

HOT TOPICS IN CARDIOLOGIA 2023

13 e 14 Novembre 2023

Villa Doria D'Angri - Via F. Petrarca 80,
Napoli

**CUORE E
POTASSIO:
EQUILIBRIO
DIFFICILE**

MAURO GIORDANO

Gli squilibri del K⁺ in PS?

American Journal of Emergency Medicine 34 (2016) 1923–1926



Contents lists available at ScienceDirect

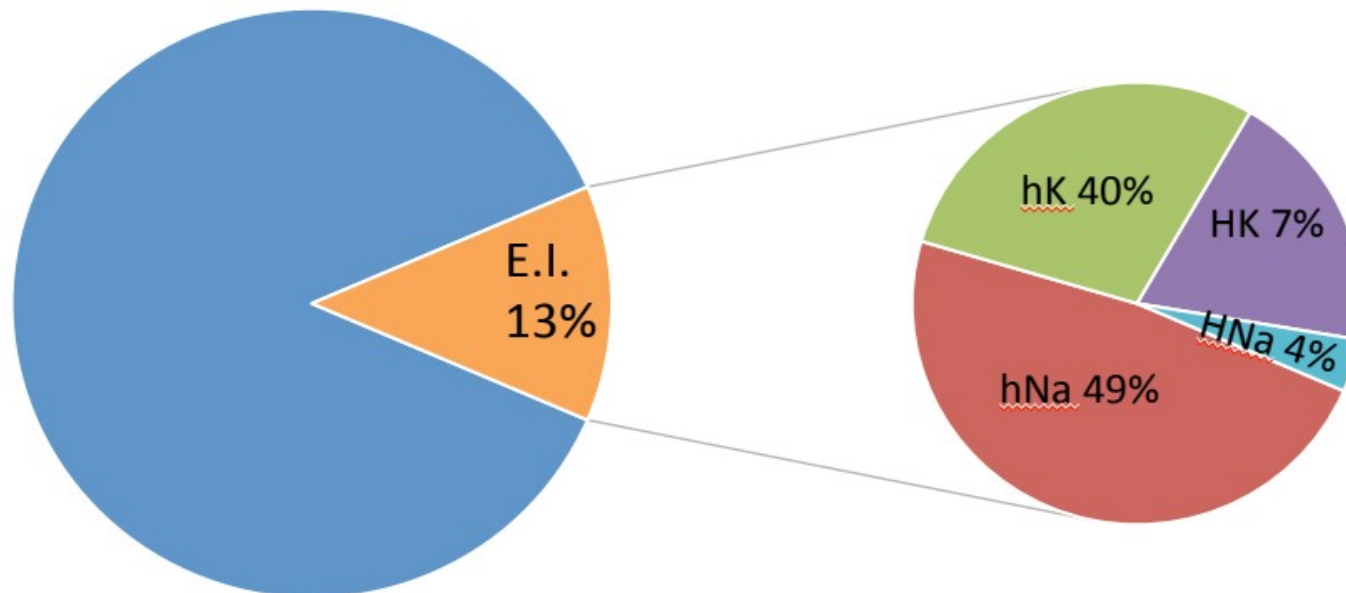
American Journal of Emergency Medicine

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

Original Contribution

Diseases associated with electrolyte imbalance in the ED: age-related differences

Mauro Giordano, MD ^{a,*}, Tiziana Ciarambino, MD ^a, Pietro Castellino, MD ^b, Lorenzo Malatino, MD ^b, Salvatore Di Somma, MD ^c, Giustina Di Loro, MD ^d, Giuseppe De Lillo, MD ^a, Tullio Di Loro, MD ^a

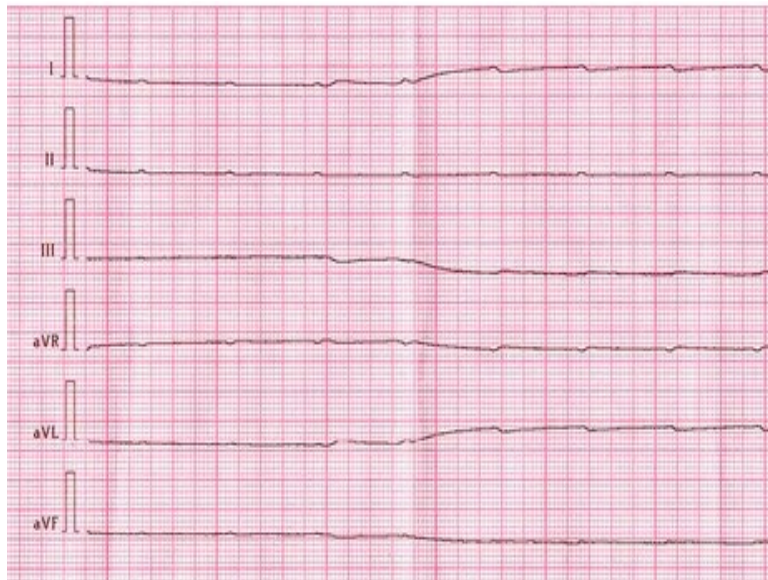




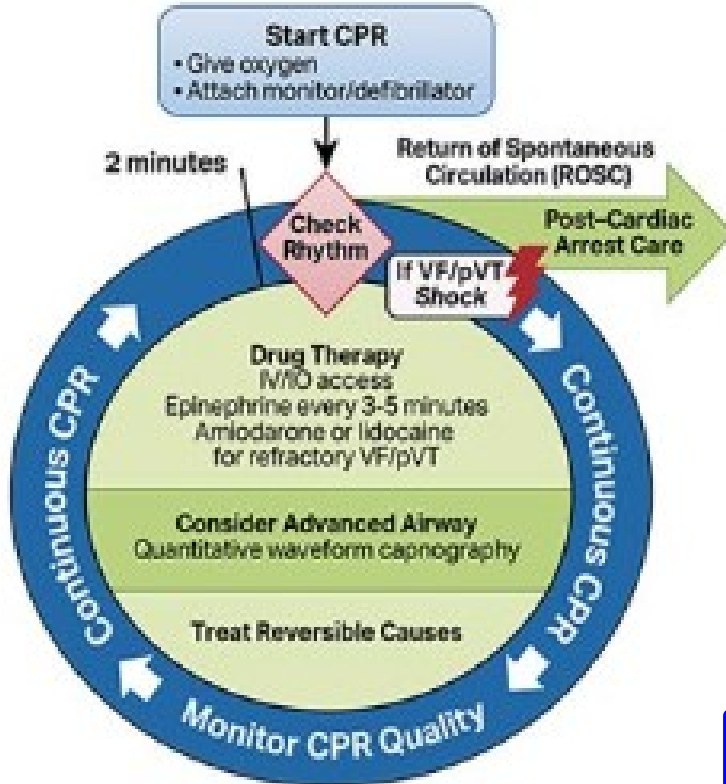
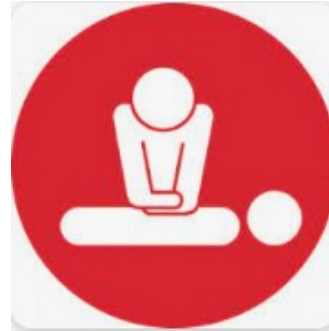
RAFFAELE di 69 aa

Obeso, mentre era in visita ambulatoriale in ospedale, per ulcere agli arti inferiori va in **arresto cardiaco**

**Caos, portato immediatamente in Shock Room del PS,
ASISTOLIA...**



START RCP...



**Si somministra
ADRENALINA 1 mg ev,
per un totale di 4 mg**

**Sopraggiungono i
rianimatori
Si procede a rapida
intubazione orotracheale
in FiO₂ 100%.**



Durante RCP si riesce ad eseguire EGA VENOSO...

