x congresso nazionale

simeu

NAPOLI 18-20 NOVEMBRE 2016

Il volto della Medicina
di Emergenza-Urgenza:

identità professionale e servizio pubblico.

Aritmie
da disordini elettrolitici

Giovanna Guiotto

Medicina d'Urgenza-PS-OM

Ospedale San Paolo – Napoli

bradiarrhytmias

Impulse generation

SA Blocks

Impulse conduction

SV Blocks

AV Blocks

IV Blocks

....possibly linked to ↓↑ K, Mg, Ca, pH

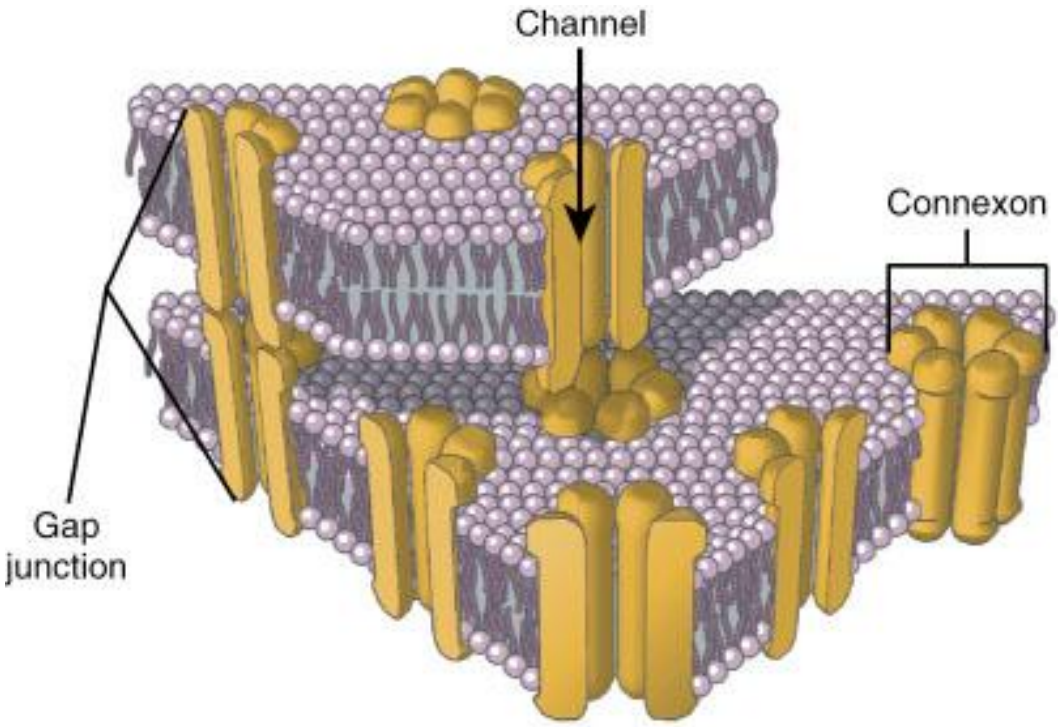
pH

K

Mg^{++}

Ca^{++}

Na..



Tachyarrhytmias

Impulse generation

Automaticity

catecolamines	↑K^+
digoxin	hypoxia
stretch	ischemia

Triggered Activity

EAD

↓ HR	↓Mg^{++}
↑ QT	↓ Ca^{++}
Drugs	↓ K^+

DAD

catecolamines	↑ K^+
digoxin	↑ Ca^{++}
↑ HR	ischemia

Impulse conduction

Re-entry

Ischemia	↑ K^+

SUBSTRATE
("REDUCED REPOLARIZATION RESERVE")

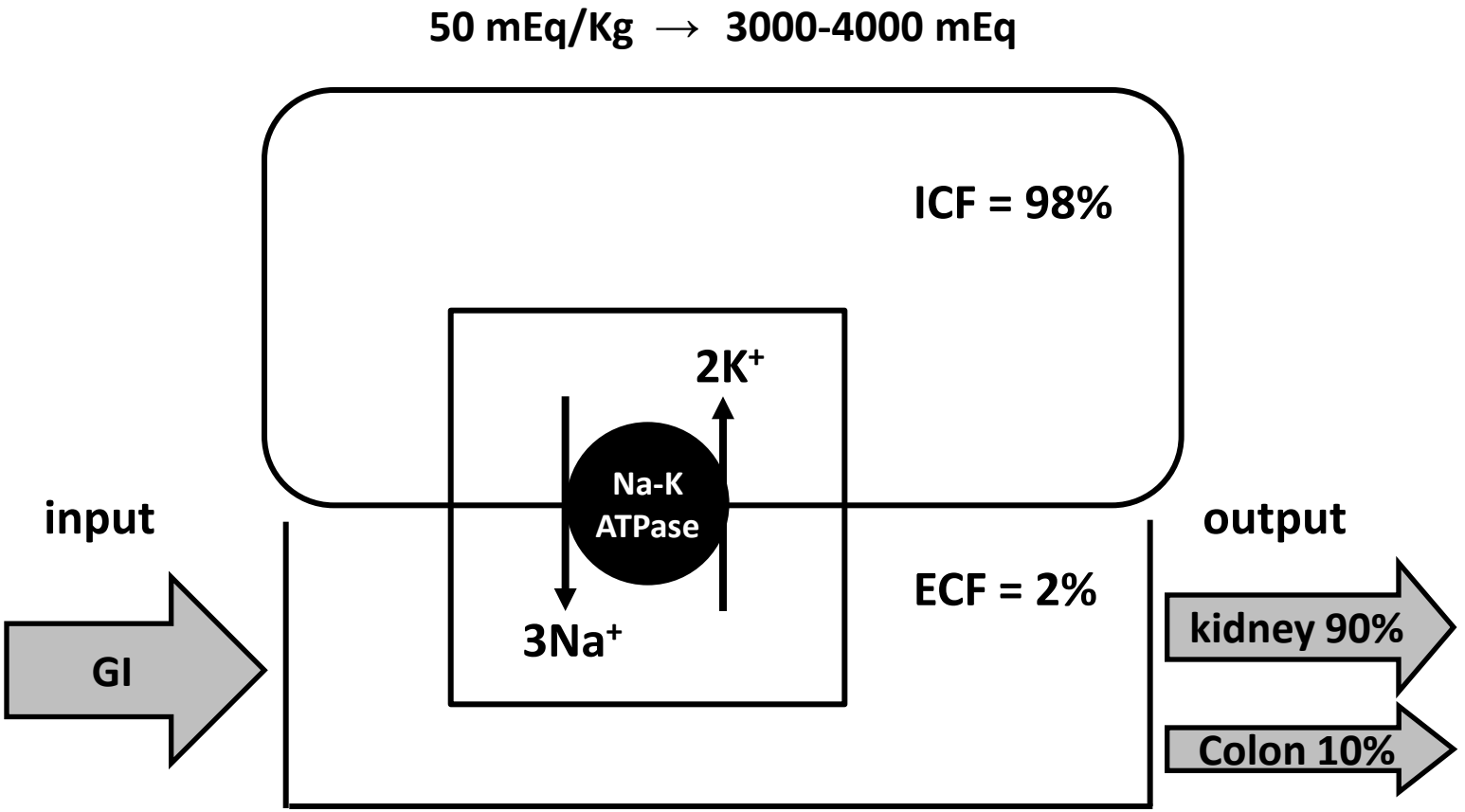
- ↓ PO_2 ↑↑ PCO_2
- ↓ ↑ pH
- ↓ ↑ K , ↓ Na, ↓ Mg^{++},↓ Ca^{++}
- ↑↓ BP
- DRUGS

Roden DM. NEJM 2004;350:1013-1022

IS A NEAR-NORMAL pH IMPORTANT ?

pH	Acid	Normal	Basic
K	↑	=	↓
Ca^{++}	↑	=	↓
Mg^{++}	↑	=	↓

K^+ DISTRIBUTION



The Nernst's law

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

HYPERKALEMIA IN ICU

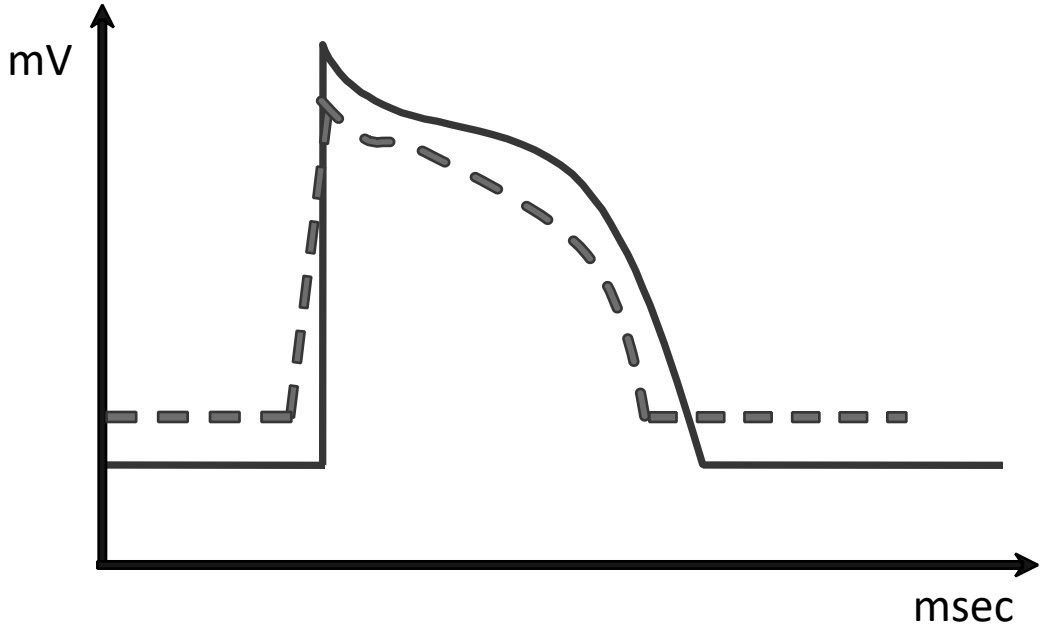
I → E SHIFT

- acidosis
- ↓ Insulin
- hyperosmolarity
- massive citolysis
- Digoxin intoxication

