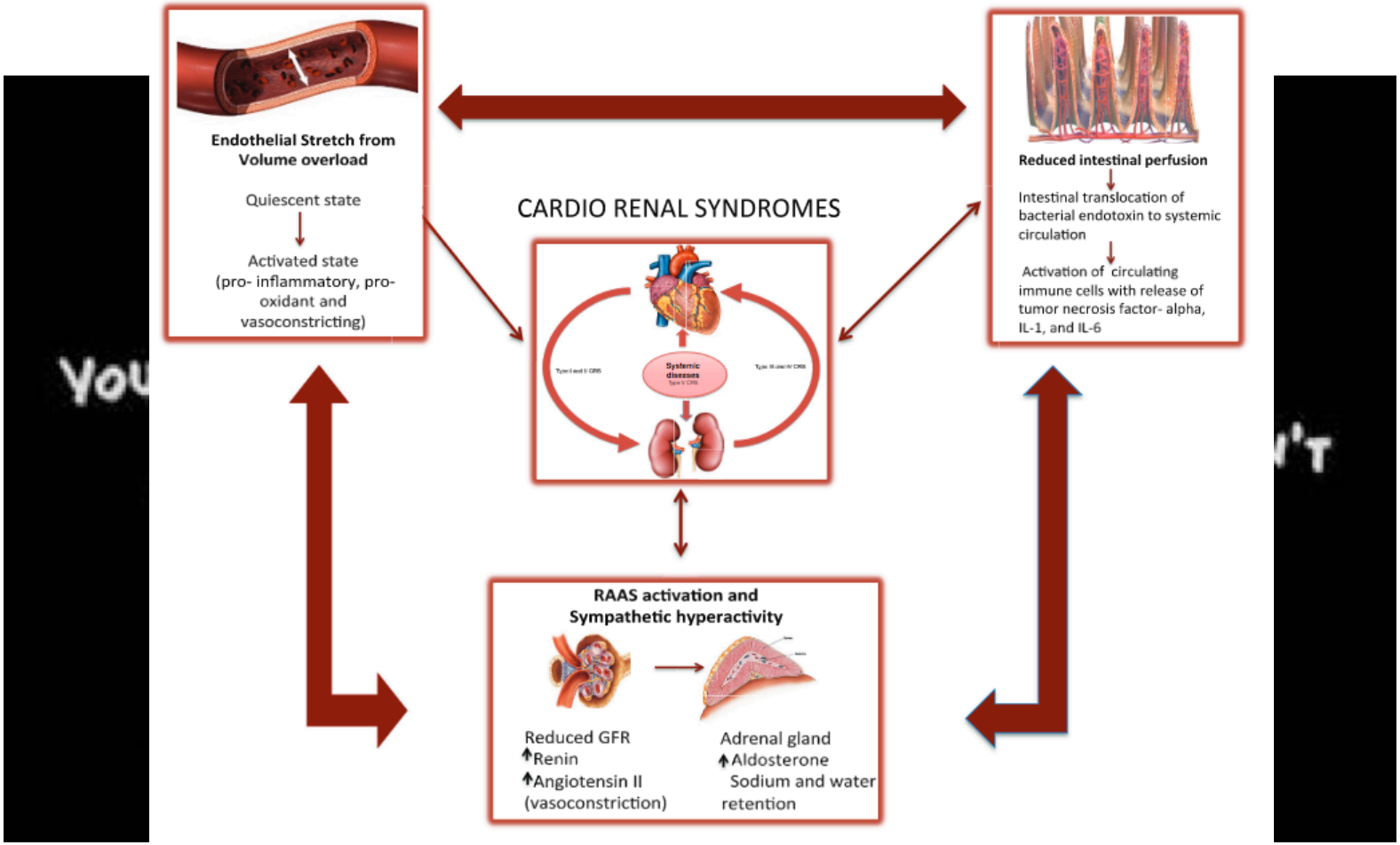
SUERO SALINO HIPERTÓNICO EN INSUFICIENCIA CARDÍACA

MITO O REALIDAD

JOSÉ PÉREZ SILVESTRE
MEDICINA INTERNA
CONSORCIO HOSPITAL GENERAL UNIVERSITARIO VALENCIA

Síndrome Cardiorrenal



Gnanaraj J, and RadhakrishnanJ. Cardio-renal syndrome. F1000Research 31 Aug 2016, 5 (F1000 Faculty Rev): 2123.

