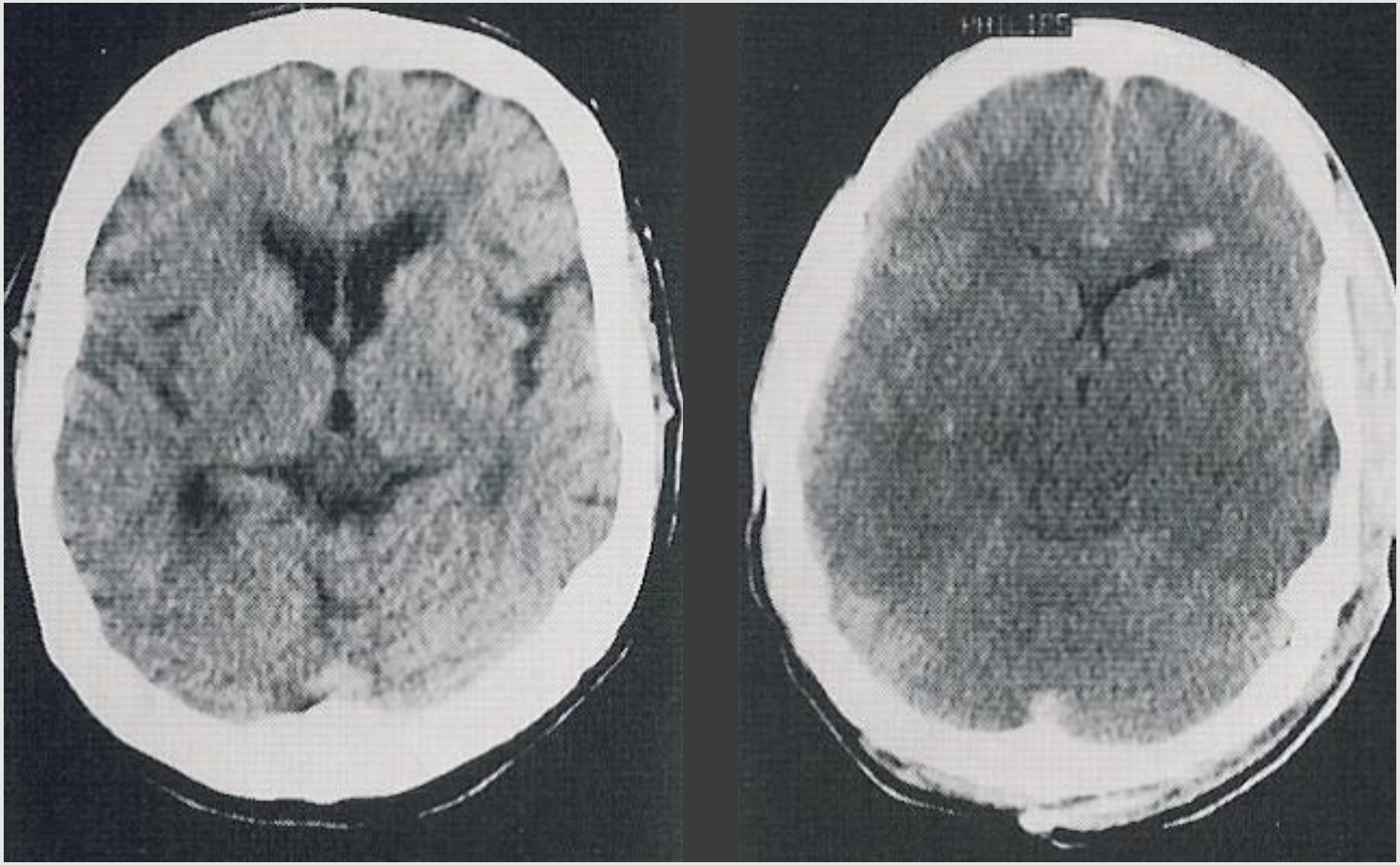
YOUNG	OLD
• HEAD TRAUMA	• STROKE
• NEUROSURGERY	• DM
• DI	• NEOPLASMS
• DM	• ART NUTR
• "DOCTORS"	• "DOCTORS"