T's of ACLS		
Causes	Signs	Treatment
Tamponade (Cardiac)	-Rapid heart rate -Narrow QRS -JVD -No pulse -Muffled heart sounds	-Pericardiocentesis -Thoracotomy
Toxins	-Prolonged QT interval	-Based on overdose agent -Supportive care
Tension Pneumothorax	-Slow heart rate -Narrow QRS -Unequal breathing -JVD -Tracheal deviation	-Needle decompression -Insertion of a chest tube
Thrombosis (Pulmonary)	-Rapid heart rate -Narrow QRS -Shortness of breath -Decreased oxygen -Chest pain	-Embolectomy -Fibrinolytic therapy -Anticoagulant therapy
Thrombosis (Coronary)	-Abnormal ECG	-Angioplasty -Stent placement -Coronary bypass surgery

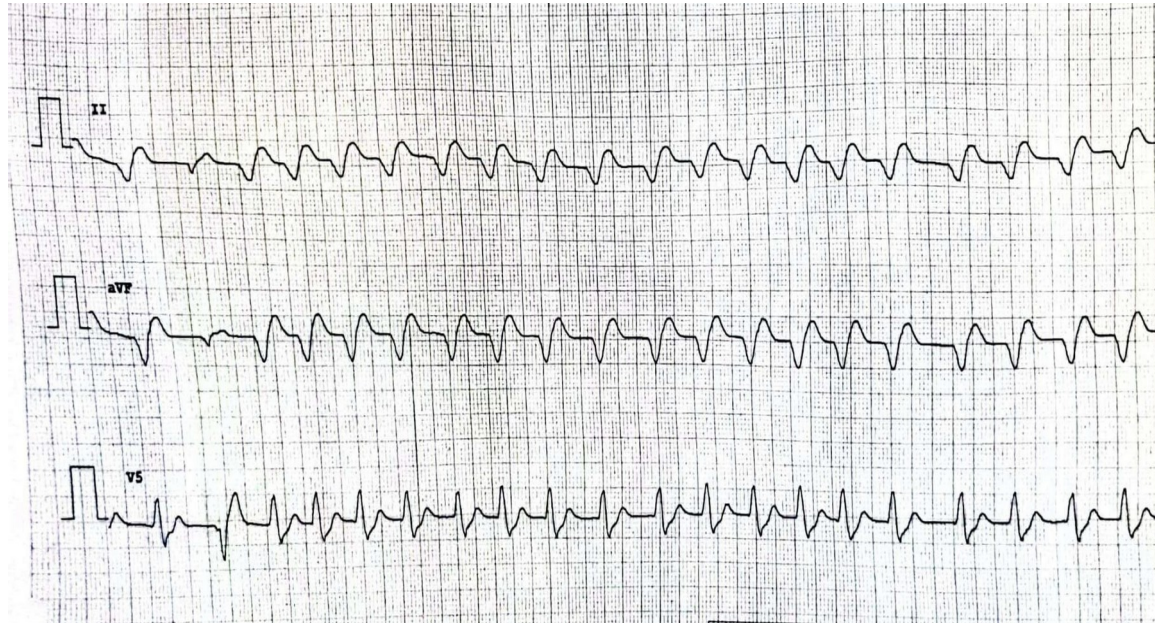
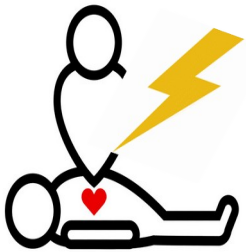
H's of ACLS		
Causes	Signs	Treatment
Hypovolemia	-Rapid heart rate -Narrow QRS -Blood loss	-Obtain IO/IV Access -Administer fluid/blood -Use fluid challenge
Hypoxia/Hypoxemia	-Slow heart rate -Cyanosis	-Ensure airway is open -Ventilate -Ensure oxygen supply is adequate
Hydrogen Ion Excess (Acidosis)	-Low amplitude QRS complex	-Atrial blood gas -Provide adequate ventilations -Sodium bicarbonate (metabolic)
Hypokalemia/Hyperkalemia	-Flattened T waves & a U wave (Hypokalemia) -Peaked T waves & a widened QRS (Hyperkalemia)	-Ventilate (respiratory) -Sodium bicarbonate (metabolic)
Hypothermia	-Shivering -Previous exposure to cold temperatures	-Active warming measures -Temperature should be above 30°C

pH	7.25
pCO2	45
pO2	29
Na ⁺	131
K⁺	11.3
Ca ⁺⁺	1.29
Hb	9.5
HCO ₃ ⁻	7
Glu	210

Si somministra :

- 1 fl Calcio Cloruro in bolo x3
- 3 fl Bicarbonato in bolo
- 10 fl Bicarbonato in 500 cc Sol Glucosata 5% + 8 UI Insulina R in infusione rapida

Dopo circa 20 min di RCP, **comparsa di polso** carotideo.
HR 30, 40, 50, 60, GCS 3, anisocoria, ECG:



**Ecocardio bedside: ventricolo sinistro ipocinetico; FE 30%.
VCI 30 mm fissa. Sezioni destre non dilatate.**

Dopo circa 30 min controllo EGA ARTERIOSO

pH	7.15
pCO ₂	35
pO ₂	441
Na ⁺	131
K⁺	8.4
Cl ⁻	107
Ca ⁺⁺	1.92
HCO ₃ ⁻	12.7
Lac	5.3

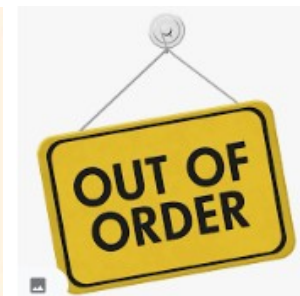
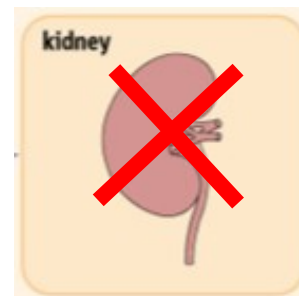
ABG for GFR?
The HCMA Index Evaluating Formula

$$(pH \times HCO_3^-) / (Cl^-)$$

normal: $(7.35 \times 24 \text{ mmol}) / 95 \text{ mmol} = 1.8$

$$(7.15 \times 12,7) / 107 = 0.9: \text{AKI !}$$

Giordano M. et al, Emergency 2018



Stabilizzato e ricoverato in Terapia Intensiva

ESAME EMOCROMOCITOMETRICO

WBC	10,9		10 ³ /uL	[4,4 - 11,3]
NEUTROFILI	54,6		%	[43,0 - 80,0]
LINFOCITI	37,7		%	[20,5 - 45,5]
MONOCITI	4,9	*	%	[5,5 - 11,7]
EOSINOFILI	2,5		%	[0,9 - 2,9]
BASOFILI	0,3		%	[0,2 - 1,0]
NEUT#	6,0		#	[2,0 - 7,5]
LIMPH#	4,1	*	#	[1,0 - 4,0]
MONO#	0,50		#	[0,20 - 1,00]
EOS#	0,30		#	[0,00 - 0,50]
BASO#	0,00		#	[0,00 - 0,20]
RBC	4,33	*	10 ⁶ /uL	[4,50 - 5,90]
HGB	10,1	*	gr/dL	[14,0 - 17,5]
HCT	32,4	*	%	[40,0 - 52,0]
MCV	74	*	fL	[80 - 99]
MCH	23,4	*	pg	[27,0 - 32,0]
MCHC	31,2	*	g/dL	[32,0 - 36,0]
PLT	272		10 ³ /uL	[140 - 300]
PCT	0,201		%	[0,150 - 0,500]
MPV	7,40		#	[6,00 - 11,00]
PDW	17,8		%	[11,00 - 18,00]
TEMPO DI PROTROMBINA				
INR	1,17			0.80-1.22
PT	76		%	[70 - 120]
PTT	26,2		s	[20,0 - 36,0]
FIBRINOGENO	411		mg/dL	[150 - 450]
D-DIMERO	1782	*	ng/mL	[< 255]

ESAME

ESAME

AZOTEMIA	49		49	mg/dL	[10 - 50]
GLICEMIA	252		252	mg/dL	[80 - 110]
CREATININA	1,71		1,71	mg/dL	[0,67 - 1,20]
BILIRUBINA TOTALE			0,37	mg/dL	[0,03 - 1,20]
BILIRUBINA DIRETTA			0,12	mg/dL	[0,00 - 0,25]
BILIRUBINA INDIRETTA			0,25	mg/dL	[0,00 - 0,75]
SODIO			132	mmol/L	[135 - 146]
POTASSIO	8,1		8,1	mmol/L	[3,5 - 5,1]
CLORO	108		108	mmol/L	[98 - 107]
PROTEINE TOTALI			7,1	g/dL	[6,6 - 8,7]
GOT			23	[IU]/L	[0 - 40]
GPT			17	[IU]/L	[0 - 41]
COLINESTERASI			3261	[IU]/L	[5320 - 12920]
AMILASI			115	[IU]/L	[28 - 100]
CALCIO	12,5		12,56	mg/dL	[8,60 - 10,20]
PROTEINA C REATTIVA			0,71	mg/dL	[0,00 - 0,50]
ALBUMINA			3,27	g/dL	[3,50 - 5,20]
TROPONINA I			< 0,100	ng/mL	[0,00 - 0,16]
MIOGLOBINA			90	ng/mL	[28 - 72]