K overload

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

Iperkaliemia



↓ resting potential

↑ gK

↓ phase 0:

low QRS voltage

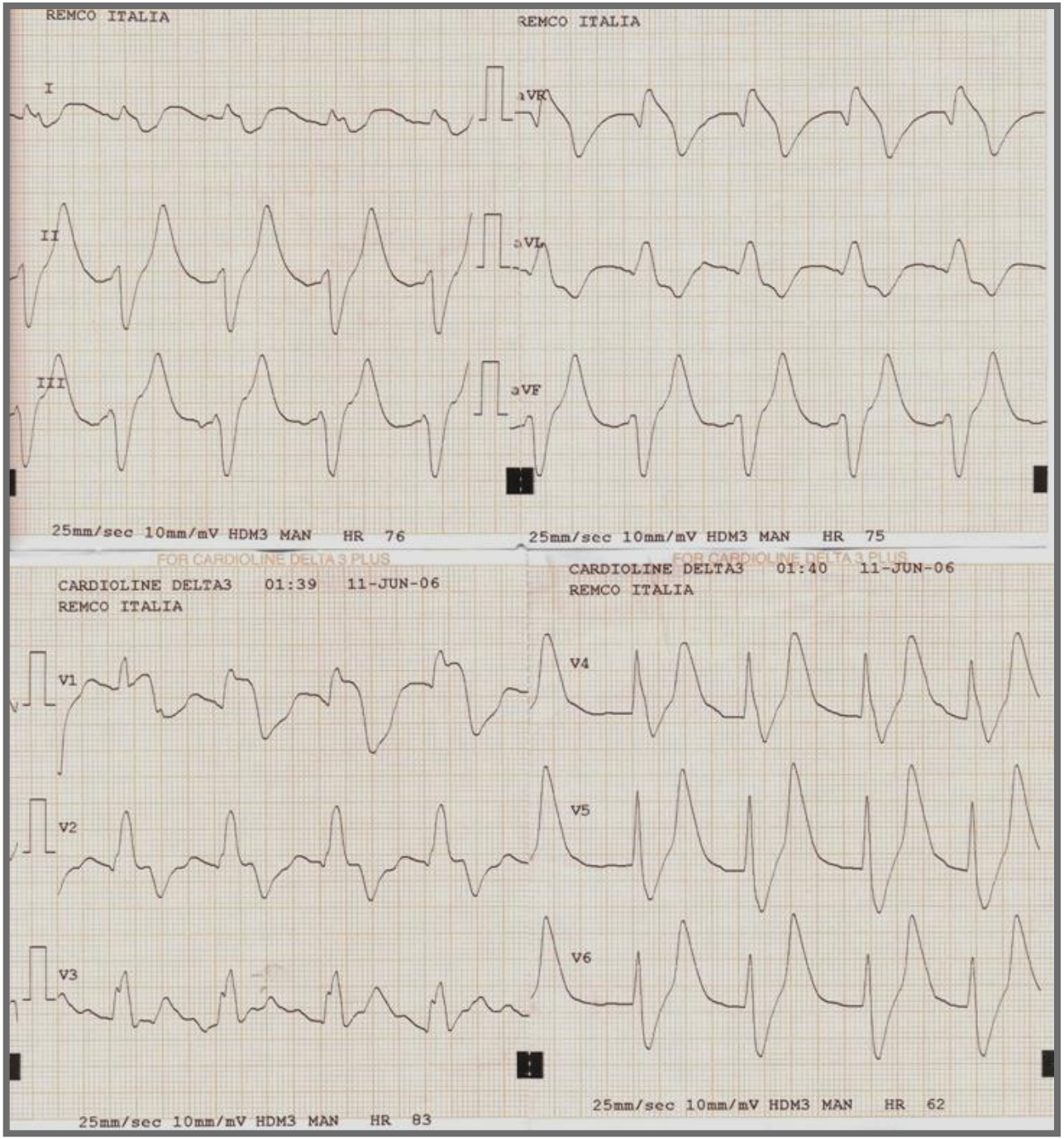
↓ conduction velocity:

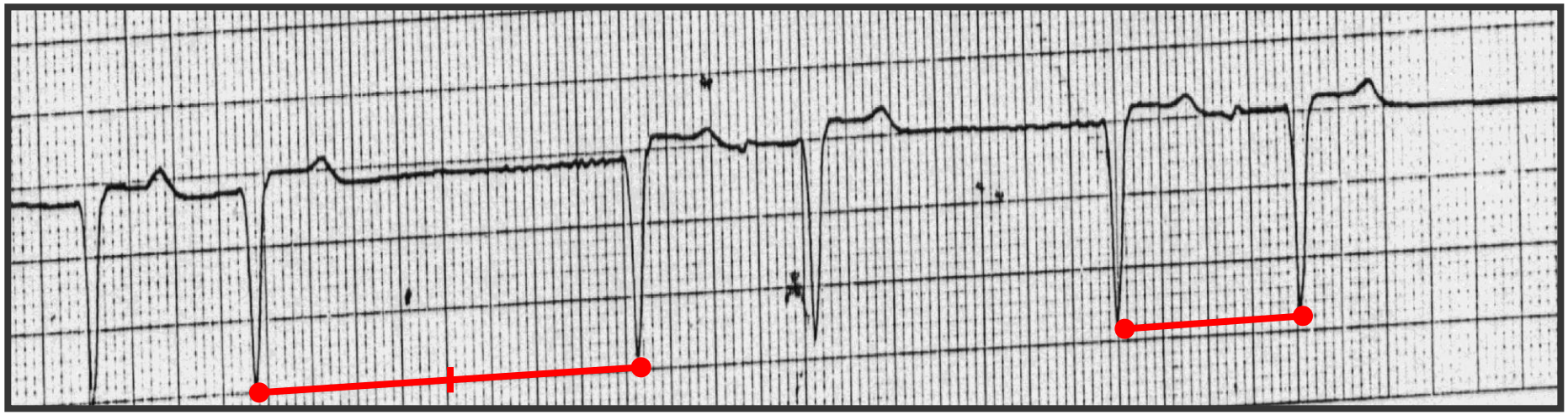
large QRS
SA e AV blocks
small P wave
atrial paralisis

↓ phase 3 :