HYPONATREMIA



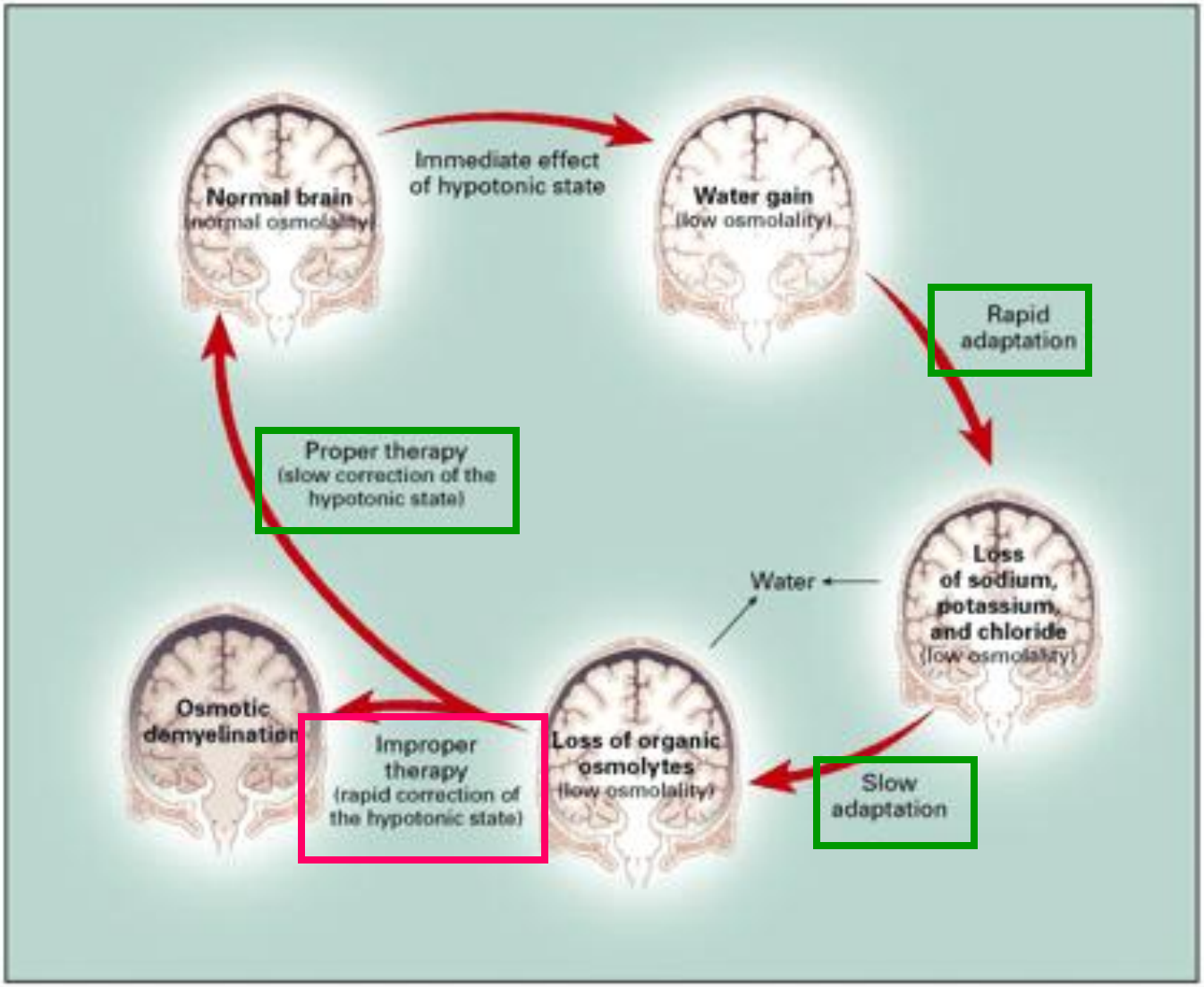


Acute Hyponatremia Can Cause Death From Cerebral Edema and Brain Herniation



Normal Brain

Hyponatremic Brain



H J ADROGUE' N E MAD IAS (2000)
NEJM 342,21:1581-9

…..Real Emergency in ED

1) W 40 Y; 60 bw, symptomatic, hypotensive, Na 116

122-**116** = 6 x (0.5 x 60 x 0.33) = 60 mEq/ 4H