- **Anamnesi & Terapia:**
- diabete mellito
- **Insufficienza Renale Cronica 3b**
- cirrosi epatica - **SPIRONOLATTONE**
- ipertensione arteriosa - **ACE INIBITORI**
- FA permanente in terapia anticoagulante, edema e ulcere venose arti inferiori da alcuni anni

Clinical Management of Hyperkalemia

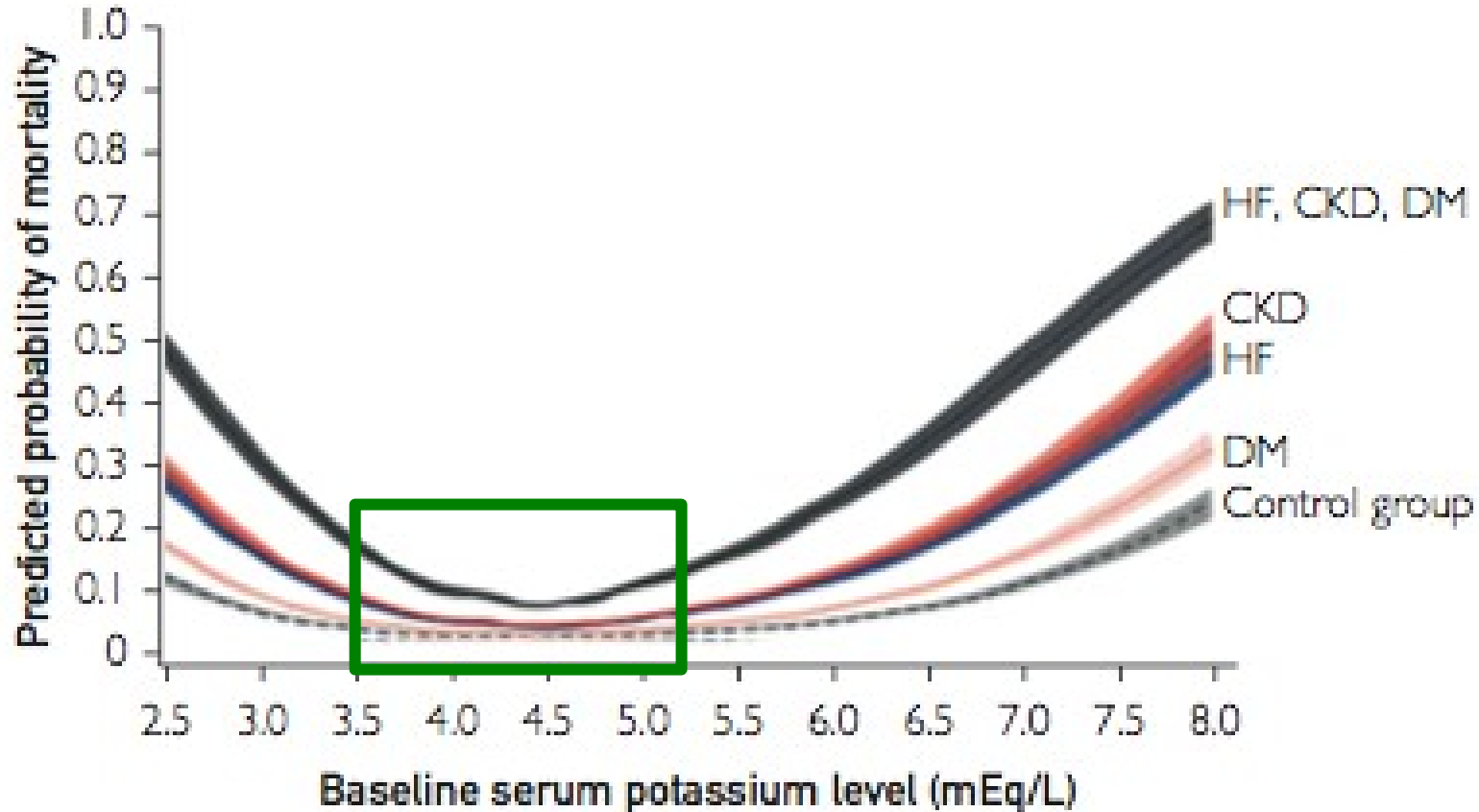
Biff F. Palmer, MD; Juan Jesus Carrero, PharmD, PhD; Deborah J. Clegg, PhD;
Gates B. Colbert, MD; Michael Emmett, MD; Steven Fishbane, MD;
Debra J. Hain, PhD, APRN, AGPCNP-BC; Edgar Lerma, MD;
Macaulay Onuigbo, MD; Anjay Rastogi, MD; Simon D. Roger, MD;
Bruce S. Spinowitz, MD; and Matthew R. Weir, MD