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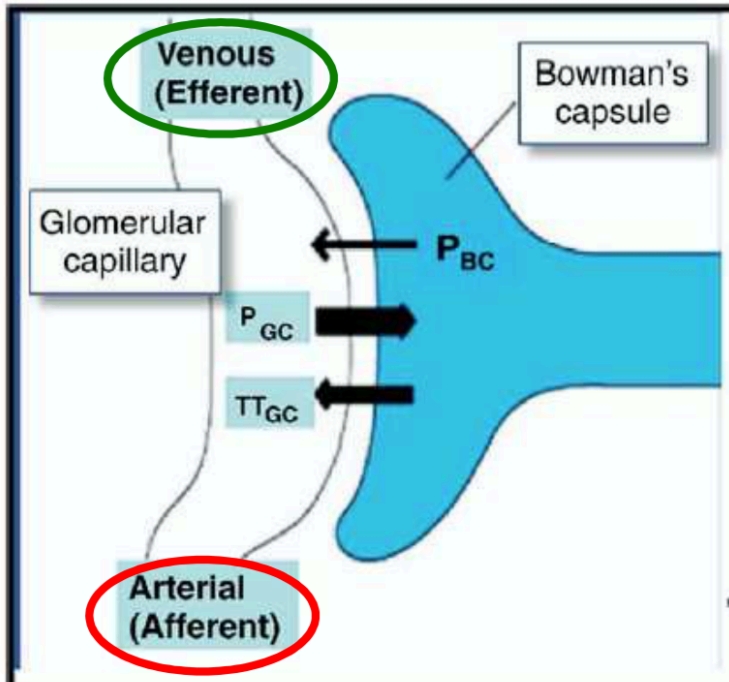

Forces	Normal: Afferent end of glomerular capillary (mmHg)	Normal: Efferent end of glomerular capillary (mmHg)	↑ RA pressure: Afferent end of glomerular capillary (mmHg)	↑ RA pressure: Efferent end of glomerular capillary (mmHg)
1. Favoring Filtration				
Glomerular-capillary hydrostatic pressure, P_{GC}	60	58	55	63
2. Opposing Filtration				
a. Hydrostatic pressure in Bowman's capsule, P_{BC}	15	15	15	15
b. Oncotic pressure in glomerular capillaries, π_{GC}	21	33	21	33
Net filtration pressure (1-2)	24	10	19	15
Filtration pressure:	*14 mmHg*		*4 mmHg*	

Figure 1 **Impact of Venous Congestion on Glomerular Net Filtration Pressure**

An illustration of the afferent and efferent pressures at a glomerular capillary in a patient with normal hemodynamics and a patient with increased right atrial (RA) pressure and venous congestion. P_{BC} = hydrostatic pressure in Bowman's capsule; P_{GC} = glomerular capillary hydrostatic pressure; π_{GC} = oncotic pressure in glomerular capillaries.

J Am Coll Cardiol 2009;53:598–99

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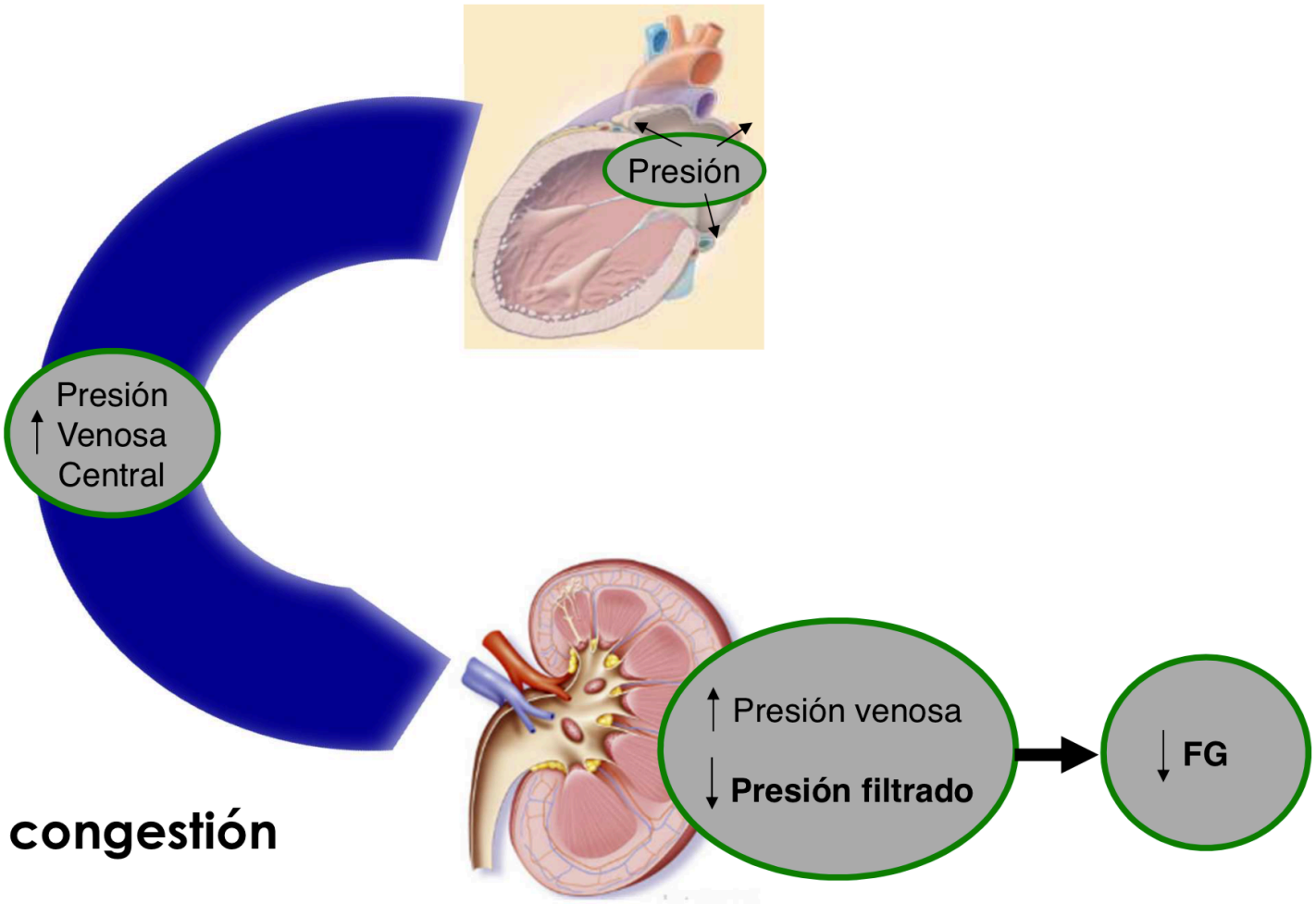