HS 3% = 513 mEq/L

60 mEq = 116 ml= 30 ml/H x 4H…..

Plus Colloids 750 ml

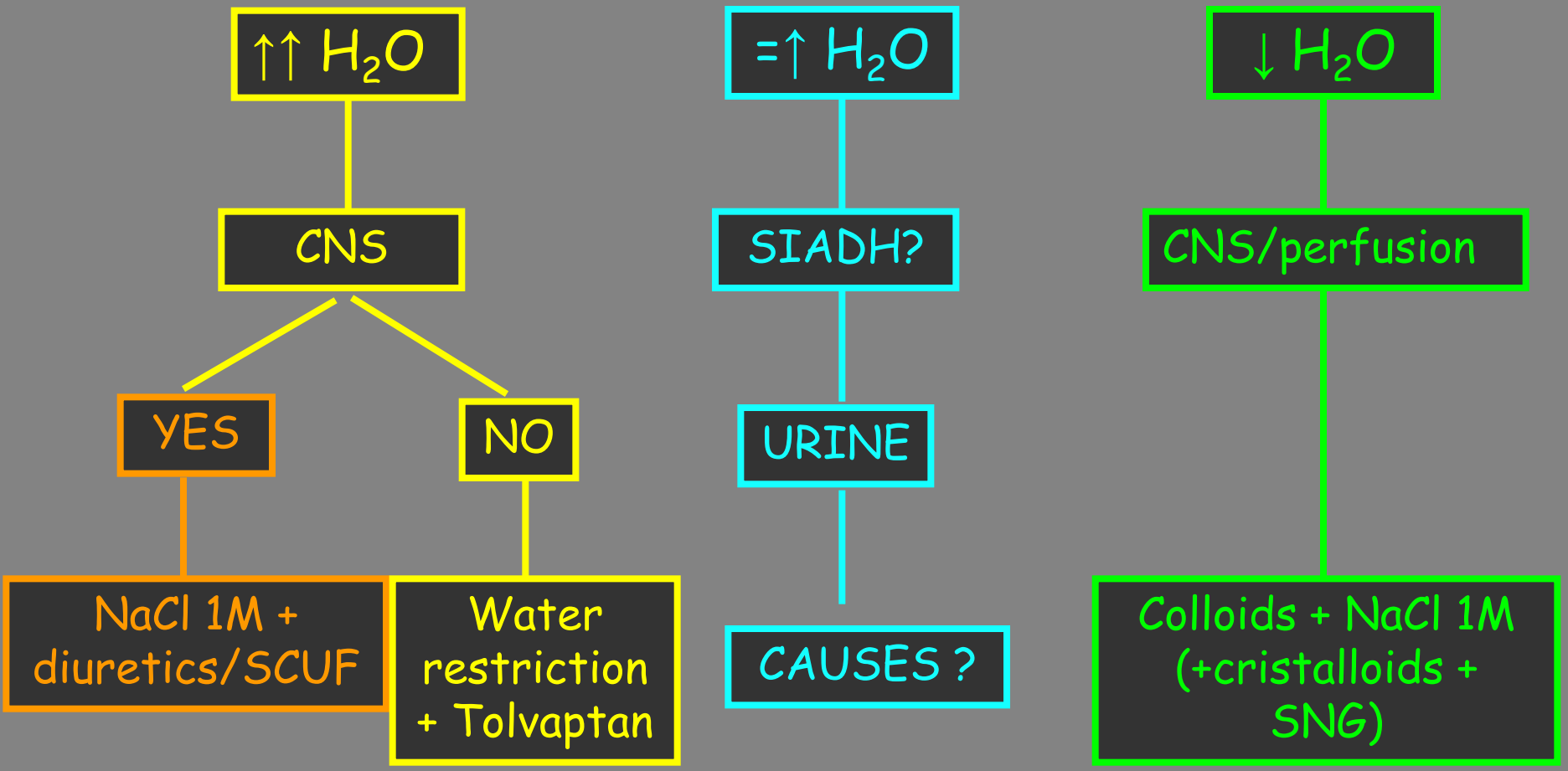
2) W 40 Y; 60 bw, symptomatic, edematous, Na 116

P_{osm} = (**116** x 2) + (108/18) = 238

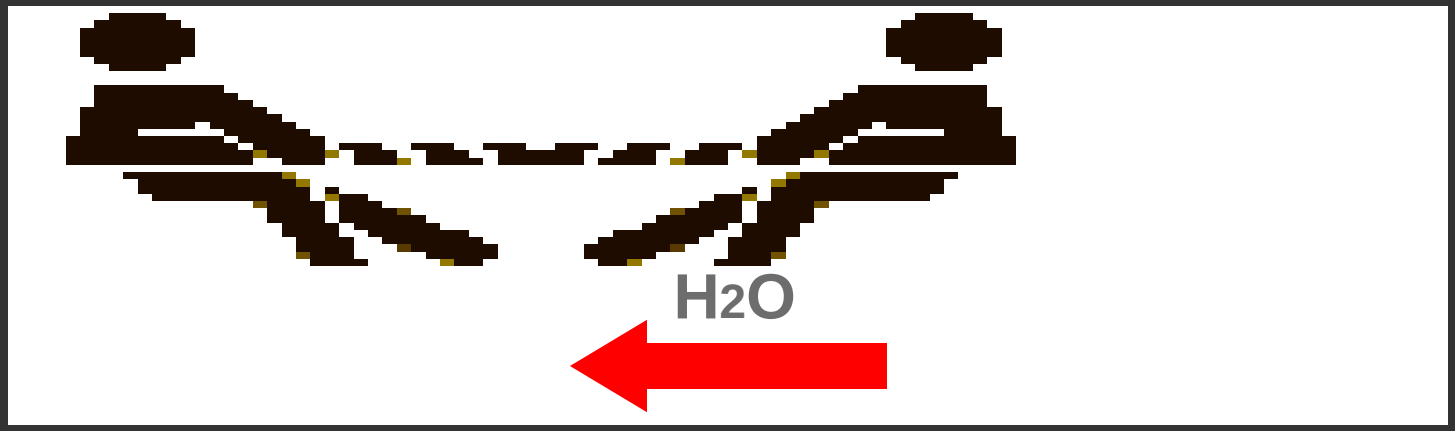
$$\text{Water Excess} = 30 \times \frac{285 - 238}{238} = 6\ \text{L}$$