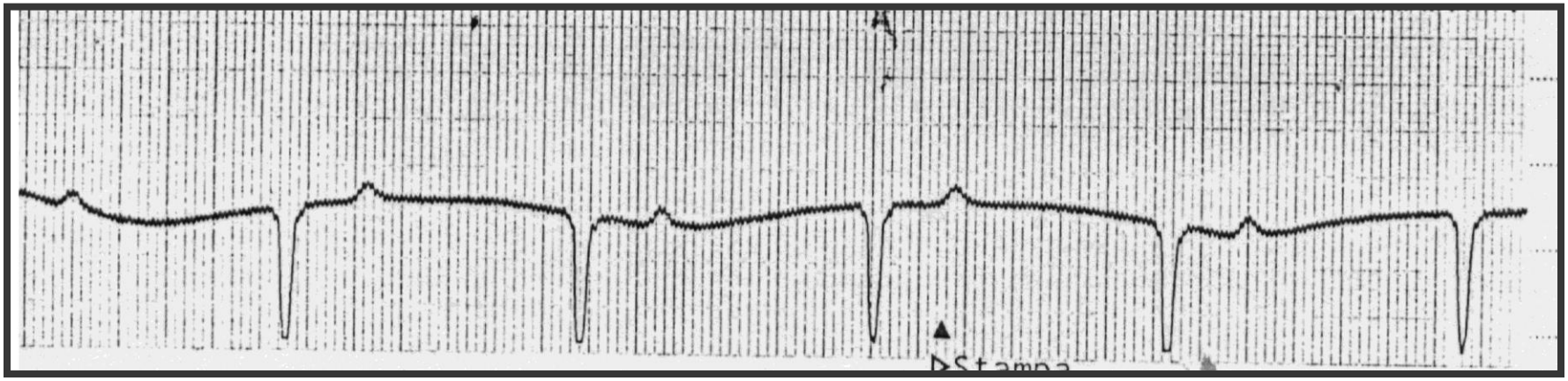
short QT
tall T wave
ST elevation

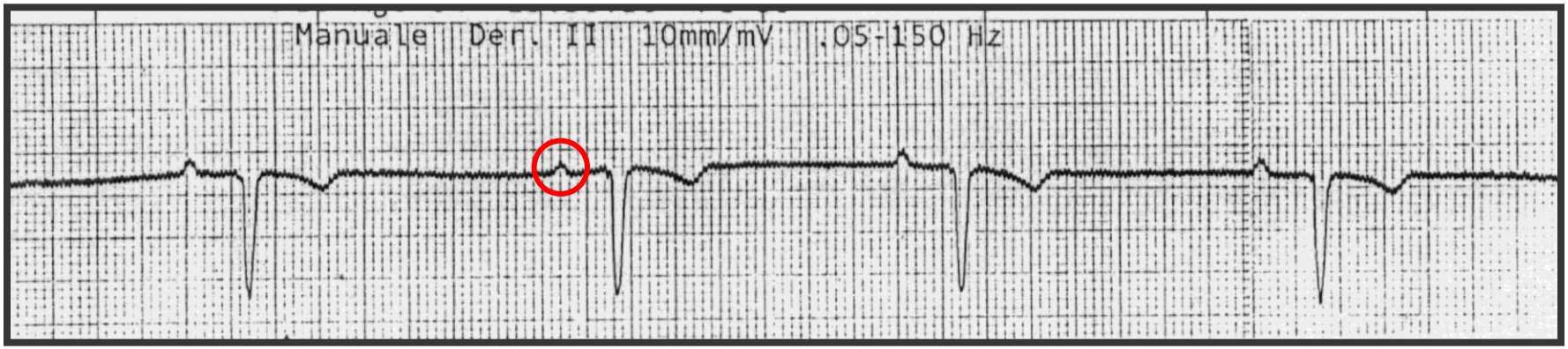
K^+ 9.8


REMCO ITALIA
REMCO ITALIA
I
aVR
II
aVL
III
aVF
25mm/sec 10mm/mV HDM3 MAN HR 76
25mm/sec 10mm/mV HDM3 MAN HR 75
FOR CARDIOLINE DELTA3 PLUS
FOR CARDIOLINE DELTA3 PLUS
CARDIOLINE DELTA3 01:39 11-JUN-06
REMCO ITALIA
CARDIOLINE DELTA3 01:40 11-JUN-06
REMCO ITALIA
V1
V2
V3
V4
V5
V6
25mm/sec 10mm/mV HDM3 MAN HR 83
25mm/sec 10mm/mV HDM3 MAN HR 62