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Importance of Venous Congestion for Worsening of Renal Function in Advanced Decompensated Heart Failure

Methods

A total of 145 consecutive patients admitted with ADHF treated with intensive medical therapy guided by pulmonary artery catheter were studied. We defined WRF as an increase of serum creatinine ≥0.3 mg/dl during hospitalization.

Table 2 Hemodynamic Variables on Admission and Time of PAC in All Patients and Stratified According to Those Who Developed WRF (n = 58) and Those Who Did Not (n = 87)

	All Patients (n = 145)			Patients With WRF (n = 58)			Patients Without WRF (n = 87)		
	Baseline	Follow-Up	p Value	Baseline	Follow-Up	p Value	Baseline	Follow-Up	p Value
HR (beats/min)	88 ± 40	89 ± 18	NS	86 ± 22*	90 ± 16*	NS	89 ± 46	88 ± 19	NS
SBP (mm Hg)	109 ± 18	109 ± 18	NS	111 ± 21*	110 ± 25*	NS	108 ± 15	109 ± 15	NS
CVP (mm Hg)	14 ± 7	9 ± 6	<0.001	18 ± 7†	11 ± 8‡	<0.001	12 ± 6	8 ± 5	<0.001
SPA (mm Hg)	55 ± 15	46 ± 7	<0.001	57 ± 13*	49 ± 15*	<0.001	54 ± 16	46 ± 12	<0.001
PCWP (mm Hg)	24 ± 7	18 ± 5	<0.001	25 ± 7*	19 ± 5*	<0.001	24 ± 7	18 ± 5	<0.001
CI (l/min/m^2)	1.9 ± 0.6	2.5 ± 0.6	<0.001	2.0 ± 0.8§	2.7 ± 0.7‖	<0.001	1.8 ± 0.4	2.4 ± 0.5	<0.001

J Am Coll Cardiol 2009;53:589–96

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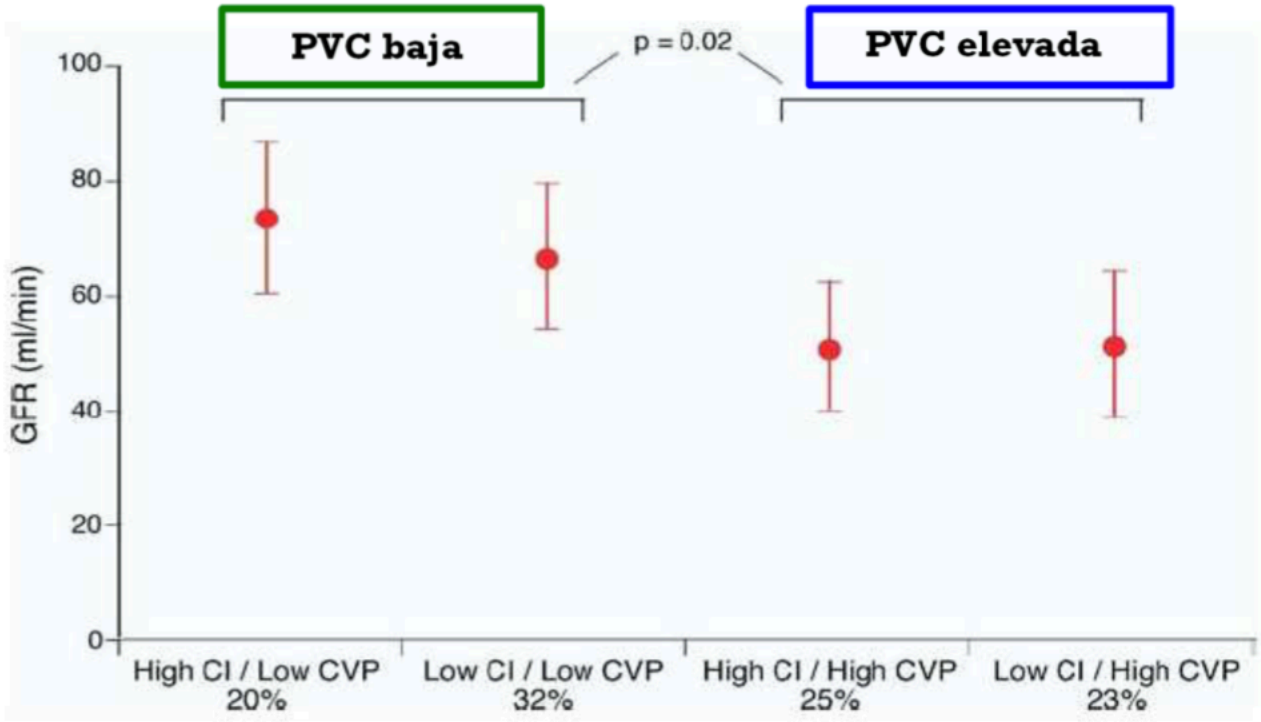