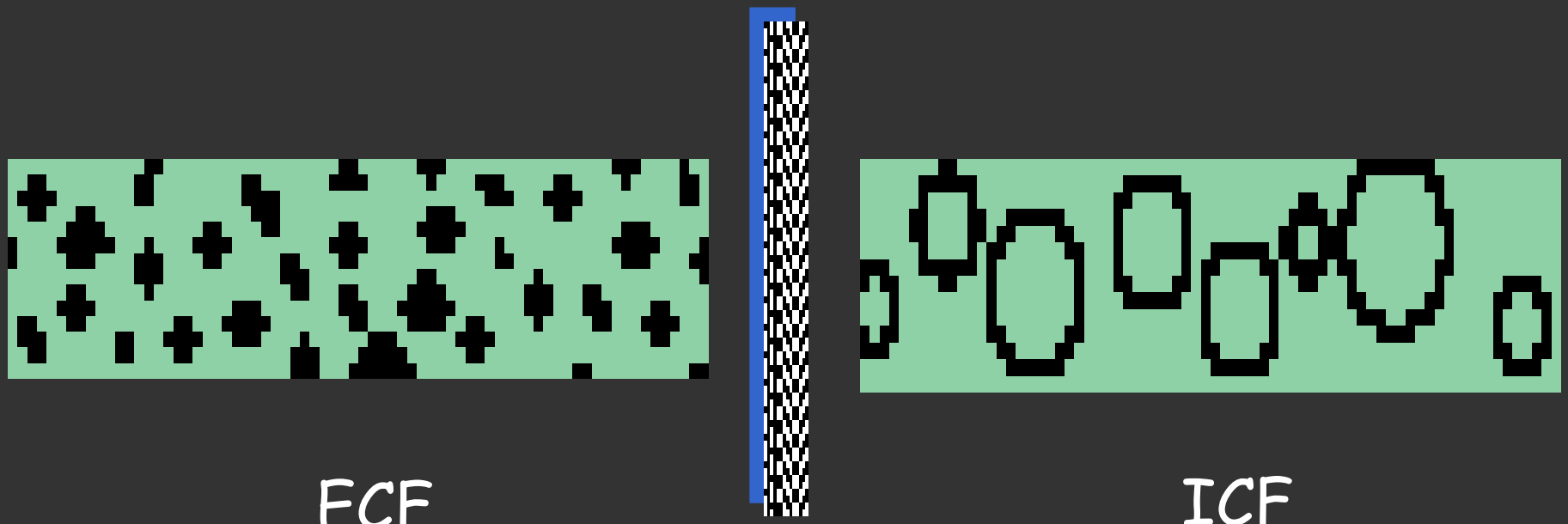

2008 3 12

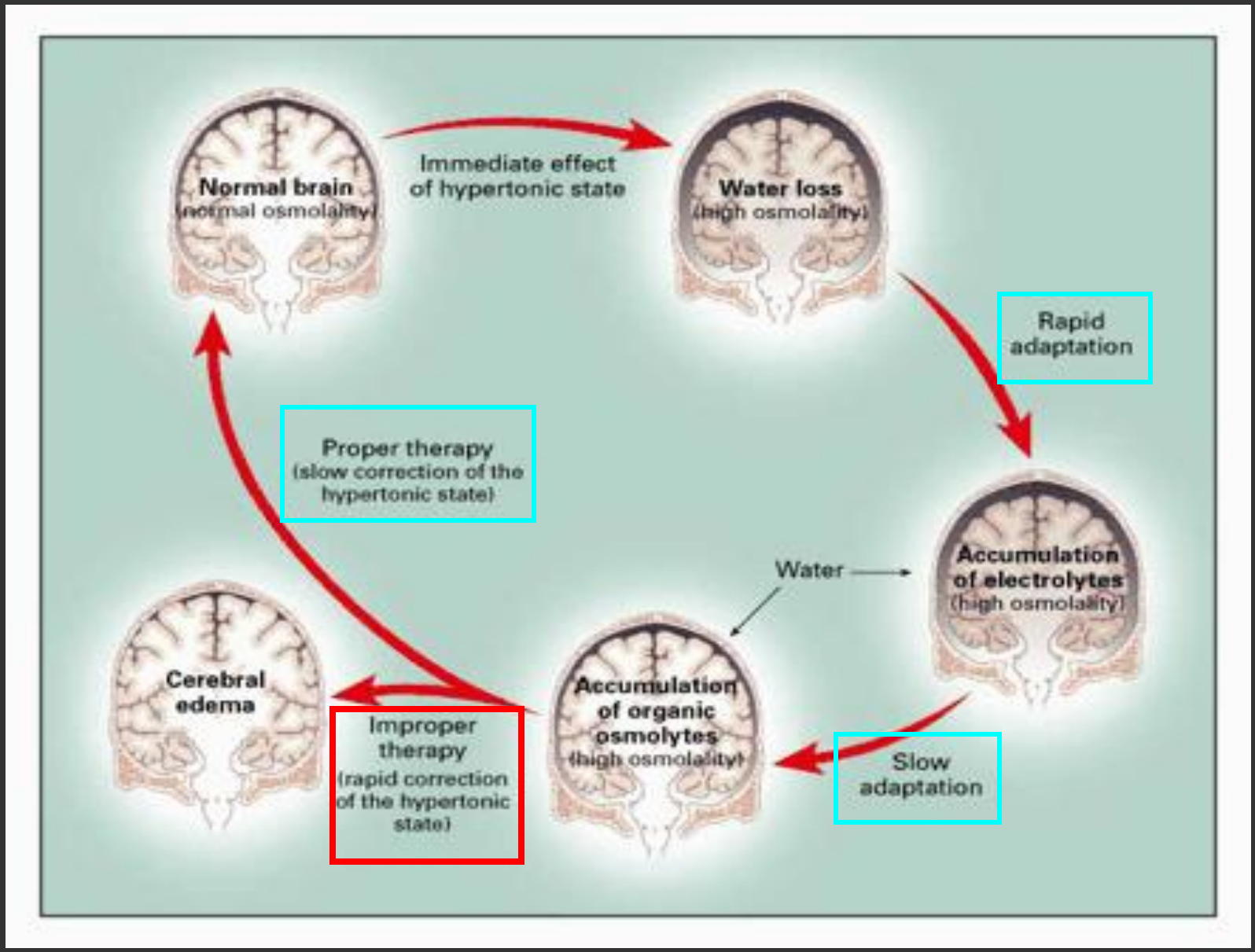
HYPONATREMIA



HYPERNATREMIA







H.Adroguè, N.Madias NEJM 2000; 342: 1493-99

HOW TO CORRECT HYPERNATREMIAS

↓ perfusion ⟶ colloids + NS or 1/2N

= perfusion ⟶ NaCl + water

Cerebral impairment ⟶ *Two steps*

HYPERKALEMIA IN ICU

I → E SHIFT

- acidosis
- ↓ Insulin
- hyperosmolarity
- massive citolysis

K overload

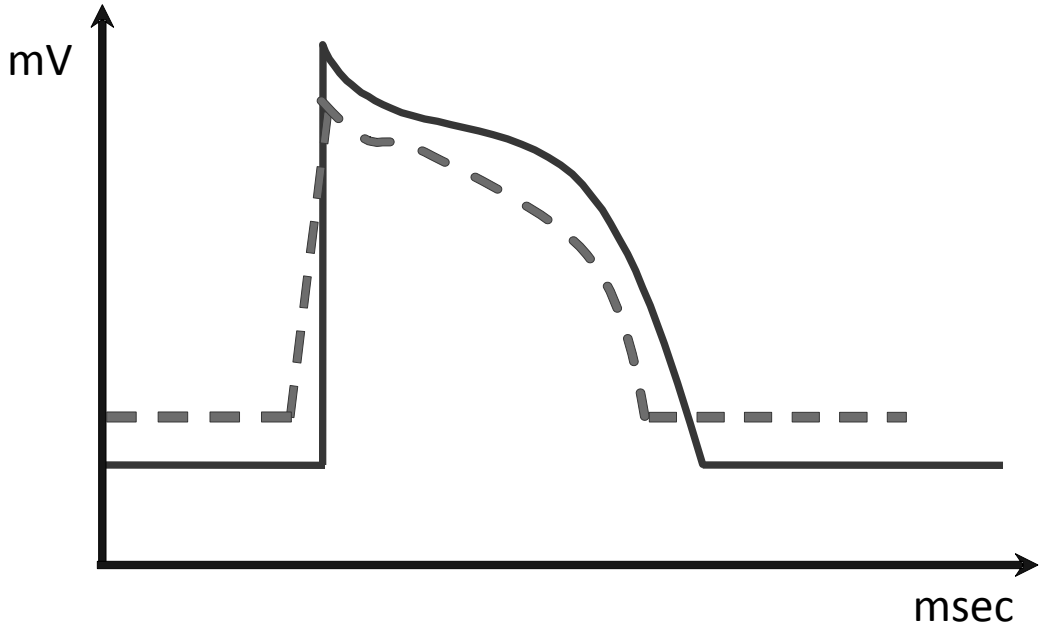
- renal failure
- adrenal insufficiency
- digoxin intoxication
- Hypoaldosteronism
- Drugs (ACE-I...K sparing diuretics)

The Nernst's law

$$E_m = 61.5 \times \log \frac{[K]_e}{[K]_i}$$

$$E_m = 61.5 \times \log \frac{7}{170} = -85 \text{ mV}$$

Iperkaliemia



↓ resting potential

↑ gK

↓ phase 0:

low QRS voltage

↓ conduction velocity:

large QRS
SA e AV blocks
small P wave
atrial paralisis

↓ phase 3 :

short QT
tall T wave
ST elevation

pH	7.472↑
pCO2	29.7↓
pO2	97.7
HCO3-att	21.2
HCO3-std	23.1
ctCO2	22.1
BE(B)	-1.7
BE(ecf)	-2.4

OSSIGENAZIONE 37°C

tHb	10.3↓
Hct	30
ctO2(a)	14.3↓
BO2	14.2↓
pO2	97.7
sO2	99.0↑
O2Hb	98.0↑
COHb	0.6
MetHb	0.4
HHb	1.0