$CaCl_2$ 10% 10 ml iv





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

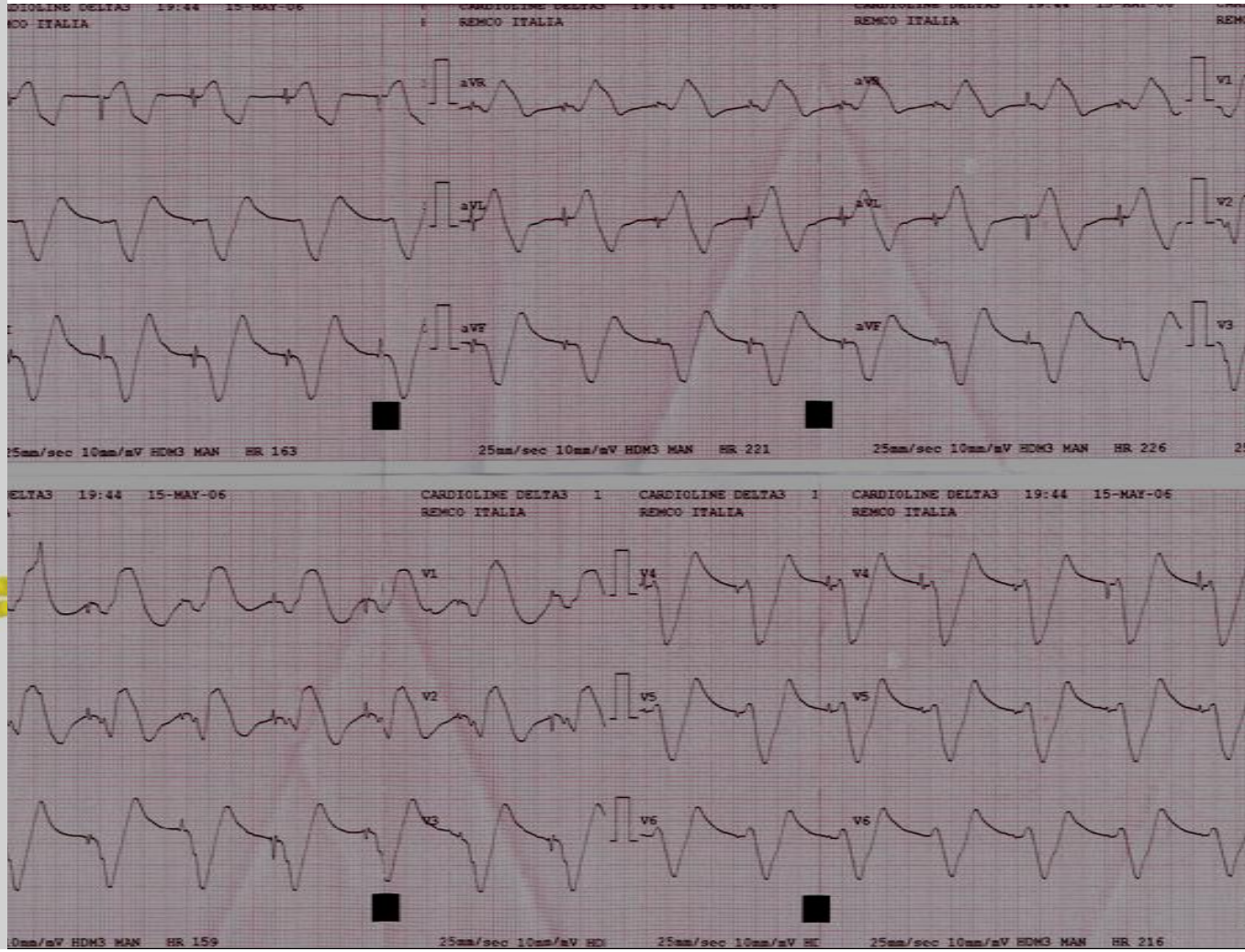
Rita, 75 y.
fatigue

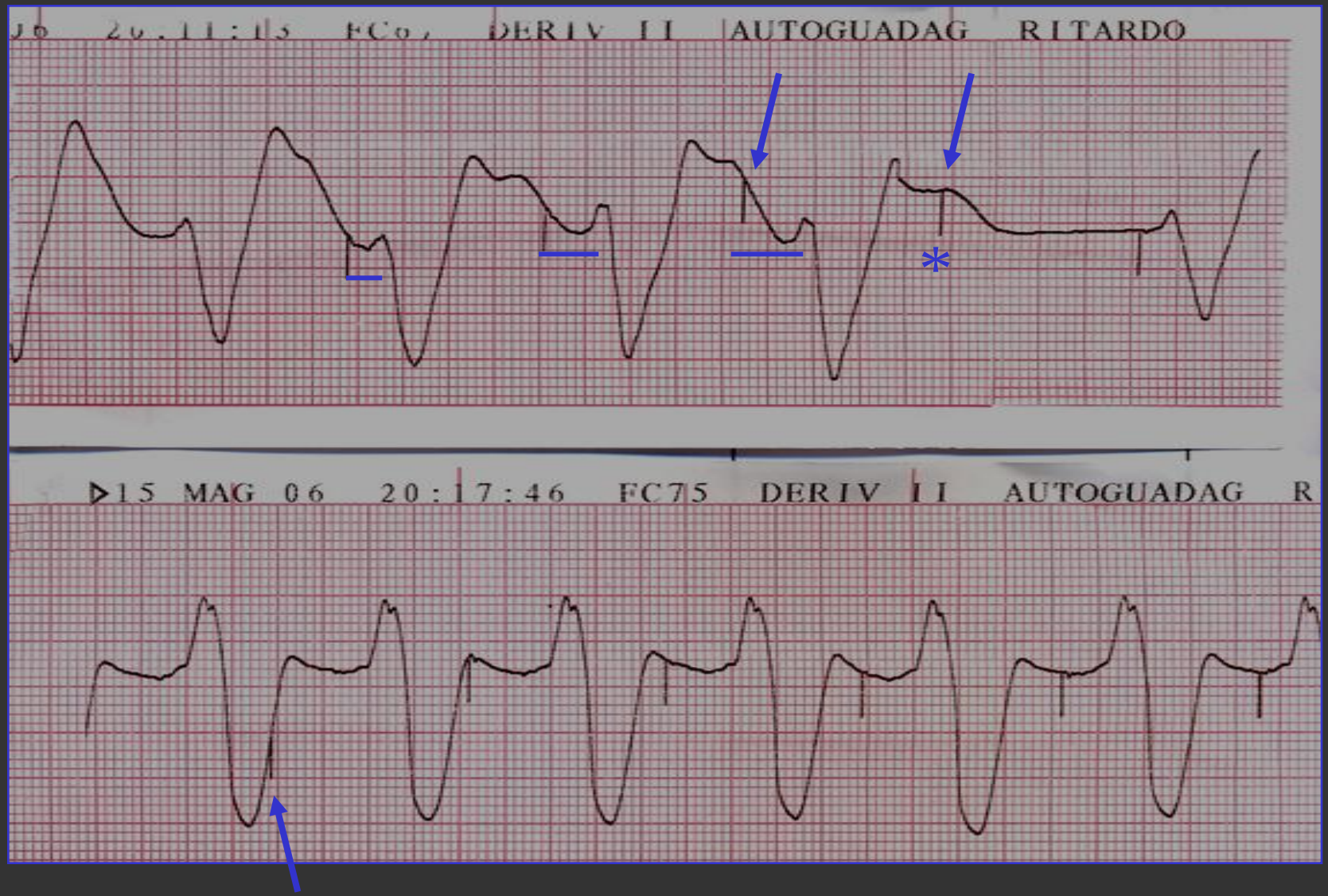
Enalapril
Spironolattone

BP 100/60 HR 70

SpO_2 97% FiO_2 21%

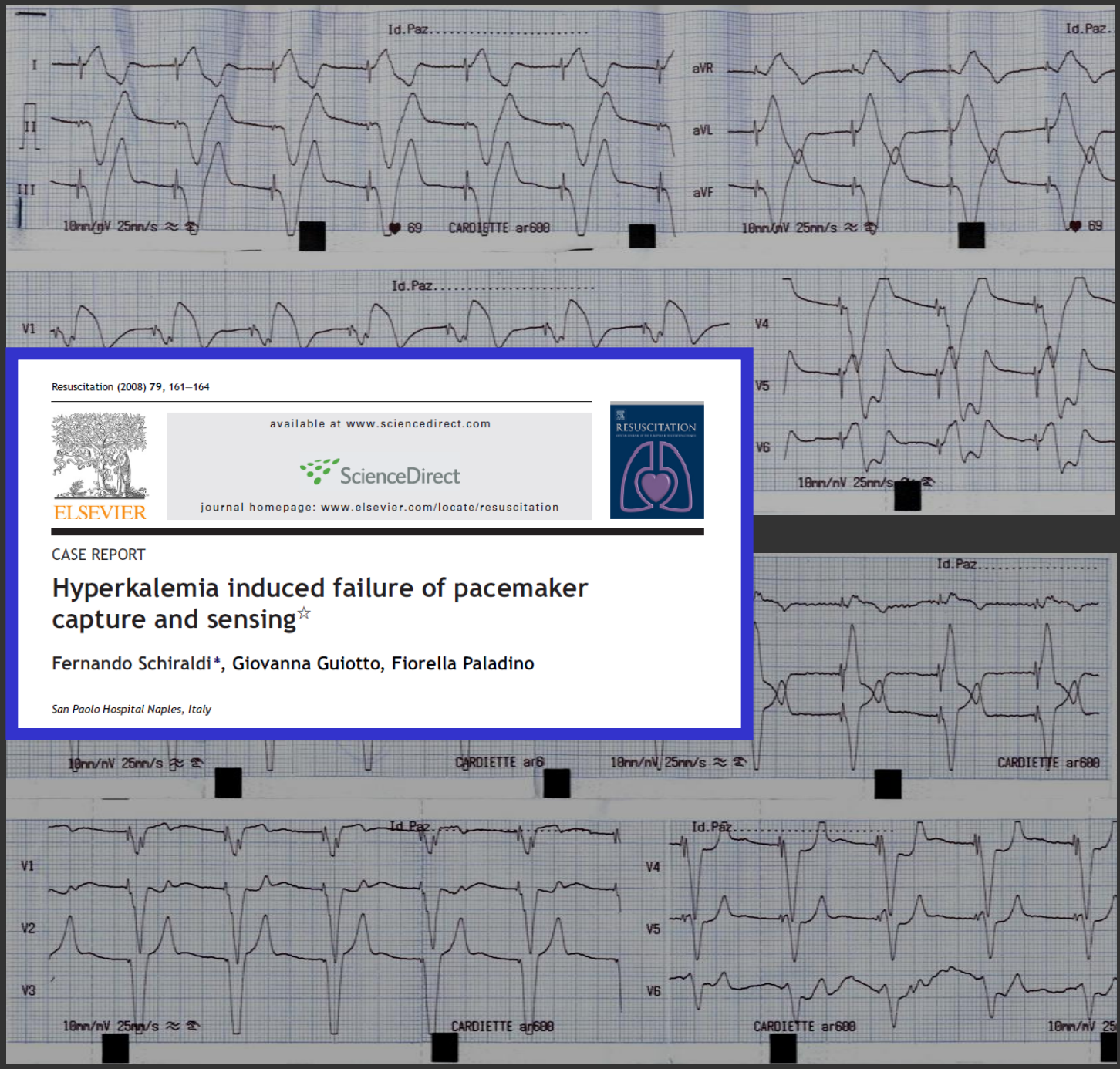
RR 22




AUTOGUADAG RITARDO
15 MAG 06 20:17:46 FC75 DERIV II AUTOGUADAG R

K^+ = 8.2 mEq/L

K^+ = 6.5 mEq/L



Resuscitation (2008) 79, 161–164

available at www.sciencedirect.com

ScienceDirect

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

ELSEVIER

RESUSCITATION

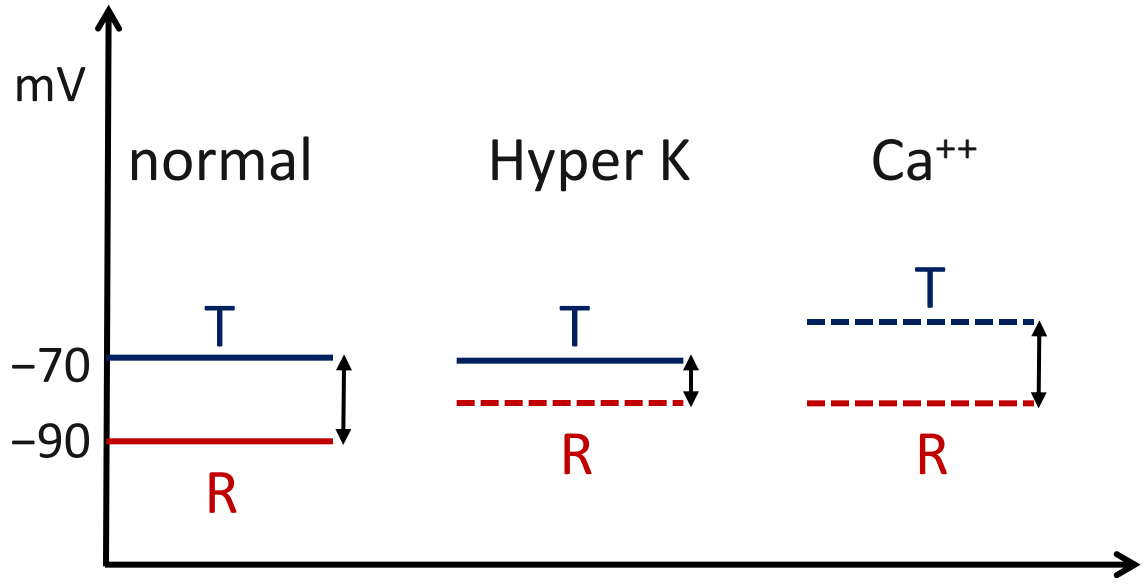
CASE REPORT

Hyperkalemia induced failure of pacemaker capture and sensing☆

Fernando Schiraldi*, Giovanna Guiotto, Fiorella Paladino

San Paolo Hospital Naples, Italy

Electrical effects of Calcium



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

(Dialysis, β-agonists ?)