Figure 3 **Relative Contributions of CVP and CI to GFR at Time of PAC Removal**

Error bars represent 95% confidence intervals. Cutoff values for CI = 2.4 l/min/m^2 and CVP = 8 mm Hg. GFR = glomerular filtration rate; PAC = pulmonary artery catheter; other abbreviations as in Figure 1.

J Am Coll Cardiol 2009;53:589–96

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Resistencia a Diuréticos

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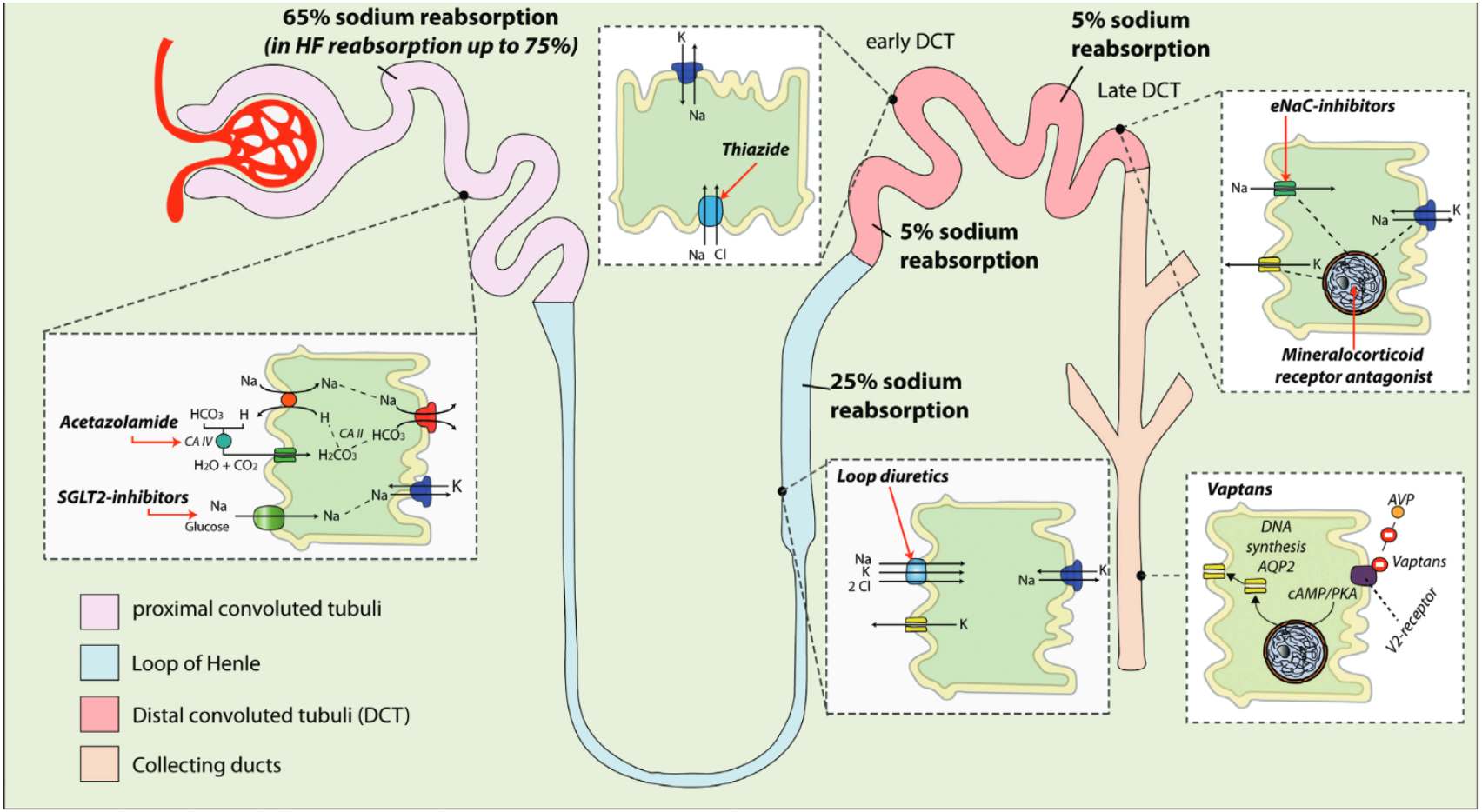

Eur J Heart Fail. 2019 Feb;21(2):137-155.