ELETTROLITI

Na+	129.8↓
K+	9.27↑
Ca++	1.23
Ca++(pH 7.4)	1.27
Cl-	107↑
Gap Anionico	10.8

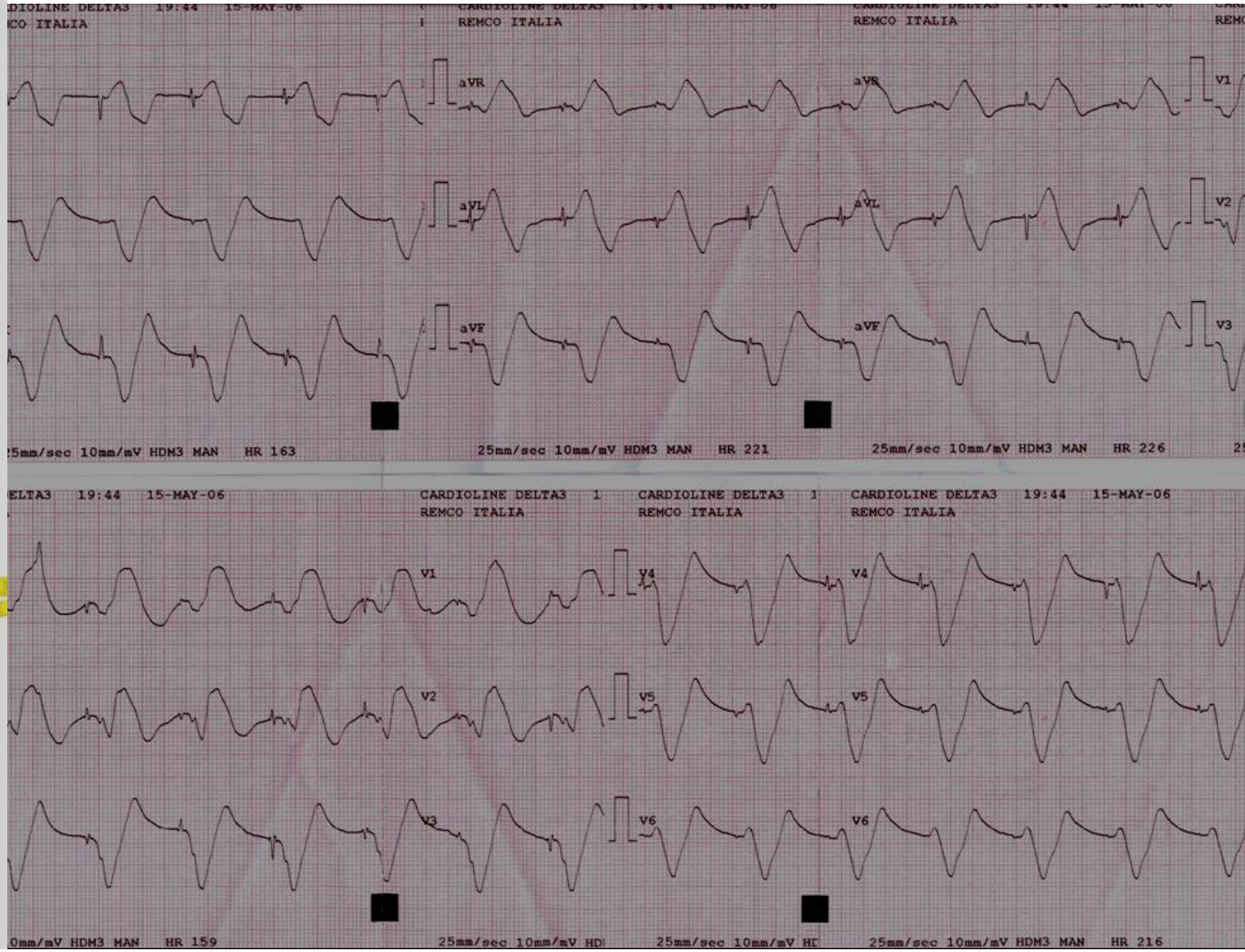
METABOLITI

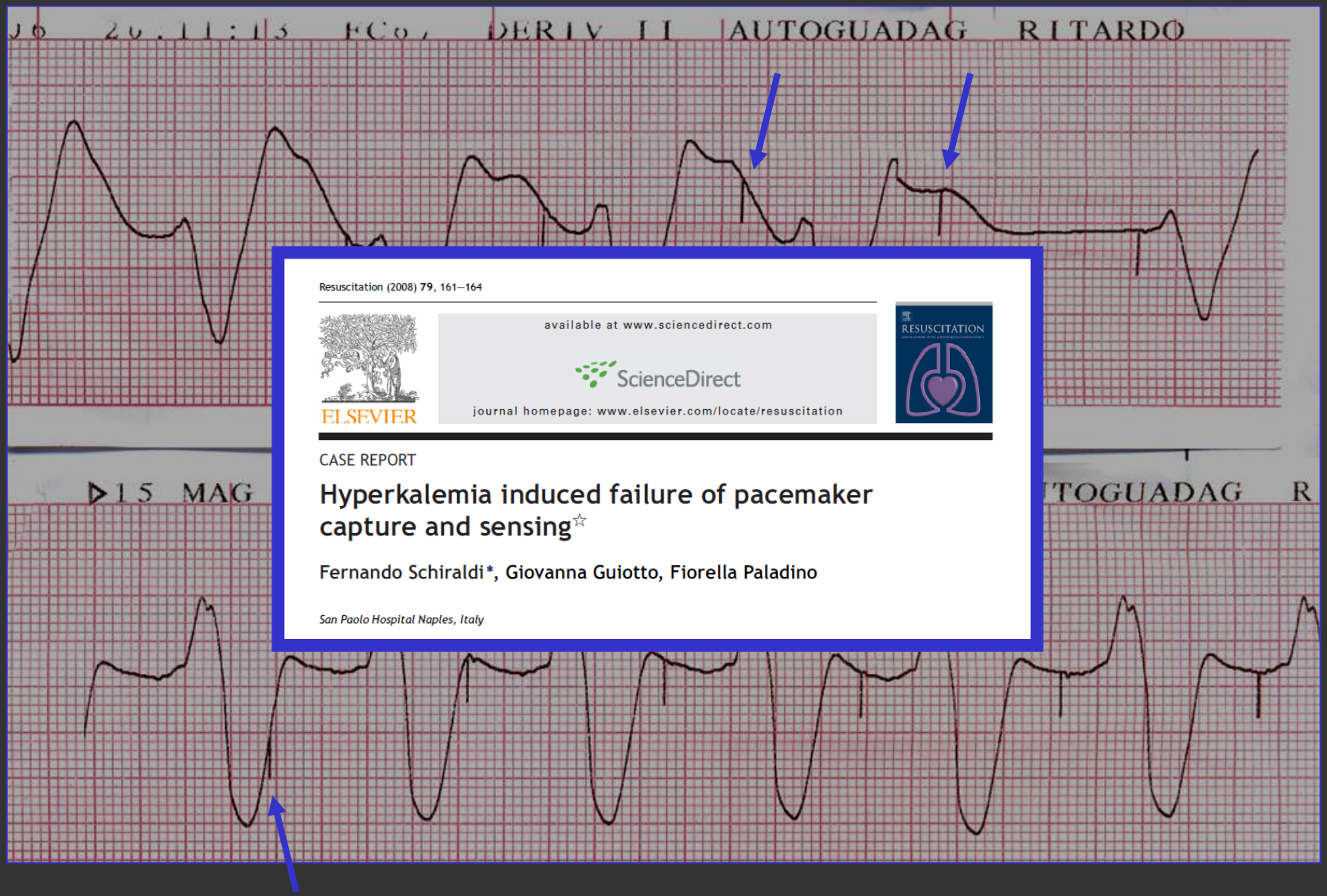
Glu	141↑
Lat	1.71

Rita, 75 y.
fatigue

Enalapril
Spironolattone

BP 100/60 HR 70
SpO_2 97% FiO_2 21%
RR 22





Resuscitation (2008) 79, 161–164

available at www.sciencedirect.com

ScienceDirect

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

ELSEVIER

RESUSCITATION

CASE REPORT

Hyperkalemia induced failure of pacemaker capture and sensing☆