HYPOKALEMIA IN ICU

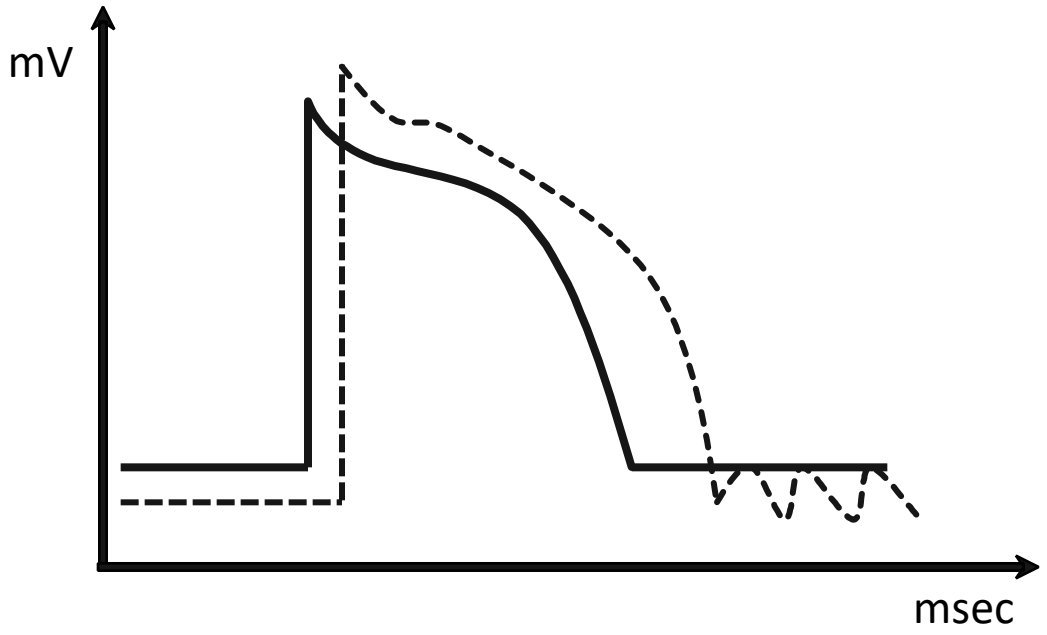
E → I SHIFT

- alkalosis
- Insulin
- β-agonists
- teophyllin
- tireotoxicosis

Low intake/wasting

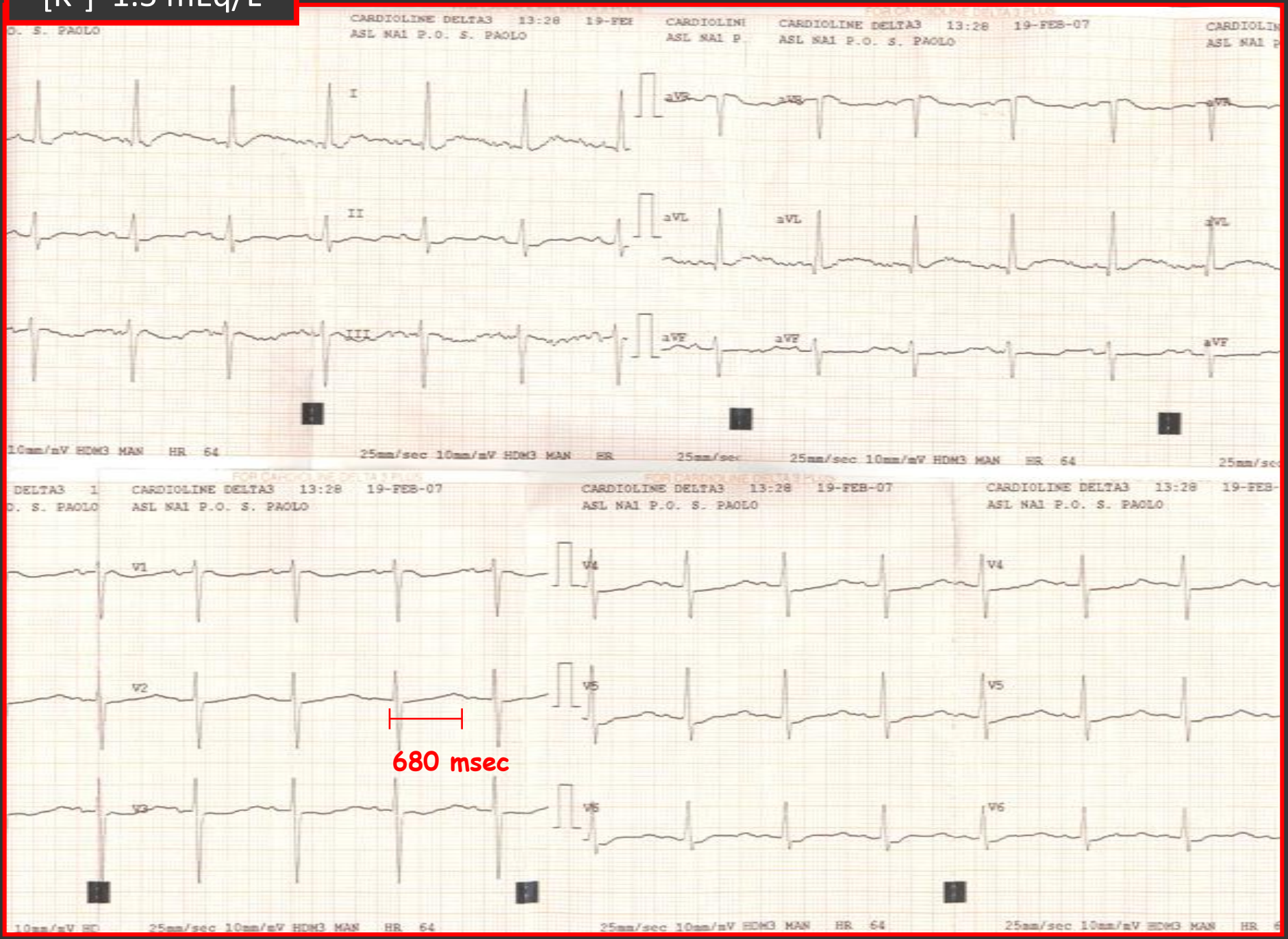
- alchoolism
- TPN
- NGS / vomiting
- Diarrhea / enemas
- Diuretics/Dialysis
- Hyperaldosteronism

Ipokaliemia



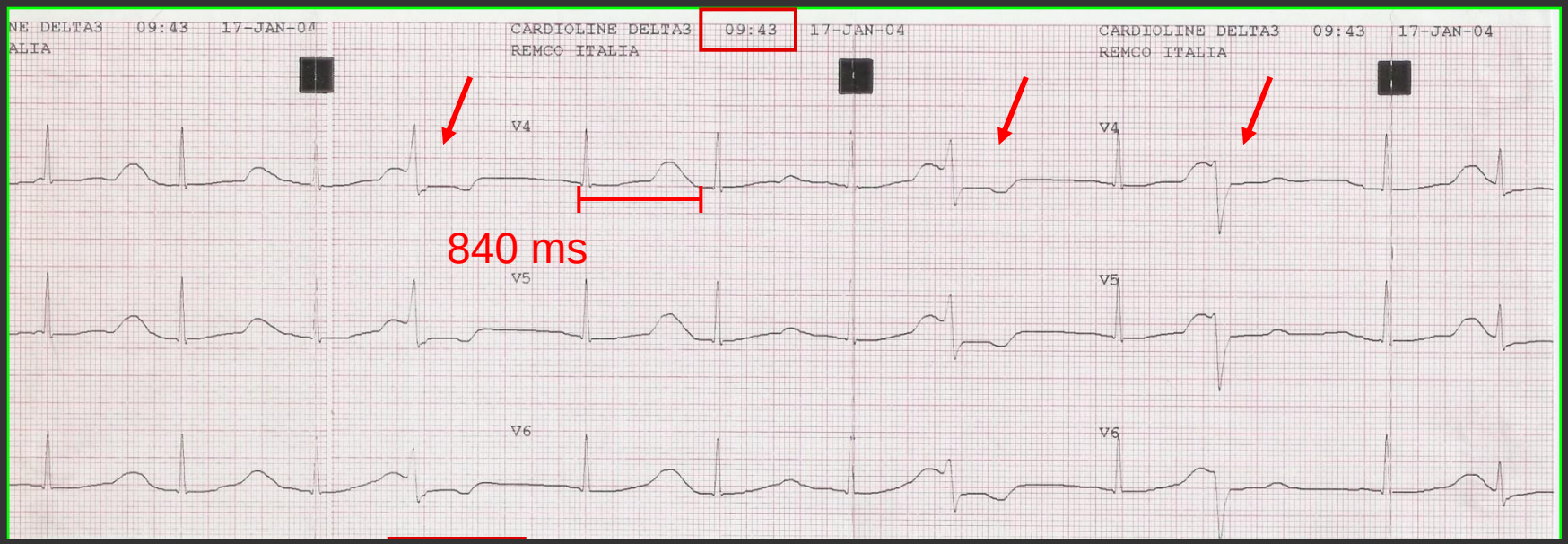
↑ resting potential	↓ gK
↑ phase 0: high amplitude QRS **↑ conduction velocity:** nerrow QRS	**phase 3 prolongation:** long QT, small T wave, U wave — *"dispersed repolarization"*

[K+] 1.5 mEq/L



Amiodarone

K^+ 1.8

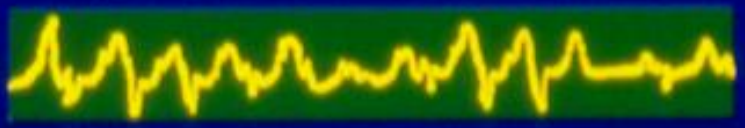


The "Sicilian Gambit"

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

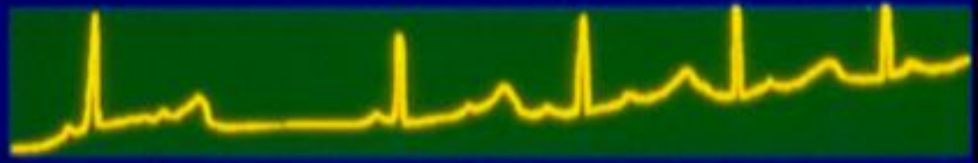
ESC. Circulation 1991;84:1831-185

♀ F.A. 58 y.



pH	7.56
PCO_2	39.2
HCO_3	35.2
PO_2	58.7
K	2. 8 mEq/l
Ca^{++}	0.8 mMol/l
Mg	0.7 "