**The exact K^+ concentration
consider to be
life-threatening
remains controversial**

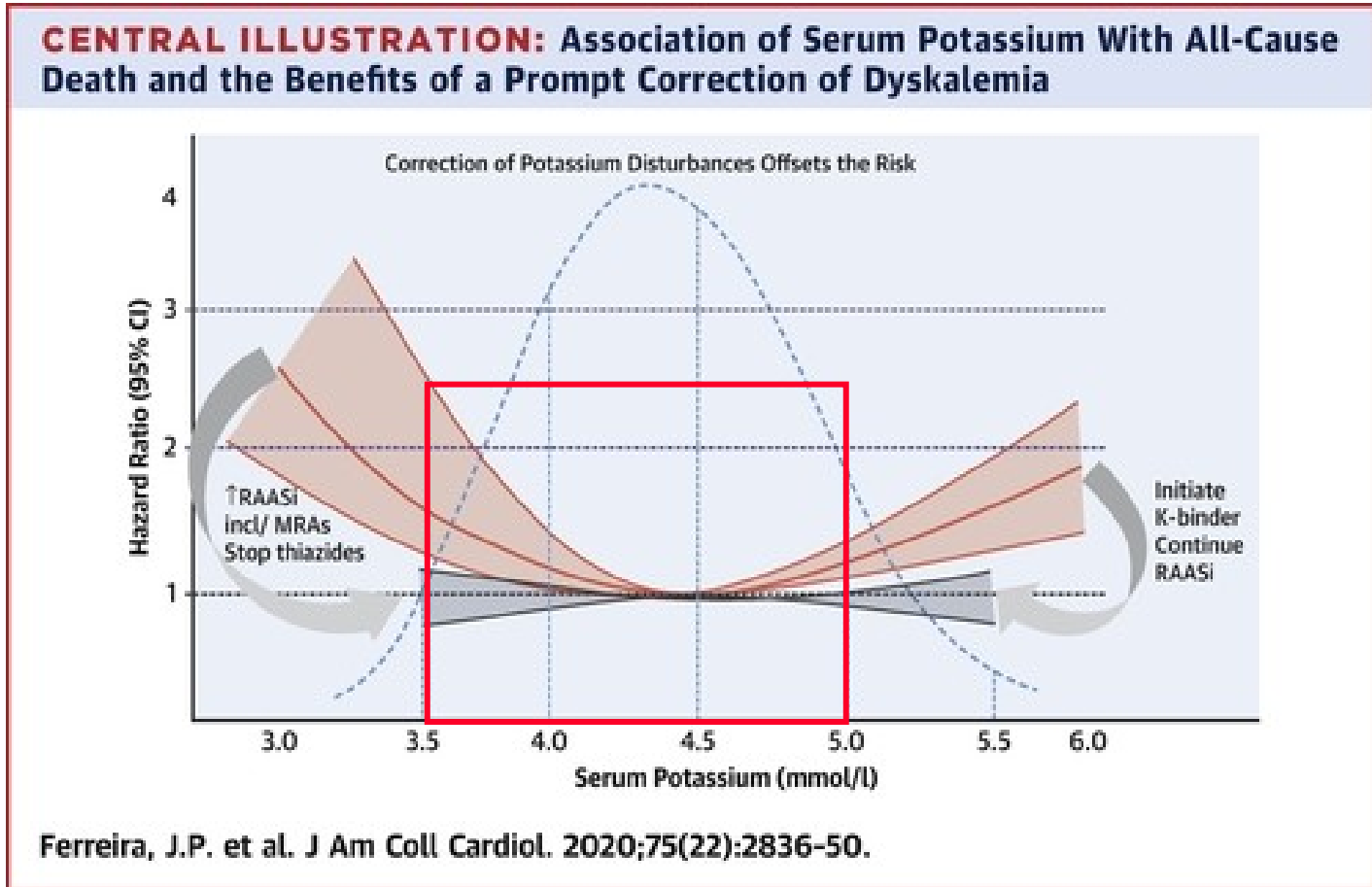
The U-Shaped Curve of Potassium

Association of serum K⁺ with all-cause mortality

Increased with HF, CKD and DM






Abnormalities of Potassium in Heart Failure: JACC State-of-the-Art Review



Review

Hyperkalemia in Diabetes Mellitus Setting

Kleber Goia-Nishide ¹, Lucas Coregliano-Ring ¹ and Érika Bevilaqua Rangel ^{1,2,*}

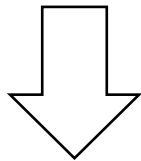
- ¹ Department of Medicine, Nephrology Division, Federal University of São Paulo, São Paulo 04038-901, Brazil; kleber.nishide@unifesp.br (K.G.-N.); lucas.ring@unifesp.br (L.C.-R.)
- ² Jewish Institute of Research and Education, Albert Einstein Hospital, São Paulo 05652-900, Brazil
- * Correspondence: erikabr@uol.com.br

Diabetic patients,

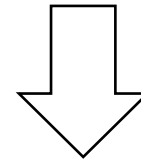
- are **more susceptible to hyperkalemia** due to kidney disease progression or use of renin-angiotensin-aldosterone blockers.
- Hyperkalemia is a potentially life-threatening condition that increases the risk of cardiac arrhythmia episodes and sudden death, making the management of potassium levels a challenge to reduce the mortality rate in this population.

K⁺ BALANCE

Excretion & Reabsorption



90 %



10 %

Gotta be Renal !

OMEOSTASI K⁺

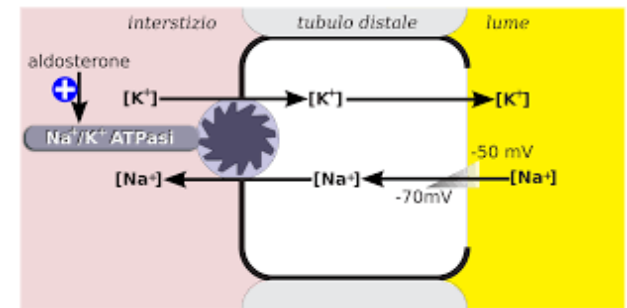
Reni



Equilibrio acido-base



Aldosterone



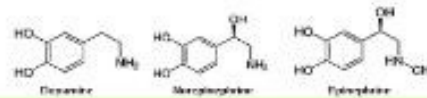
Insulina



Catecolammine

CATECHOLAMINES

- Norepinephrine – alpha agonist property
- Epinephrine – mixed acting (alpha & beta agonist)
- Isoproterenol – selective beta agonist
- Dopamine – immediate precursor of NE



GI & Dieta



ALIMENTI RICCHI DI POTASSIO

(1 mEq = 39 mg; 5900 mg = 151 mEq)



BANANE

400 mg



PATATE

420 mg



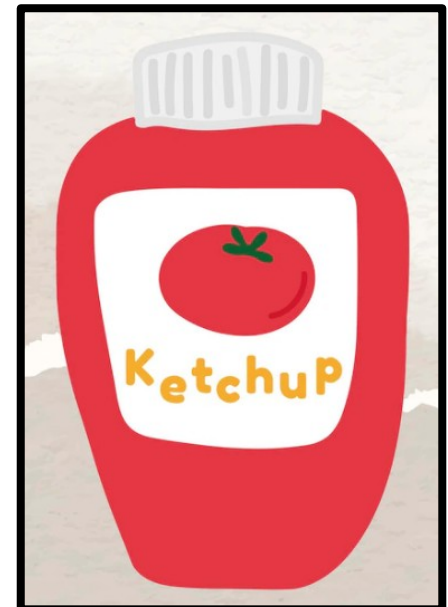
FAGIOLI

500 mg



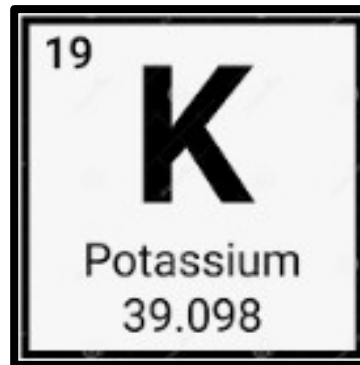
UVA

800 mg




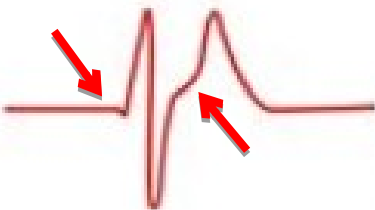

5900 mg

Di quanto potassio abbiamo bisogno?