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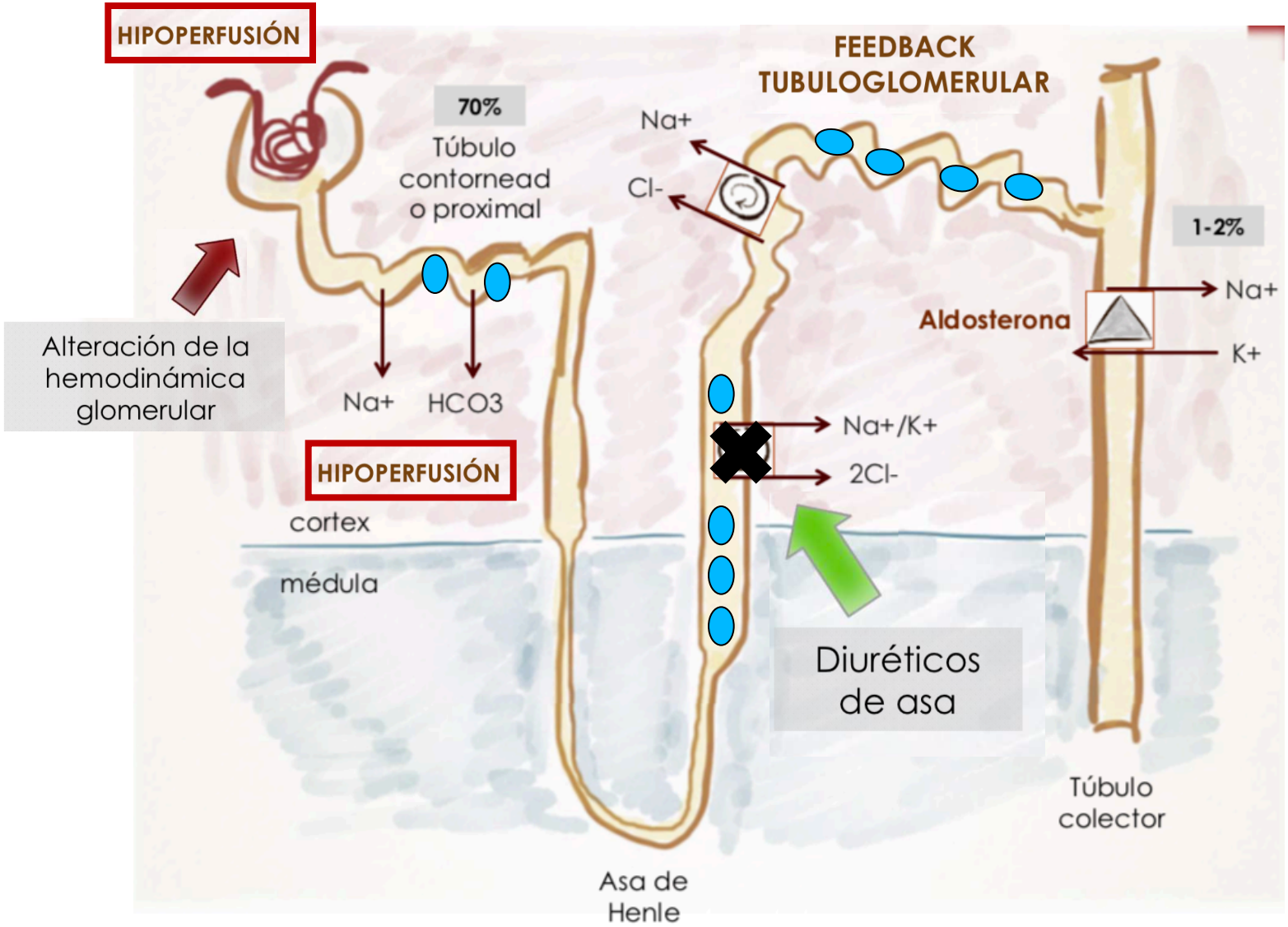