lidocain 100 mg + 2 mg/kg/h

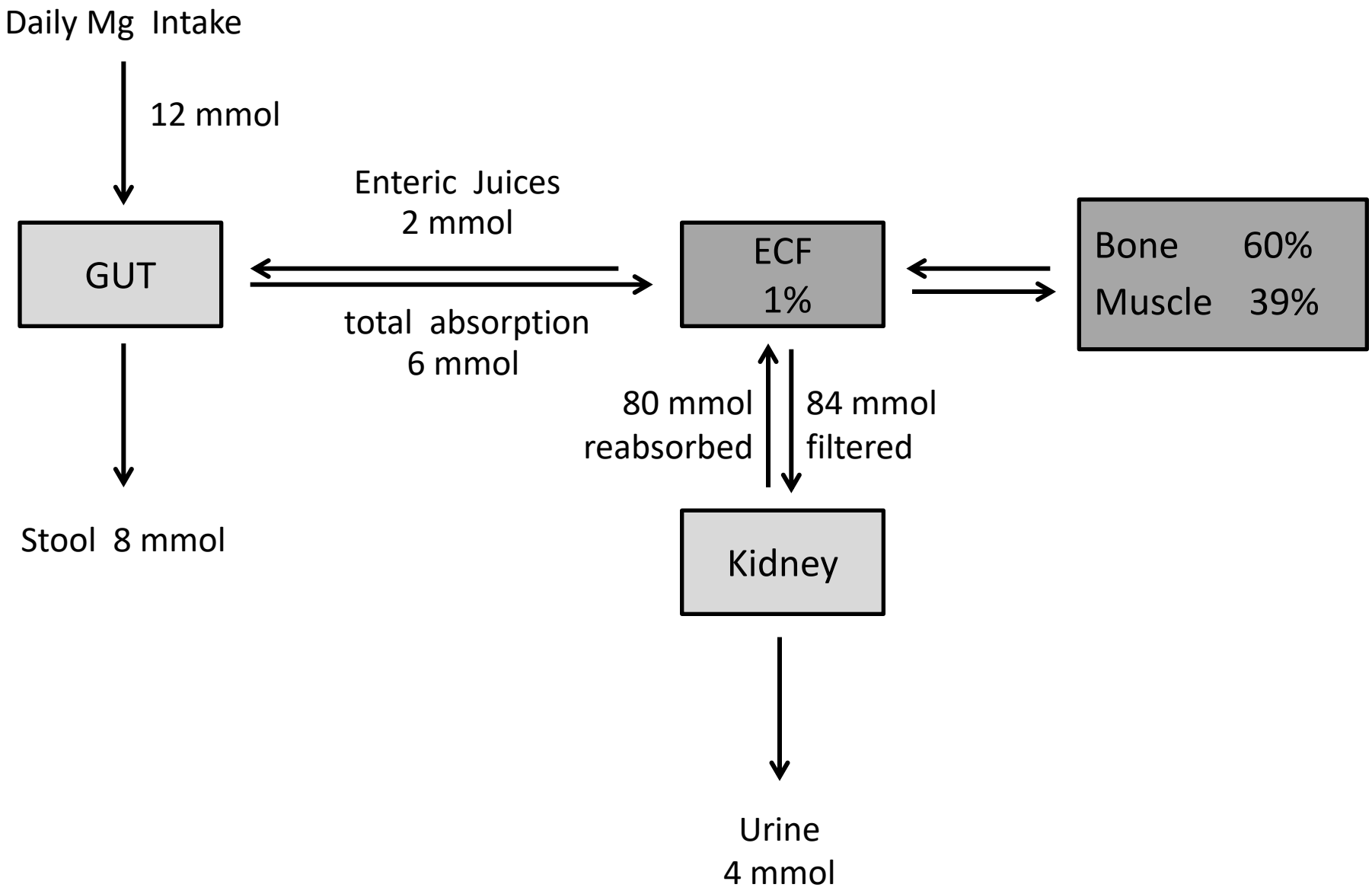


$CaCl_2$ 6 mEq + 12 mEq / 2h
$MgSO_4$ 4 mEq / h

FS93

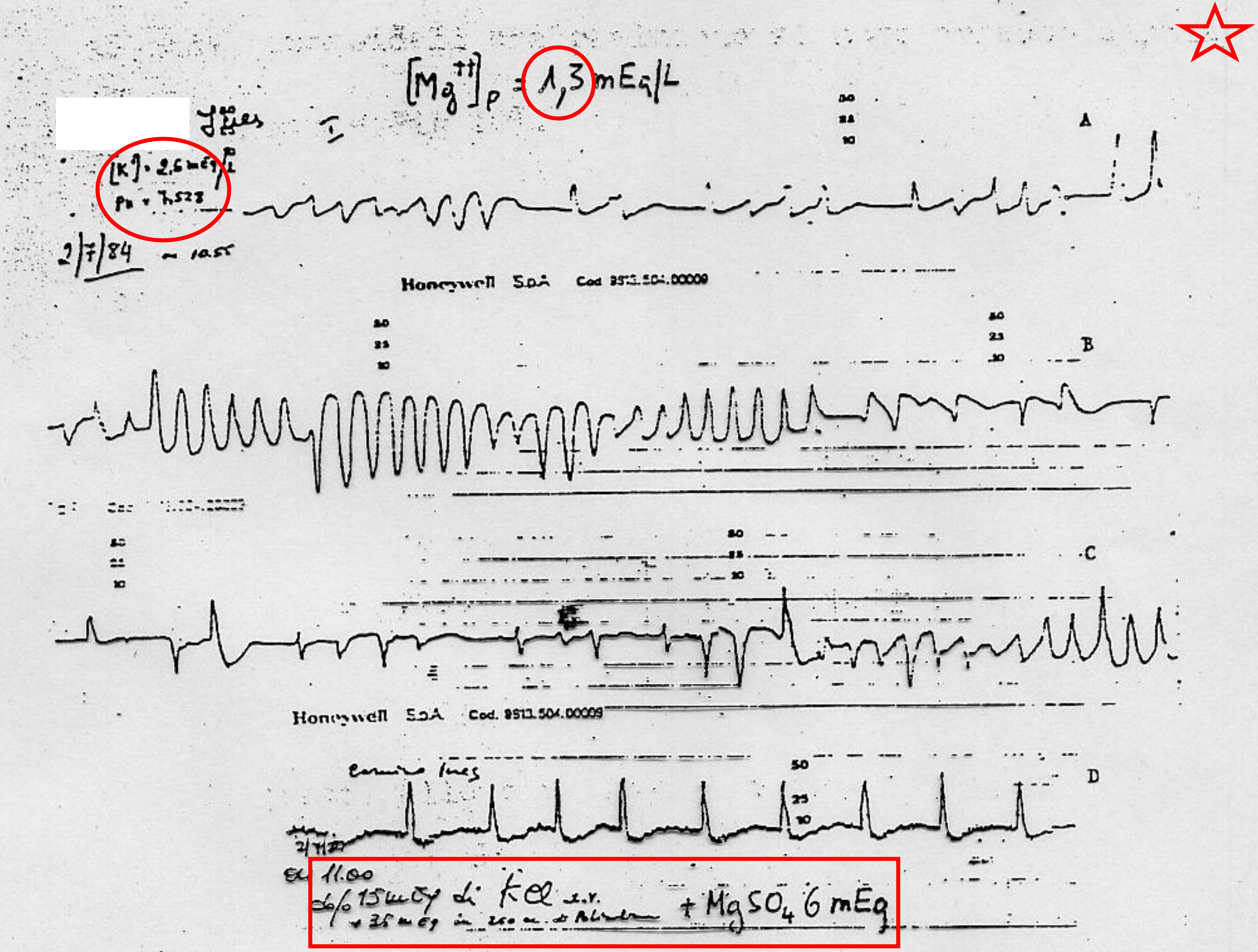
MAGNESIUM

1.7–2.6 mg/dl
0.7–1.1 mmol/L



HypoMg^{++}-related cardiac effects

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



[Mg++]p = 1,3 mEq/L
A
Honeywell S.p.A. Cod. 9513.504.00009
B
C
Honeywell S.p.A. Cod. 9513.504.00009
D
+ MgSO4 6 mEq