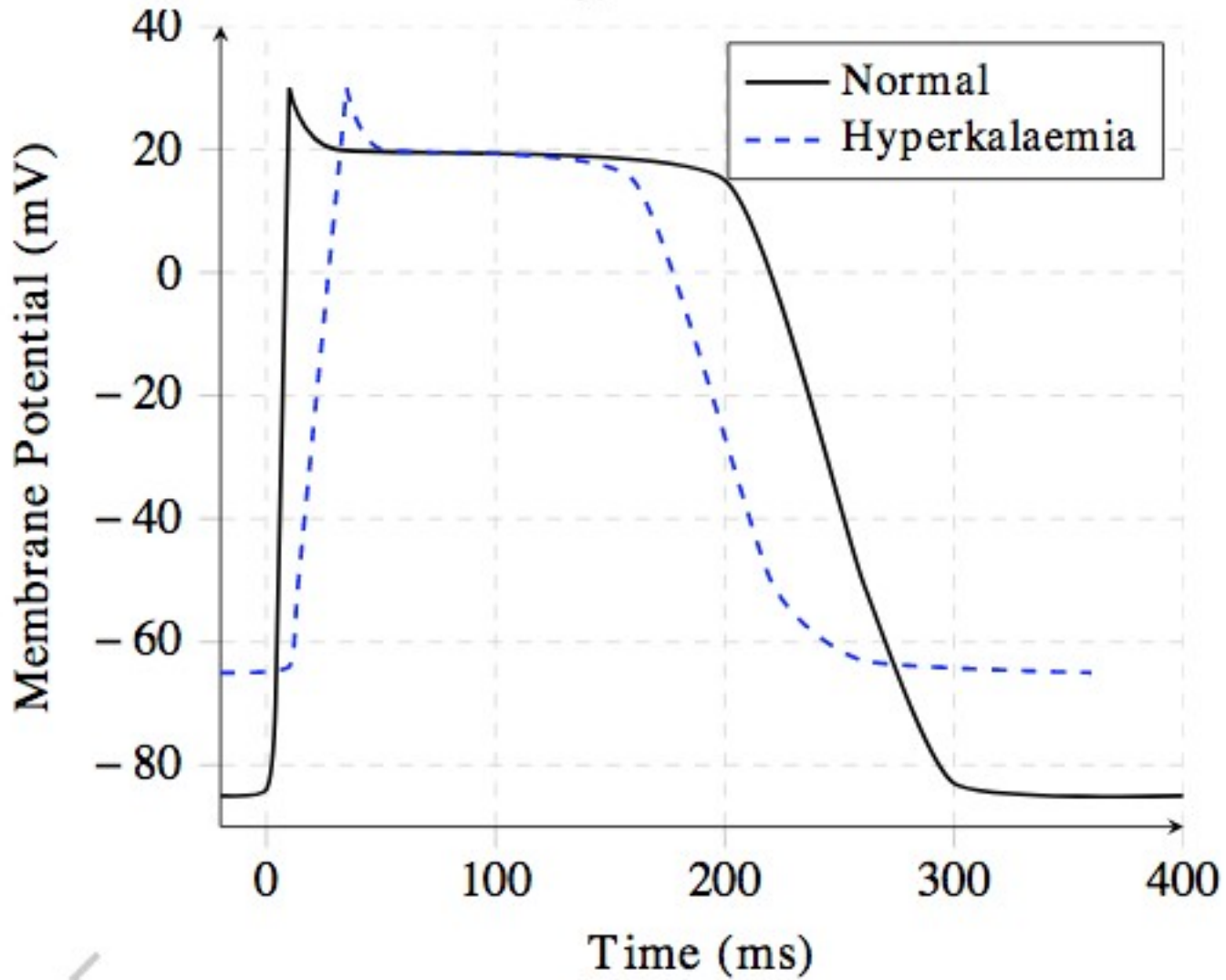


1 mEq/Kg/die

Hyperkalemia ECG changes

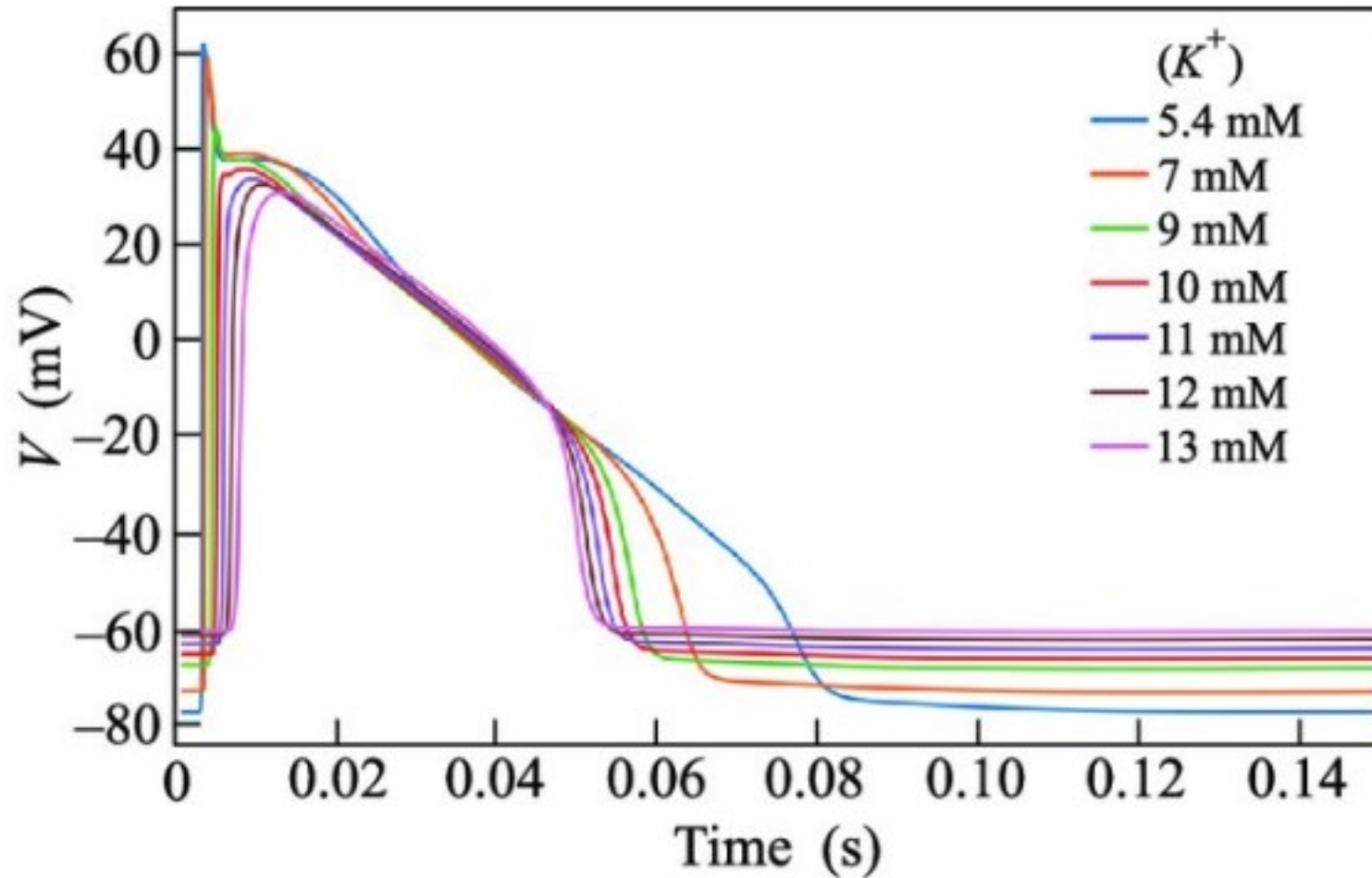
Serum Potassium	Typical ECG Appearance	Possible ECG Abnormalities
Mild (5.5-6.5 mEq/L)		<u>Peaked T waves</u> Prolonged PR segment
Moderate (6.5-8.0 mEq/L)		<u>Loss of P wave</u> Prolonged QRS complex <u>ST-segment elevation (PSEUDO)</u> Ectopic beats and escape rhythms
Severe (> 8.0 mEq/L)		<u>Progressive widening of QRS complex</u> <u>Sine wave</u> <u>Ventricular fibrillation</u> <u>Asystole</u> HEART ARREST IN DIASTOLE

Ventricular Action Potential in Hyperkalaemia:

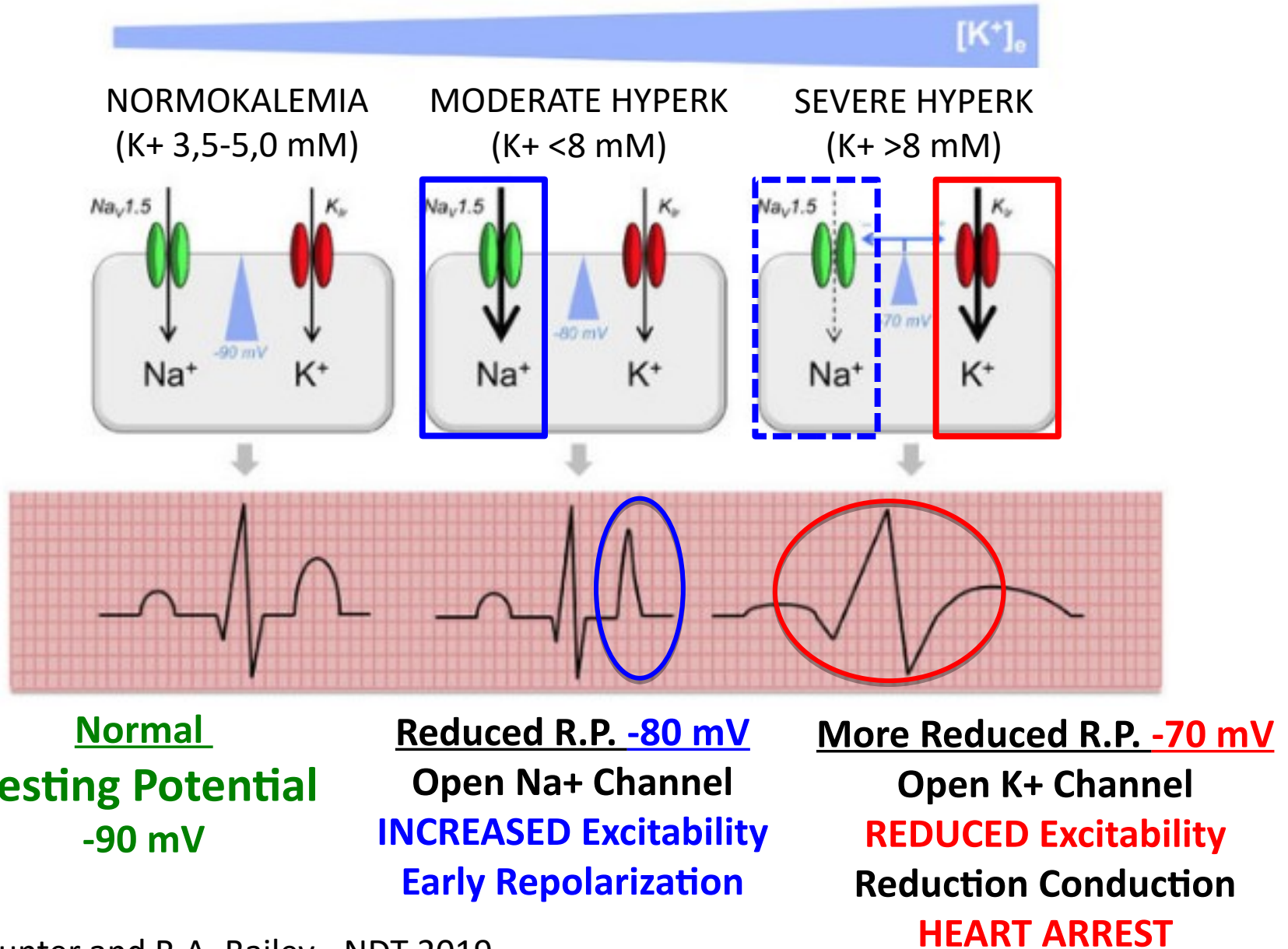


Cardiac Excitation Waves under Strong Hyperkalemia Condition¹

V. A. Tselaya^a, I. Y. Kalita^{a, b}, A. V. Krasheninnikova^a, R. A. Doronin^a,
N. N. Kudryashova^{a, c}, and K. I. Agladze^{a, *}



RESTING POTENTIAL IN HYPERKALEMIA



HYPERKALEMIA TREATMENT IN EMERGENCY

START therapy: K^+ > 6,5 mMol/L (Timing 60, 120, 360 min)

RAPID ACTION TRANS-CELLULAR SHIFT

- CALCIM CHLORIDE IV (2-60 min)
- GLUCOSE & INSULIN INFUSION (5-60 min)
- BICARBONATE INFUSION (5-90 min) 150 mEq/1L
- B-2 ADRENERGIC AGONISTS (5-60 min)

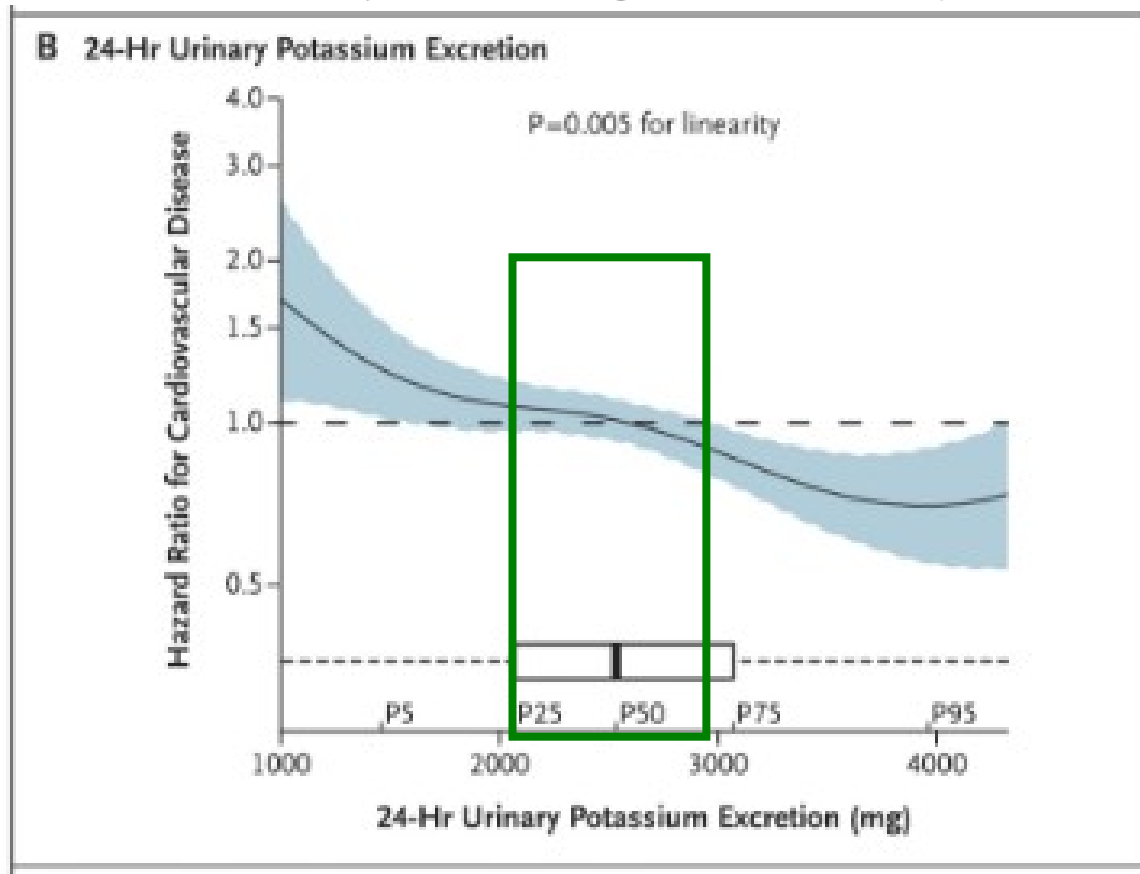


SLOW ACTION BODY REMOVING

- DIURETICS
- STOP RAAS INIBITING DRUGS
- GI K^+ BINDERS
 - Polystyrene, (15-30 g x OS/ENEMA)
 - Zirconium, (10 g x OS)
 - Patiromer, (8,4-25 g x OS)
- DIALYSIS

24-Hour Urinary Sodium and Potassium Excretion and Cardiovascular Risk

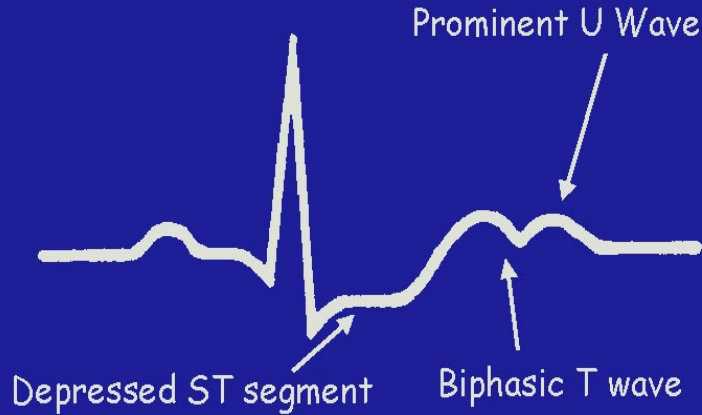
Yuan Ma, Ph.D., Feng J. He, Ph.D., Qi Sun, M.D., Sc.D., Changzheng Yuan, Sc.D., Lyanne M. Kieneker, Ph.D., Gary C. Curhan, M.D., Sc.D., Graham A. MacGregor, M.D., Stephan J.L. Bakker, M.D., Ph.D., Norm R.C. Campbell, M.D., Molin Wang, Ph.D., Eric B. Rimm, Sc.D., JoAnn E. Manson, M.D., Dr.P.H., [et al.](#)