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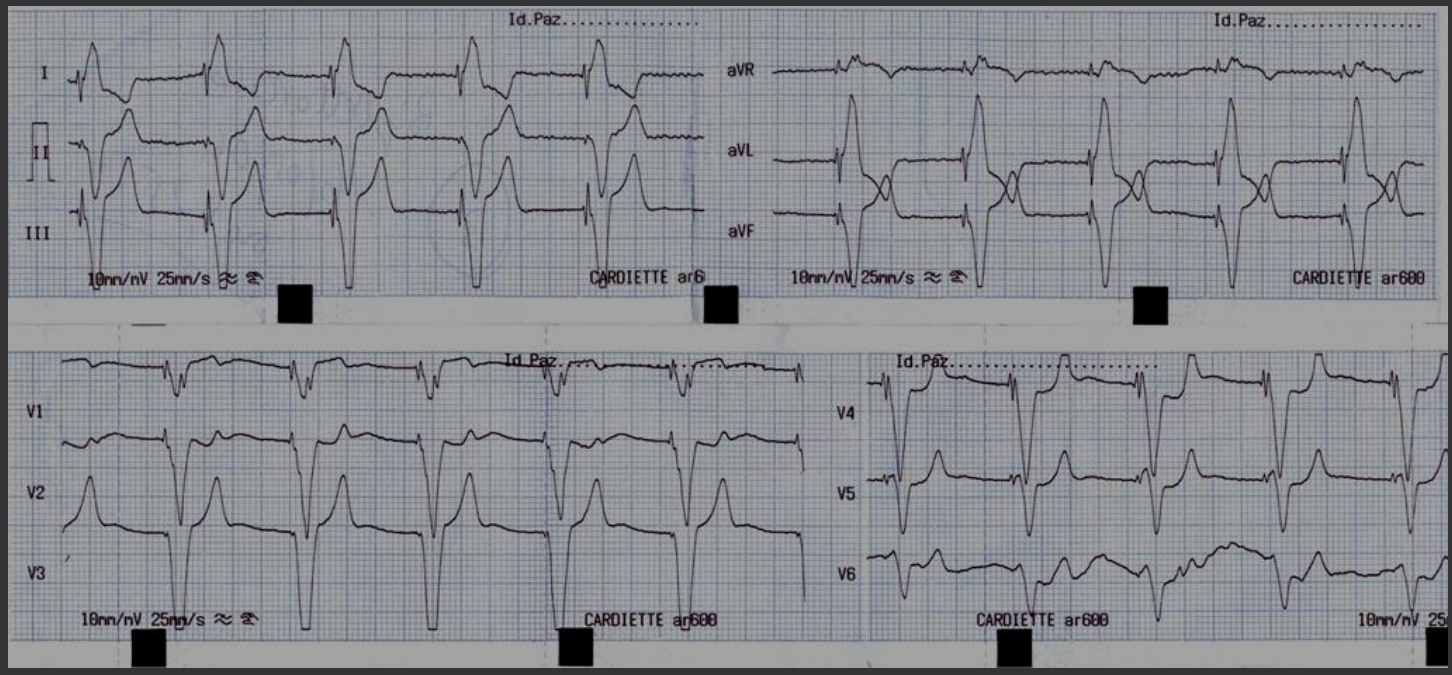
San Paolo Hospital Naples, Italy

K^+ = 8.2 mEq/L

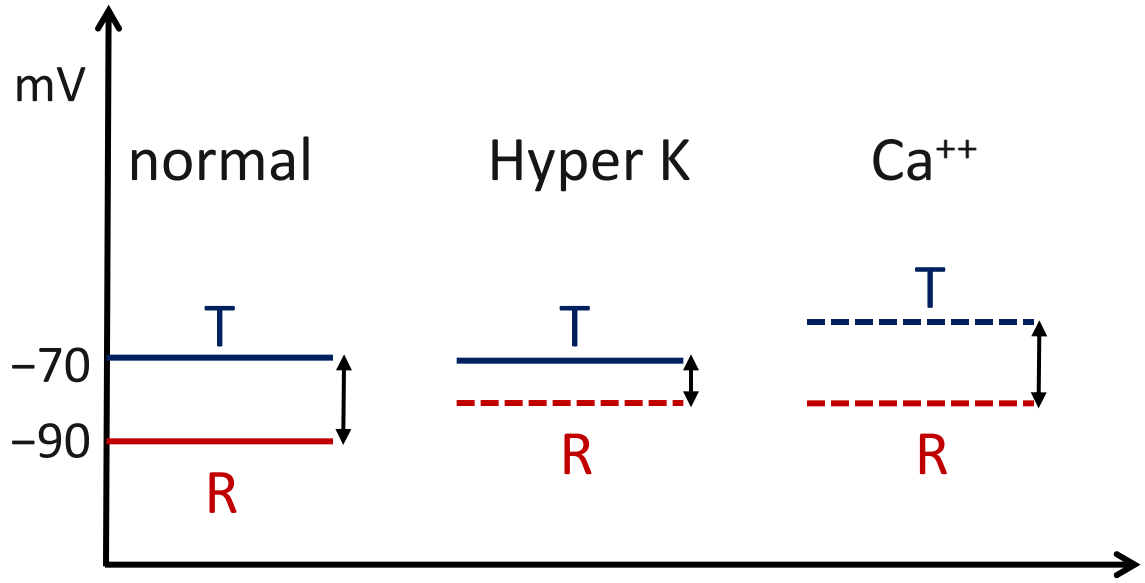
K^+ = 6.5 mEq/L



TIME SCHEDULED APPROACH TO HYPERKALEMIA

SUBSTANCE	TIME ONSET	LASTING
Calcium chloride	1-2 min	15-20 min
Sodium bicarbonate	10-15 min	60-120 min
Insulin + glucose	20-30 min	2-4 hours
β-agonists		

Electrical effects of Calcium



HYPOKALEMIA IN ICU

E → I SHIFT

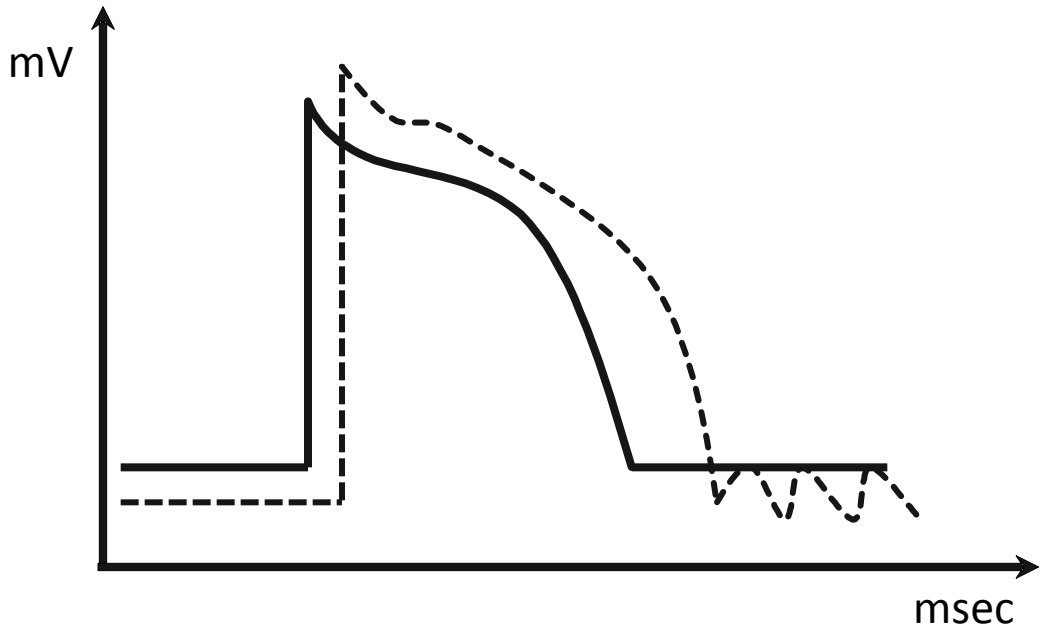
- alkalosis
- Insulin
- β-agonists
- teophillin
- tireotoxicosis