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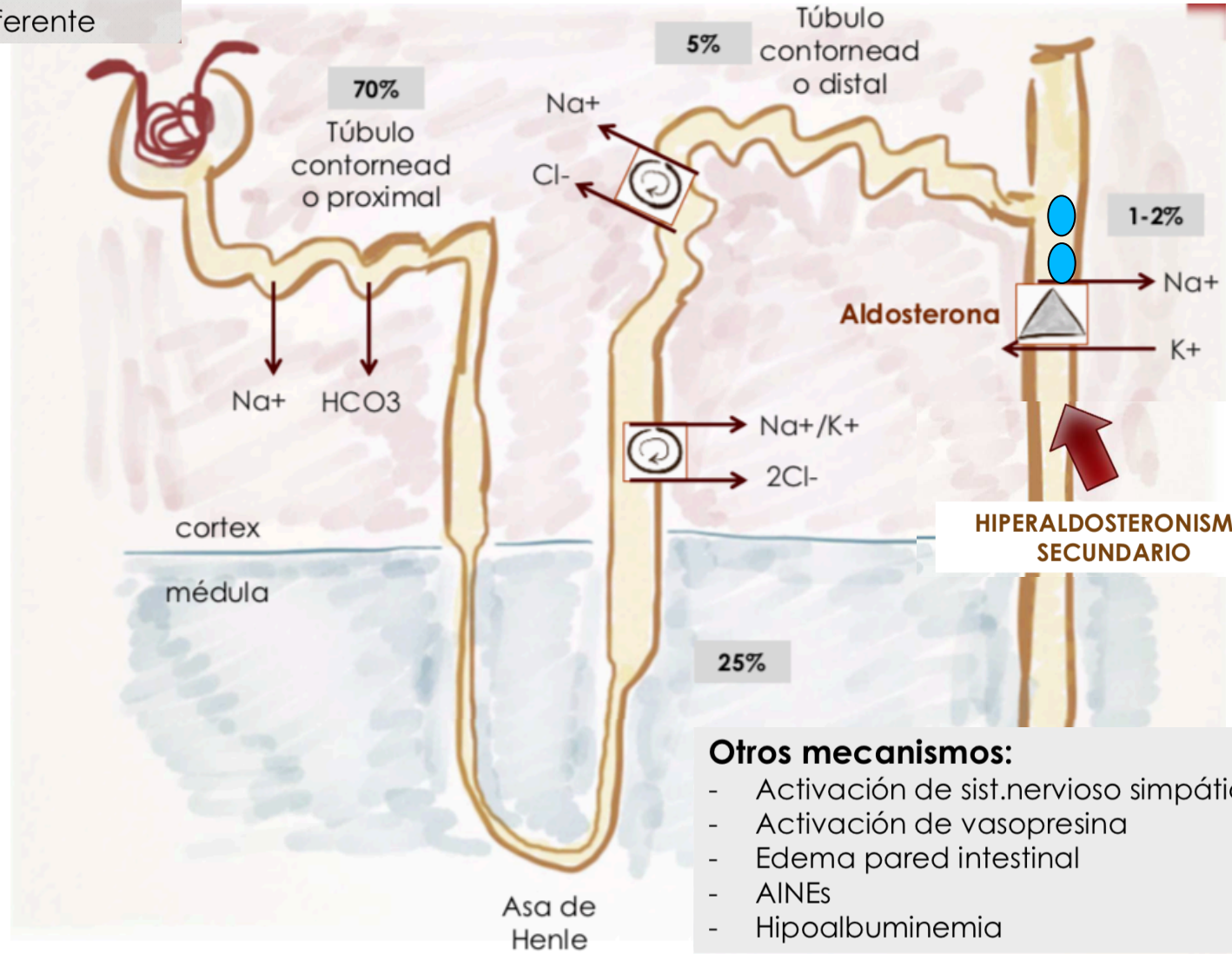
Vasoconstricción aferente



HIPERALDOSTERONISMO SECUNDARIO

Otros mecanismos:

- Activación de sist.nervioso simpático
- Activación de vasopresina
- Edema pared intestinal
- AINEs
- Hipoalbuminemia