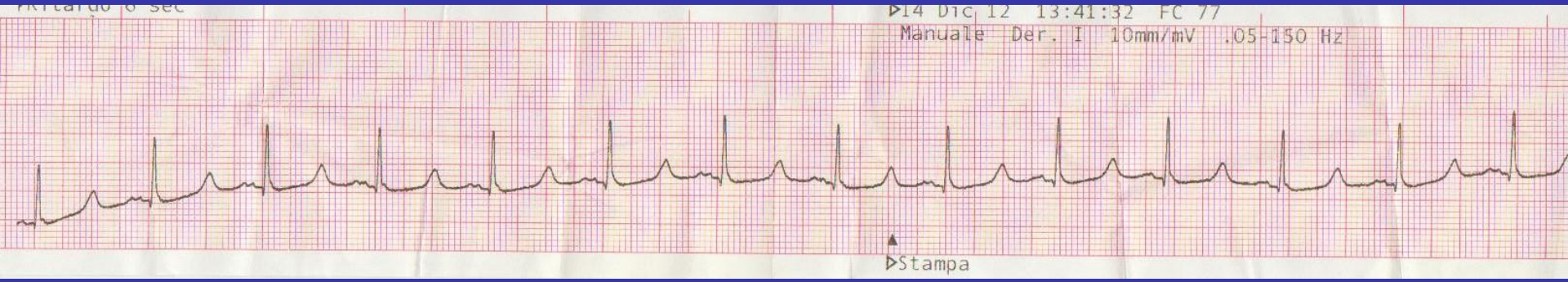
HyperMg^{++}-related cardiac effects

- SA block
- AV block
- Intraventricular delay

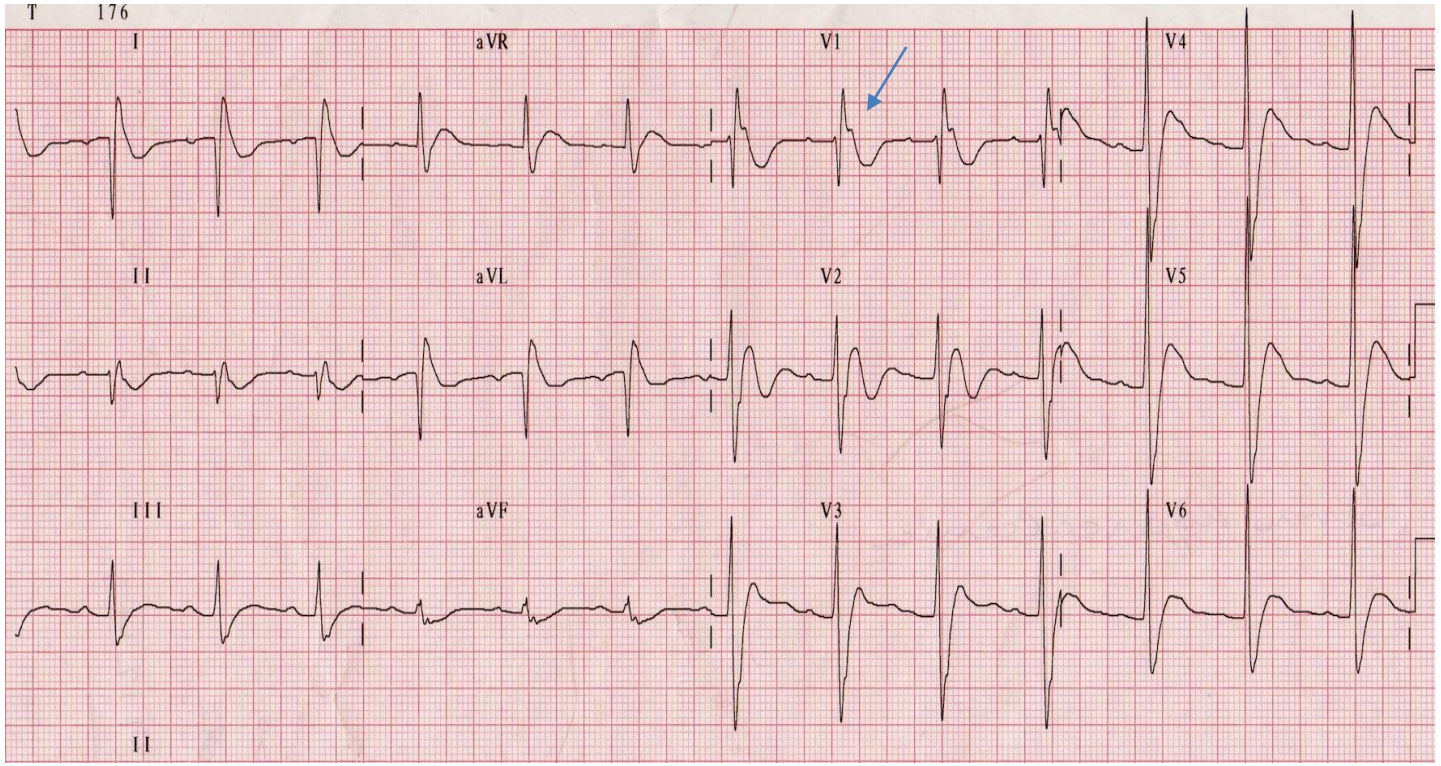
HypoCa^{++}-related cardiac effects

*Long JT

*QT Dispersion (if low Mg^{++})



Ca^{++} 6.1 mmol/L

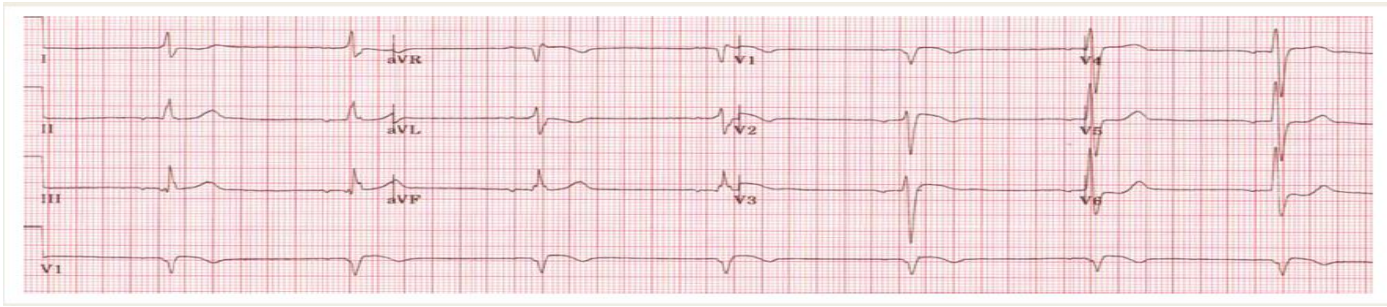


TERAPIA

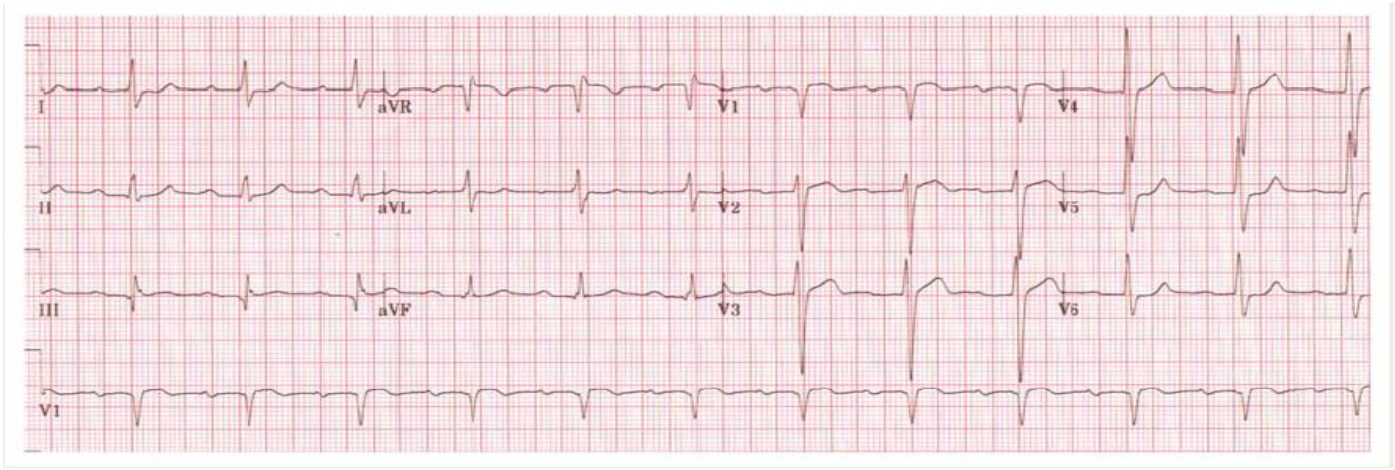
- **cristalloidi 1000 ml/H per 2-4 H + furosemide** } **diuresi: 200 ml/h**
- **albumina**
- **steroidi, indometacina**
- **difosfonati**
- **dialisi**