Low intake/wasting

- alchoolism
- TPN
- NGS / vomiting
- Diarrhea / enemas
- Diuretics
- Hyperaldosteronism

pH	Acid	Normal	Alkaline
K	↑	N	↓
Ca^{++}	↑	N	↓
Mg^{++}	↑	N	↓

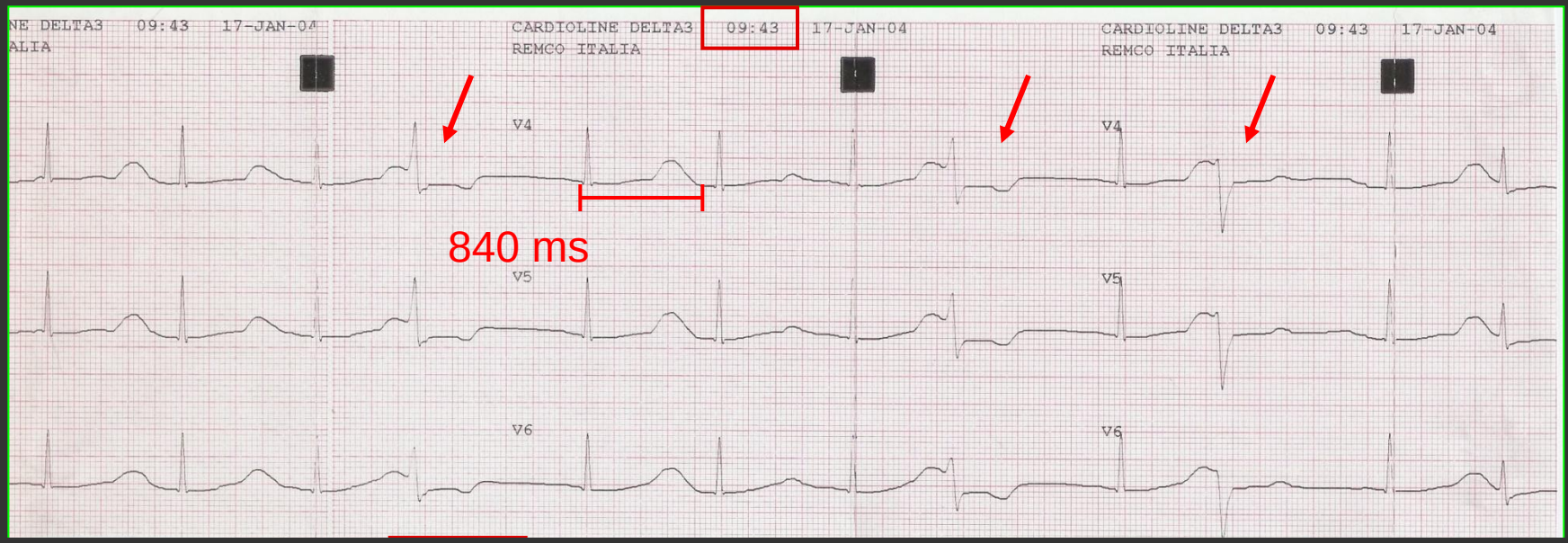
Ipokaliemia



↑ resting potential	↓ gK
↑ phase 0: high amplitude QRS **↑ conduction velocity:** nerrow QRS	**phase 3 prolongation:** long QT small T wave U wave *"dispersed repolarization"*

Amiodarone

K^+ 1.8



The "Sicilian Gambit"

DRUG	channels					receptors				pump
	Na			Ca	K	α	β	M_2	P	Na/K ATPase
	fast	med	slow							
Lidocain (Ib)	○									
Propafenon (Ic)	●						◐			
Flecainide (Ic)		●			○					
Propranolol (II)	○						●			
Amiodaron (III)	○			○	●	◐	◐			
Sotalol (III)					●		●			
Verapamil (IV)	○			●		◐				
Atropine								●		
Adenosine									○	
Digoxin								○		●