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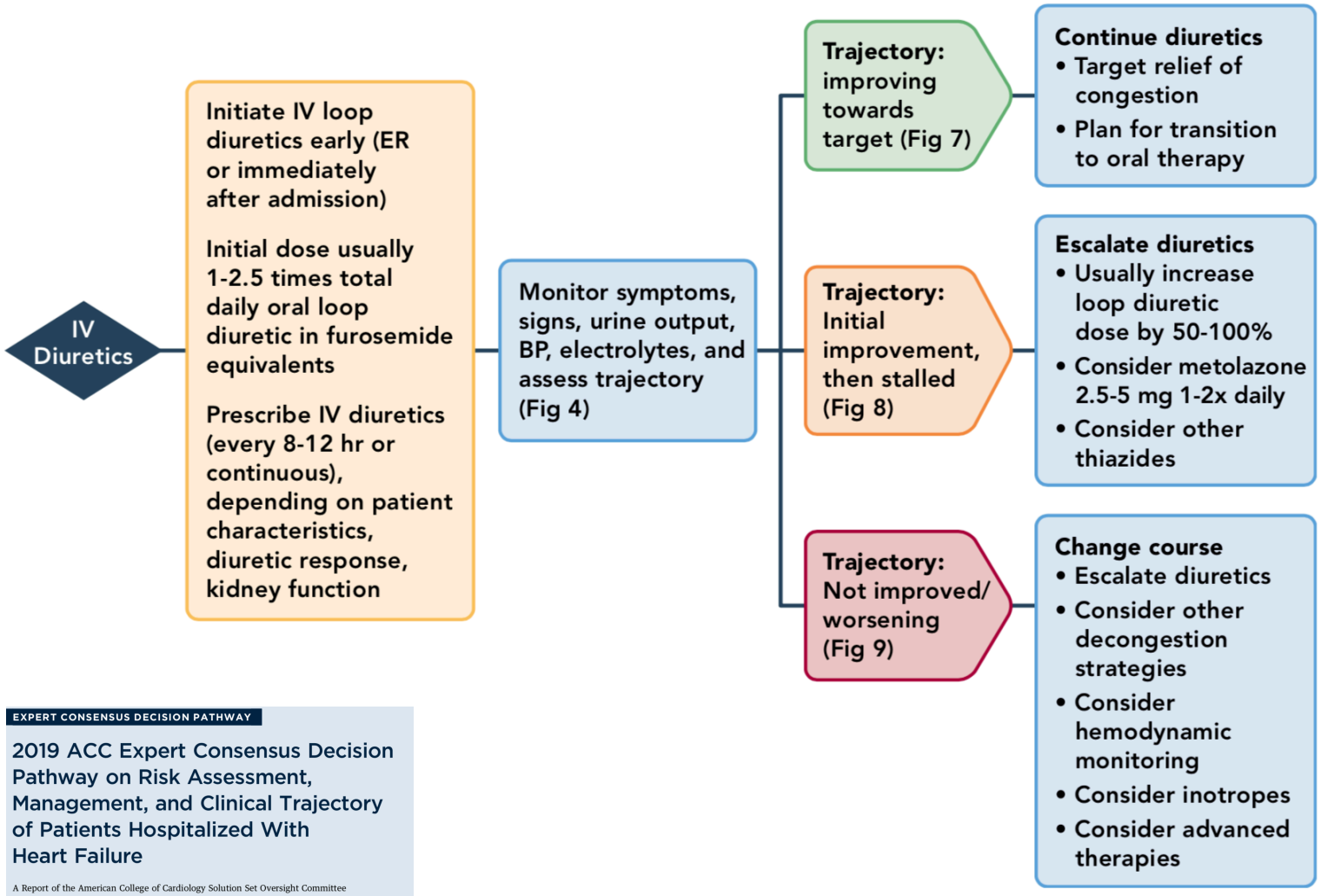
FIGURE 6 Diuretic Therapy in Different Clinical Trajectories



EXPERT CONSENSUS DECISION PATHWAY

2019 ACC Expert Consensus Decision Pathway on Risk Assessment, Management, and Clinical Trajectory of Patients Hospitalized With Heart Failure

A Report of the American College of Cardiology Solution Set Oversight Committee

https://doi.org/10.1016/j.jacc.2019.08.001

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Go to part 2: treatment algorithm after 24-hours

cPROTOCOLO DE SUERO SALINO HIPERTÓNICO:

- Furosemida: 250-500 mgr/12h/iv en 30 minutos
- BoiK aspártico: 2 comprimidos cada 8 horas
- Restricción hídrica de 1.000 cc diarios
- Función renal e ionograma diario
- 150 cc SSH/12h/iv en 30 min. Concentración de Na^+ en la infusión según natremia

Concentración de la infusión	Niveles de Na^+ en sangre	Forma de preparación
Suero salino hipertónico al 4,6%	<125 mEq/L	Diluir 19 ampollas de ClNa 20% en 1.000 ml de suero salino 0,9% y administrar 150 ml de la dilución en 30 minutos/12 horas
Suero salino hipertónico al 3,5%	126-135 mEq/L	Diluir 14 ampollas de ClNa 20% en 1.000 ml de suero salino 0,9% y administrar 150 ml de la dilución en 30 minutos/12 horas
Suero salino hipertónico al 2,4%	136-145 mEq/L	Diluir 8 ampollas de ClNa 20% en 1.000 ml de suero salino 0,9% y administrar 150 ml de la dilución en 30 minutos/12 horas
Suero salino hipertónico al 1,4%	>145 mEq/L	Diluir 3 ampollas de ClNa 20% en 1.000 ml de suero salino 0,9% y administrar 150 ml de la dilución en 30 minutos/12 horas

ELSEVIER

European Journal of Heart Failure 2 (2000) 305–313

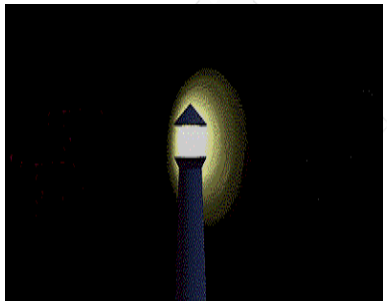
The European Journal of Heart Failure

www.elsevier.com/locate/heafai

Effects of high-dose furosemide and small-volume hypertonic saline solution infusion in comparison with a high dose of furosemide as a bolus, in refractory congestive heart failure

Salvatore Paterna[a], Pietro Di Pasquale[b,*], Gaspare Parrinello[a], Piera Amato[a], Antonella Cardinale[a], Giuseppe Follone[a], Alfonso Giubilato[b], Giuseppe Licata[a]