2000-3000 mg/die = **70 mMol/die**

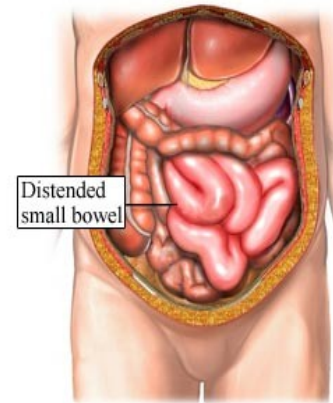
IPOKALIEMIA IN EMERGENZA

ECG Pattern of Hypokalemia



Insufficienza respiratoria acuta

Ileo paralitico



2

1

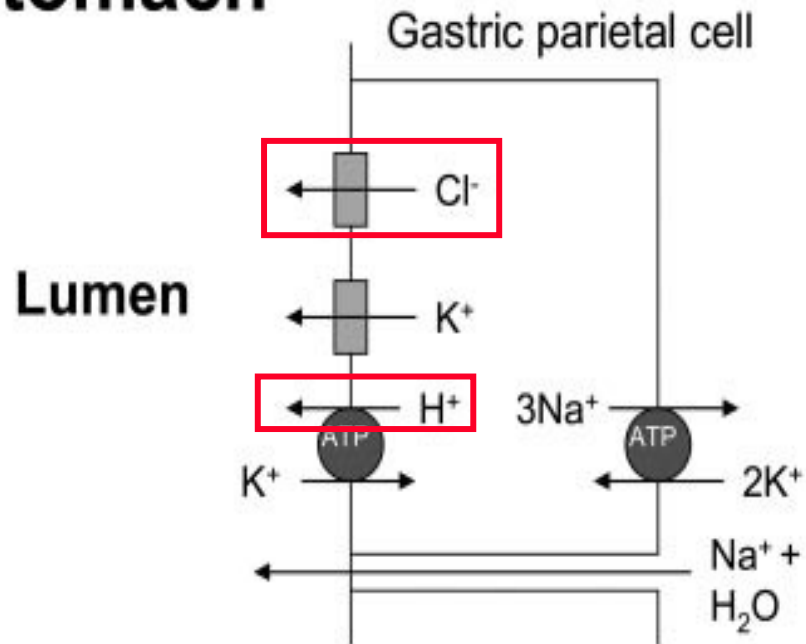
Arresto in Sistole

3

IPOKALIEMIA DA PERDITA EXTRA RENALE

VOMITO

Stomach



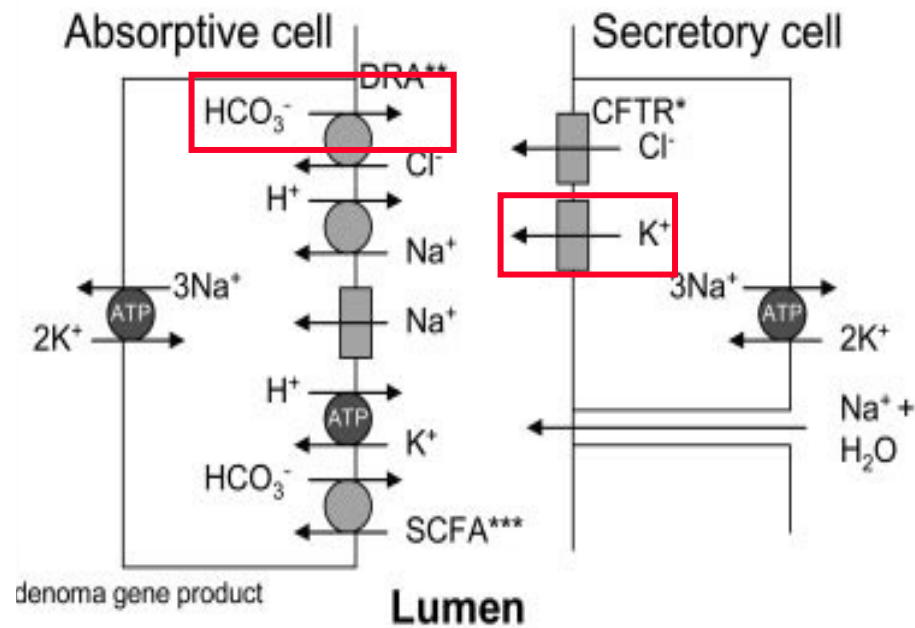
1-2
litri

ALCALOSI METABOLICA

IPOKALIEMIA DA PERDITA EXTRA RENALE

DIARRREA
(SECRETORIA)

Colon



1-10
litri

IPOKALEMIA ACUTA PERICOLOSA



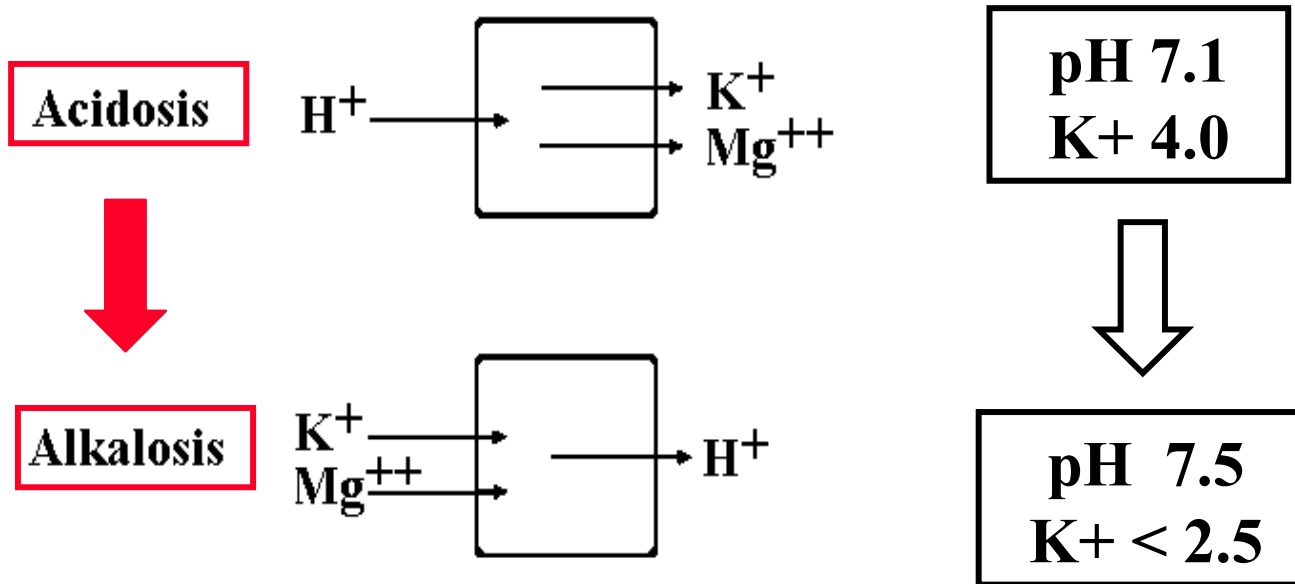
+



=



Table 7. Transcellular shifts at:



IPOKALIEMIA DA PERDITA RENALE

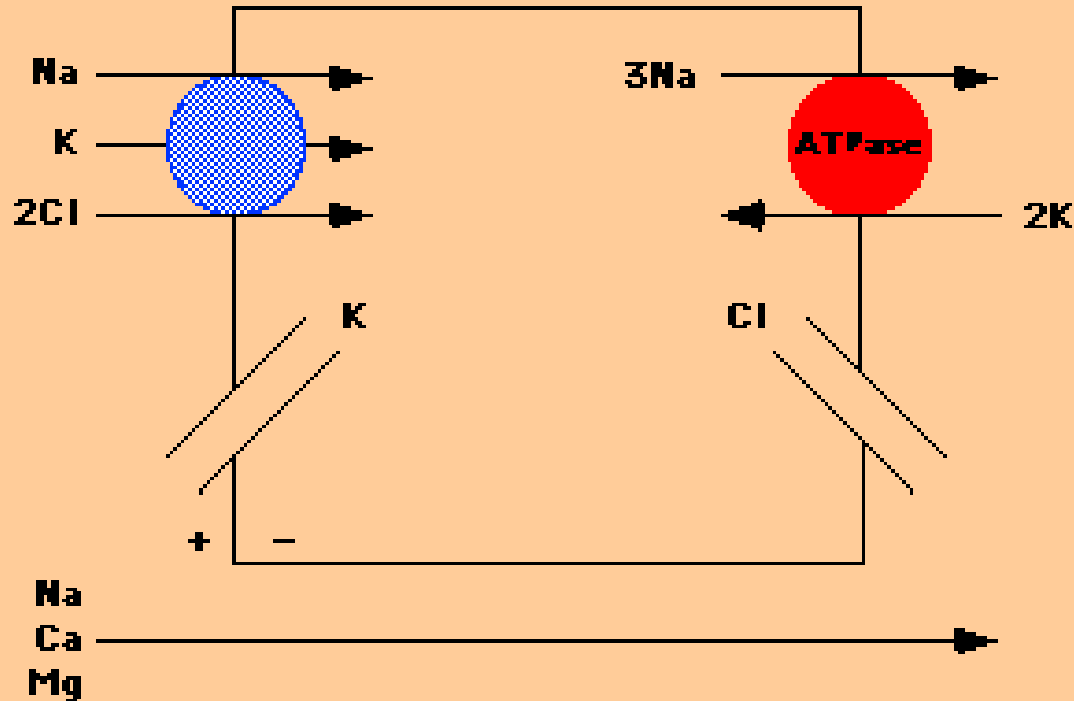
DIURETICI



Amici,
ma non per sempre !