sodium

Brugada-like electrocardiography pattern induced by severe hyponatraemia



Serum sodium concentration of 101 mmol/lt

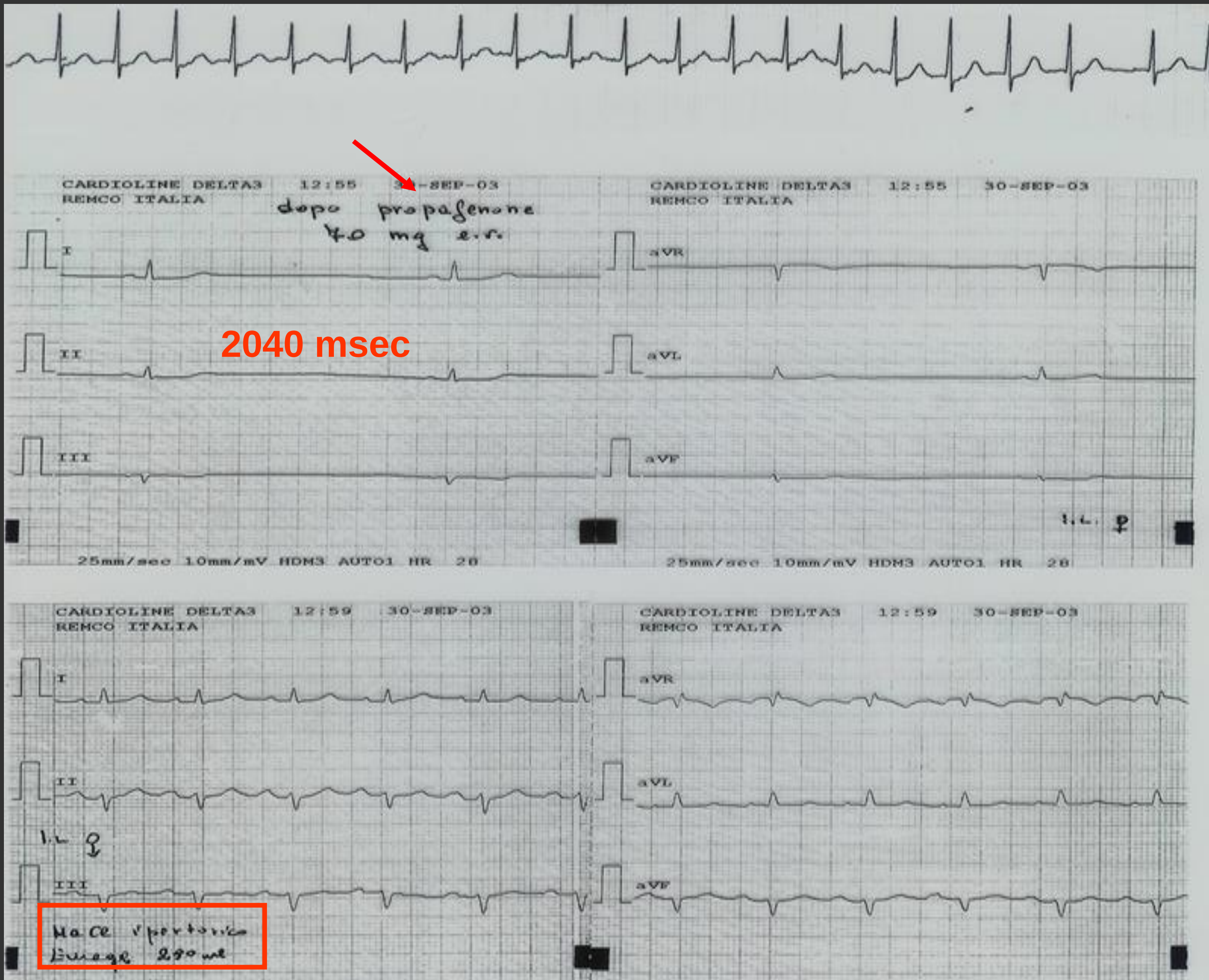


Serum sodium concentration of 119 mmol/lt

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

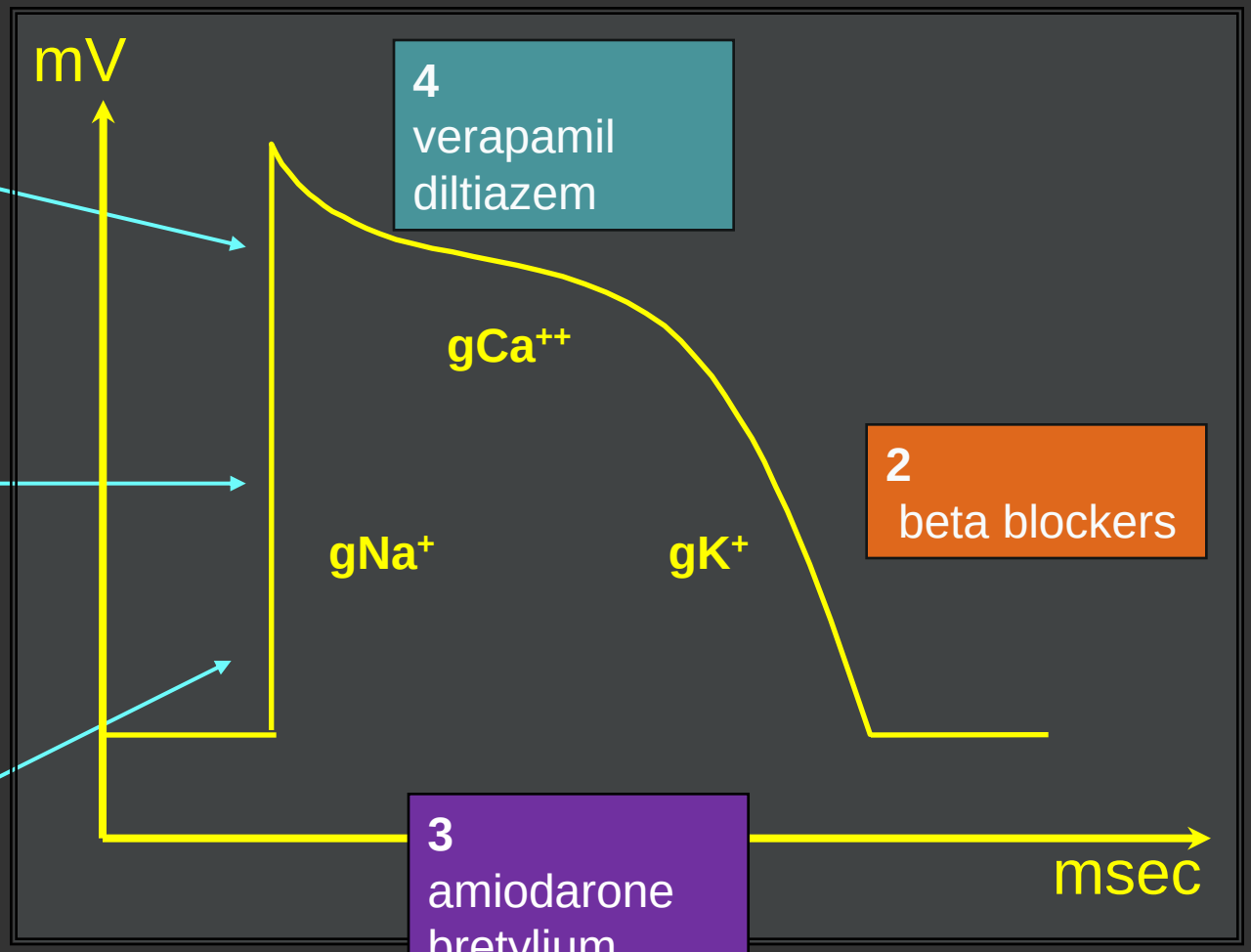

CARDIOLINE DELTA3 12:55 30-SEP-03
REMCO ITALIA
dopo propafenone
70 mg e.v.
2040 msec
I
II
III
aVR
aVL
aVF
25mm/sec 10mm/mV HDM3 AUTO1 HR 28
CARDIOLINE DELTA3 12:59 30-SEP-03
REMCO ITALIA

Ionic conductance and antiarrhytmic effects

1A
Quinidine
procainamide
disopyramide
bunaftine

1B
lidocaine
mexiletine
aprindine

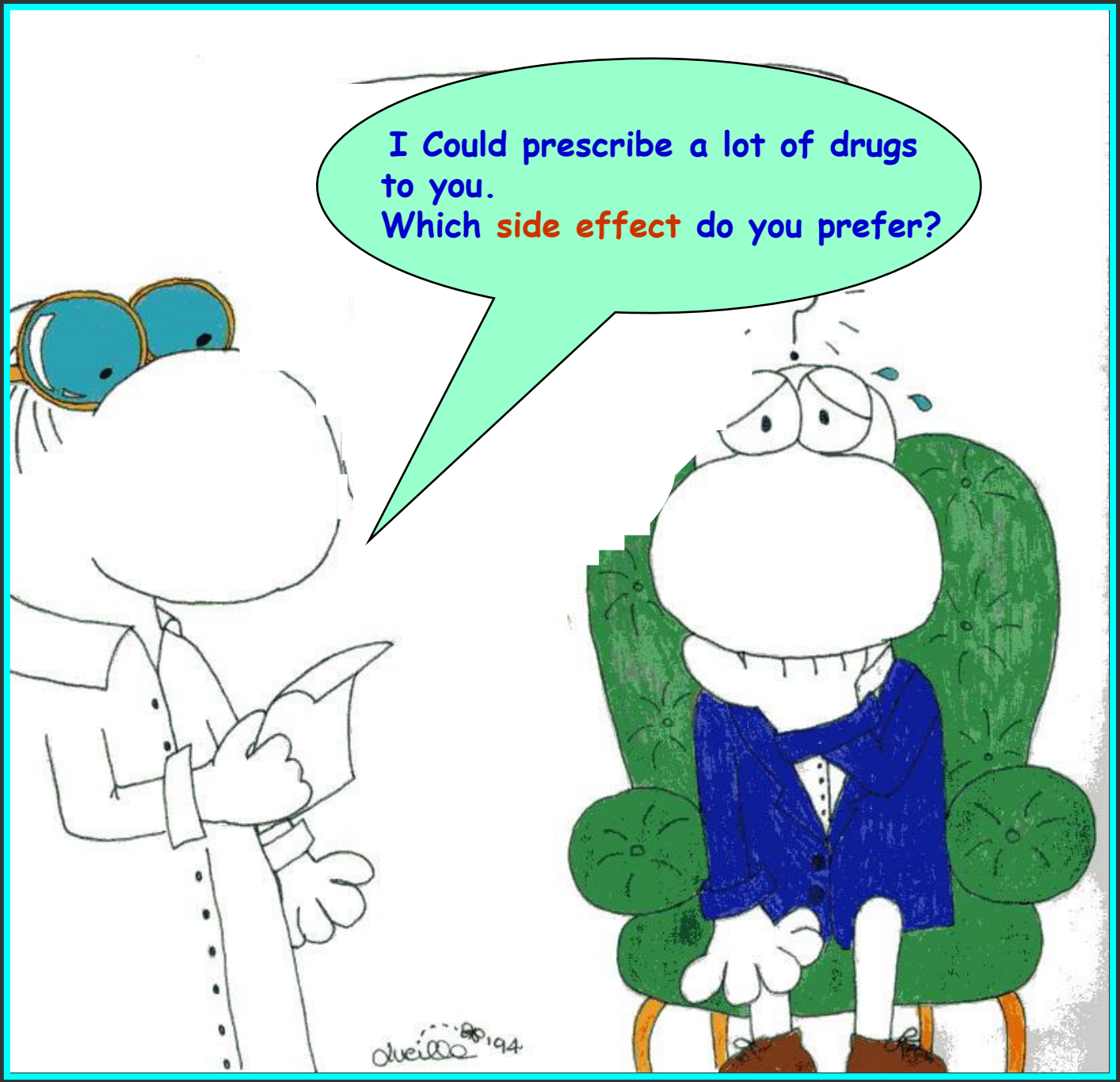
1C
lorcaidine
flecainide
encainide
propafenone



4
verapamil
diltiazem

2
beta blockers

3
amiodarone
bretylium
sotalol


I Could prescribe a lot of drugs to you.
Which side effect do you prefer?
'94