ESC. Circulation 1991;84:1831-185

How to correct hypokalemia

Emergency: KCl 10-20 mEq iv +
$MgSO_4$ 10-20 mEq iv

Male
80 kg
K=1.8

$\sum = 2/3\ TBW = 48 \times 2/3 = 32\ L$

$\Delta = (5 - 1.8) \times 32 = 100\ mEq$

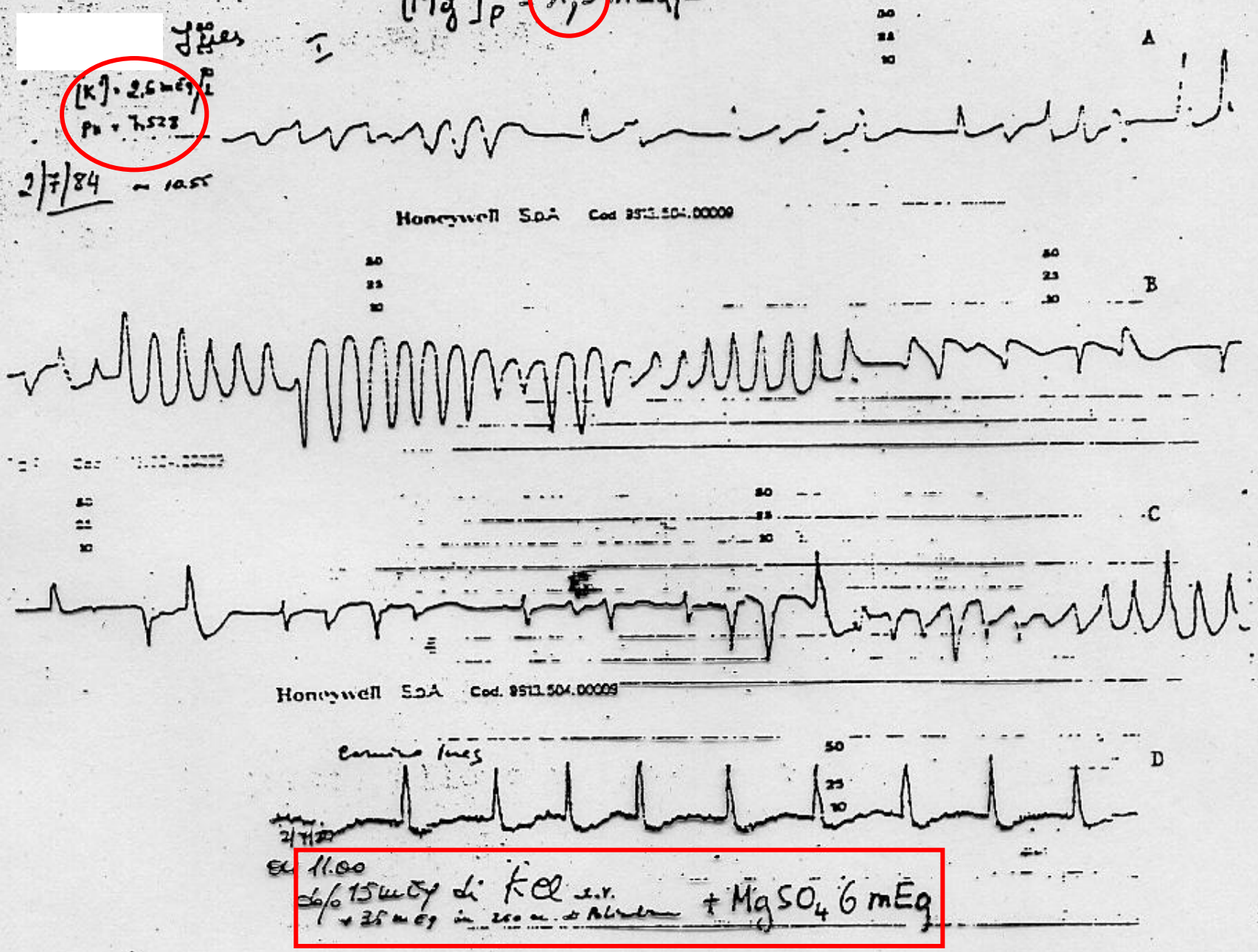
50 mEq in 2-4 h
50 mEq in 12-24 h

Mg ?

ipoMg^{++}-related cardiac effects

- ↑↑ Triggered activity
- QT Dispersion
- ↑ Digitalis Toxicity
- TdP, VF

$[Mg^{++}]_p = 1,3$ mEq/L


[K] = 2,6 mEq/L
Ph = 7,523
2/7/84 – 10.55
A
Honeywell S.p.A Cod. 9513.504.00009
B
C
Honeywell S.p.A Cod. 9513.504.00009
D
11.00
6/6 15 unità di KCl s.r.
+ 25 m Eq in 250 c.c. di Ringer
+ MgSO4 6 mEq

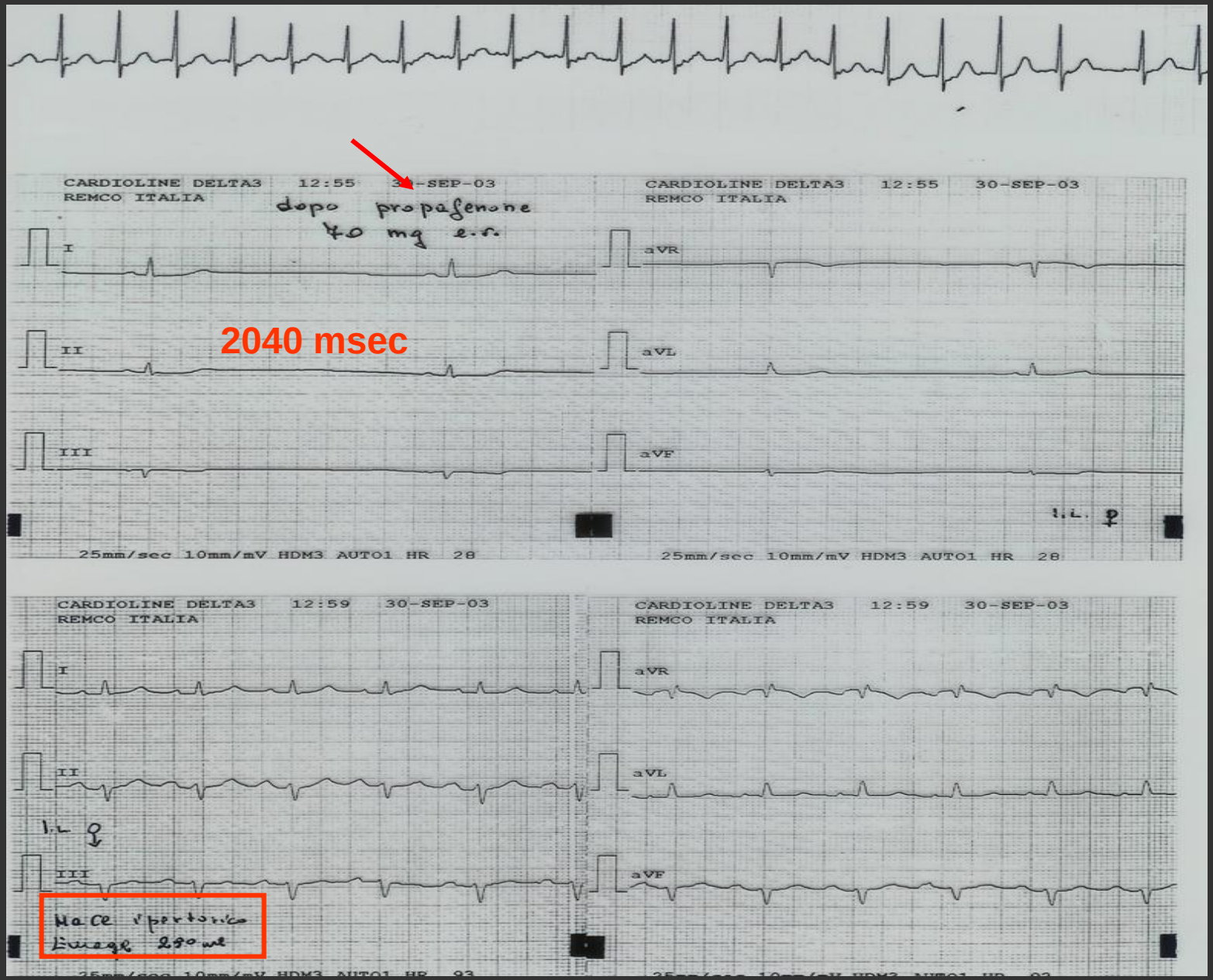

sodium

The "Sicilian Gambit"

DRUG	channels					receptors				pump
	Na			Ca	K	α	β	M_2	P	Na/K ATPase
	fast	med	slow							
Lidocain (Ib)	○									
Propafenon (Ic)	●						◉			
Flecainide (Ic)		●			○					
Propranolol (II)	○						●			
Amiodaron (III)	○			○	●	◉	◉			
Sotalol (III)					●		●			
Verapamil (IV)	○			●		◉				
Atropine								●		
Adenosine									○	
Digoxin								○		●

ESC. Circulation 1991;84:1831-185

1c ??


CARDIOLINE DELTA3 12:55 30-SEP-03
REMCO ITALIA
dopo propafenone 40 mg e.v.
I
II
III
aVR
aVL
aVF
2040 msec
25mm/sec 10mm/mV HDM3 AUTO1 HR 28
CARDIOLINE DELTA3 12:59 30-SEP-03
REMCO ITALIA
Ha ce ipertonico
Lisinopril 20 mg

KEY POINTS

- pH/Electrolytes/Fluid Balance
- Brain, Heart, Neuroexcitability…..
- Timing
- The full picture (DO_2, Age, Diseases, Drugs….)

When dealing with dyselectrolytemias……

Don't play hard…

….play first with the sea within us…….