Effects of Furosemide (Loop of Henle)

Tubular lumen



Peritubular capillary

↑
Ur Na⁺

↑
Ur Cl⁻

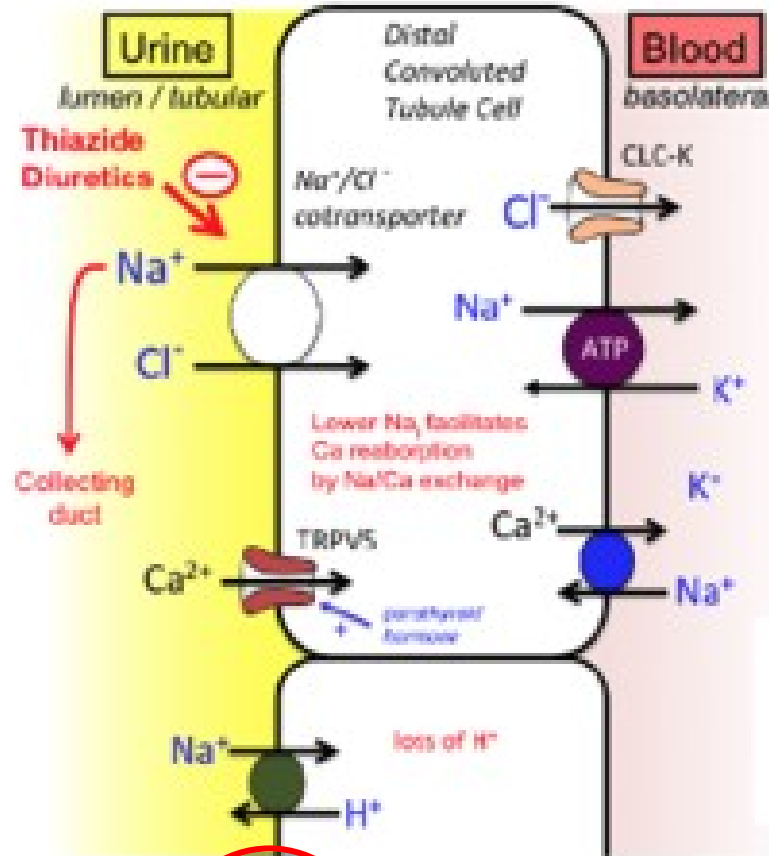
↑
Ur K⁺

↑
Ur Ca⁺⁺

↑
Ur Mg⁺⁺

↑
Ur H⁺

Effects of Thiazide Diuretics (Distal Tubule)



↑
Ur Na^+

↑
Ur Cl^-

↑
Ur K^+

↓
Ur Ca^{++}

↑
Ur Mg^{++}

↑
Ur H^+

Relation between admission serum potassium levels and long-term mortality in acute coronary syndrome

Yong Peng¹ · Fang-yang Huang¹ · Wei Liu¹ · Chen Zhang¹ · Zhen-gang Zhai
Bao-tao Huang¹ · Yan-biao Liao¹ · Qiao Li¹ · Hua Chai¹ · Xiao-lin Luo¹ ·
Xin Ren¹ · Chi Chen¹ · Qing-tao Meng¹ · De-jia Huang¹ · Hua Wang¹ ·
Mao Chen¹

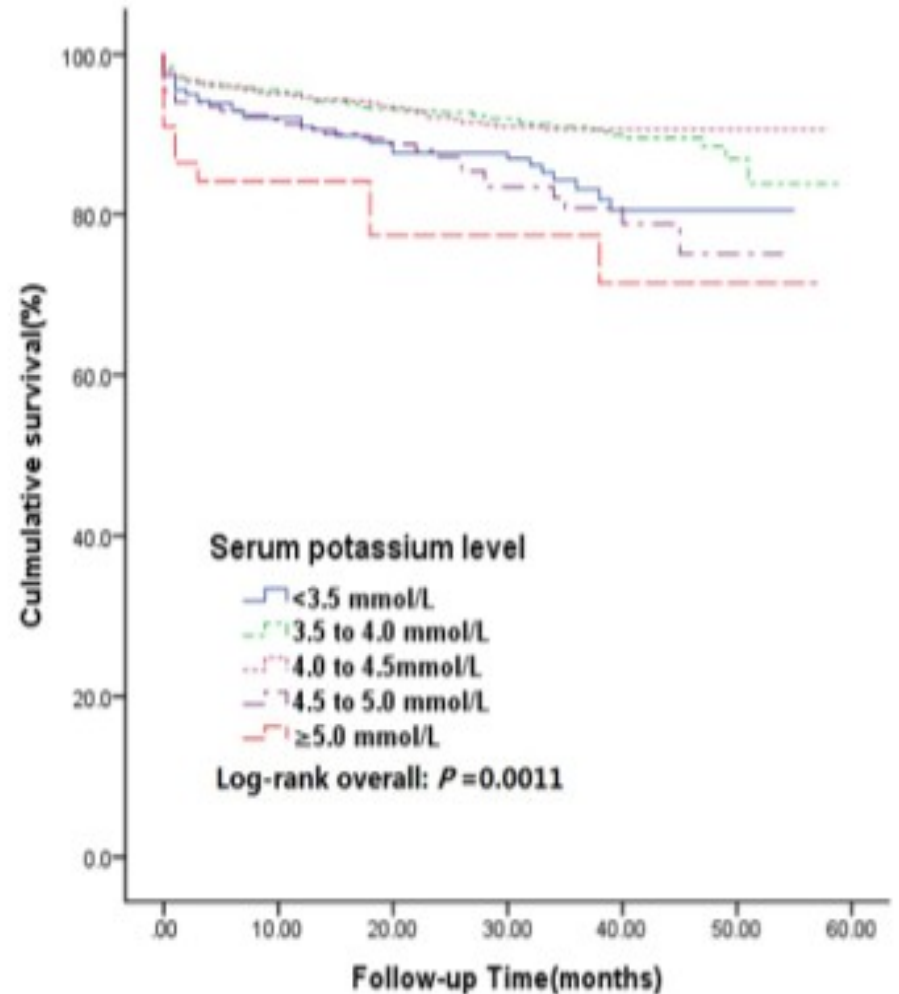


Fig. 2 Kaplan–Meier curve according to the admission serum potassium concentration strata for all-cause deaths in 2369 patients with acute coronary syndrome (ACS)

Association of serum potassium concentration with mortality and ventricular arrhythmias in patients with acute myocardial infarction: A systematic review and meta-analysis

Miriam Giovanna Colombo^{1,2,*}, Inge Kirchberger^{1,2,3,4,*},
Ute Amann^{1,2,3}, Lisa Dinser^{1,2} and Christa Meisinger^{1,2,3}

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Cardiology
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DOI: 10.1177/2047487318759694
journals.sagepub.com/home/ejpc


Discussion

This systematic review and meta-analysis showed that SPCs **less than 3.5 mEq/L and 4.5 mEq/L or greater** inpatients with **AMI** were associated with **a higher risk of short-term mortality**...

In addition, SPCs **less than 3.5 mEq/L** were associated with an **increased risk of VA**.

IDENTIKIT PAZIENTE

SINDROME CORONARICA IN PS

ALTO RISCHIO ARITMIE VENTRICOLARI

- IPERTENSIONE, DIURETICI?
- SUDORAZIONE ALGIDA, ADRENALINA?
- VOMITO ?
- IPOSTENIA MARCATA?
- **IPOKALEMIA?**





Marcianise very nice !

Schettini F.
Brunelli E.
Fischetti S.
Varrichione N.
Rozza G.
Pasquale D.
Santoro A.
Viati L.
Carlino F.
Buonanno S.
Guerrera B.
Ricciotti R.
Daddio F.
Di Sisto A.
Nasta C.
Palumbo F.
Morelli R.
Giordano F.
Gravina S.
Moretti A.
Iodice C.
Tartaglione M.
Di Nuzzo B.