[a]*Department of Internal Medicine, University of Palermo, Palermo, Italy*
[b]*Division of Cardiology, 'Paolo Borsellino', G. F. Ingrassia Hospital, Palermo, Italy*



Eur J Heart Fail. 2000; 2 :305-13

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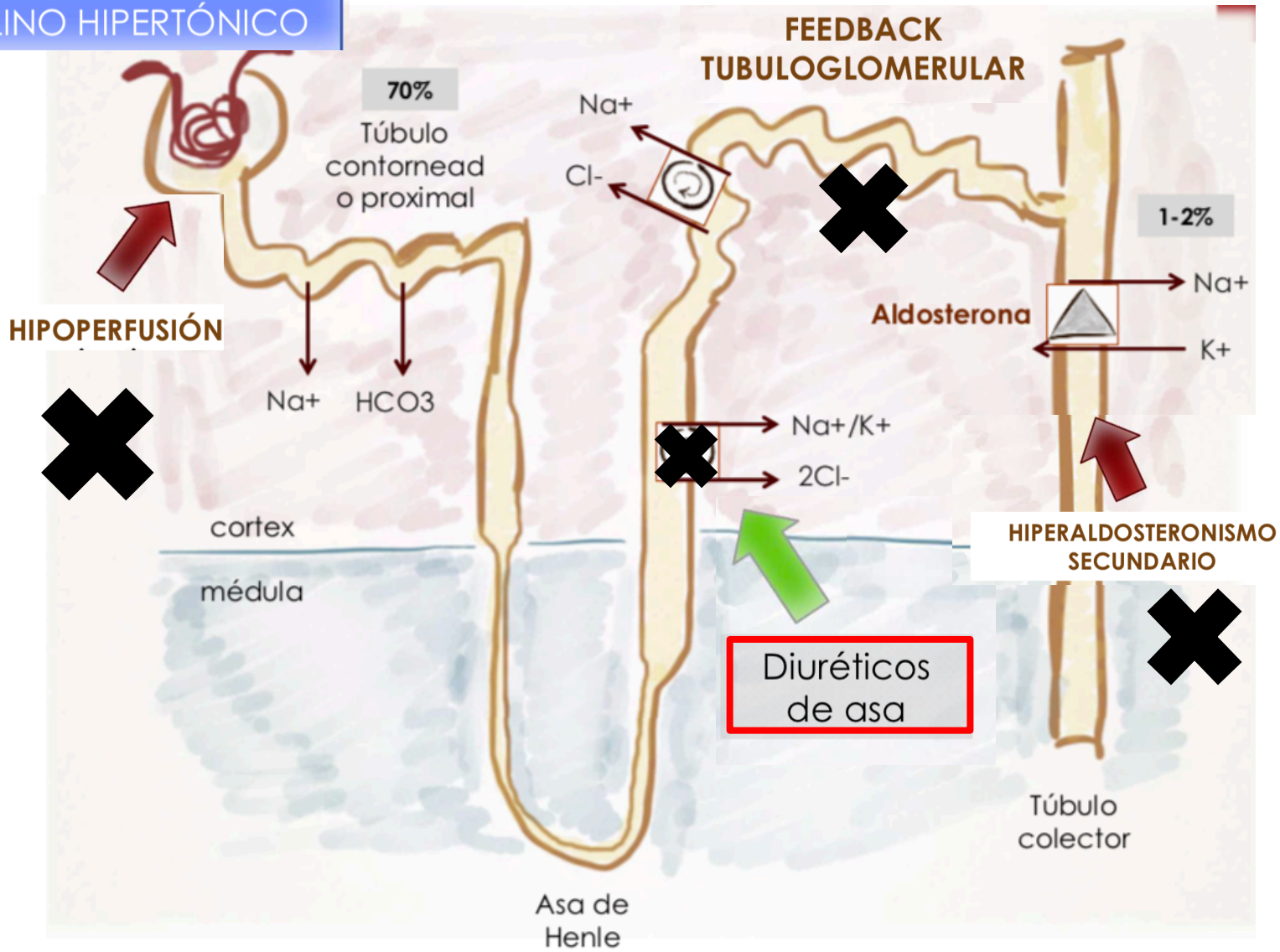
SALINO HIPERTÓNICO



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Effects of high-dose furosemide and small-volume hypertonic saline solution infusion in comparison with a high dose of furosemide as a bolus, in refractory congestive heart failure

Concentración de la infusión	Niveles de Na en sangre	Forma de preparación
Suero salino hipertónico al 4.6%	< 125 mEq/L	Diluir 19 ampollas de ClNa 20% en 1000 ml de ClNa 0,9% y administrar al paciente 150 ml en 30x/12h.
Suero salino hipertónico al 3.5%	126-135 mEq/L	Diluir 14 ampollas de ClNa 20% en 1000 ml de ClNa 0,9% y administrar al paciente 150 ml en 30x/12h.
Suero salino hipertónico al 2.4%	> 135 mEq/L	Diluir 8 ampollas de ClNa 20% en 1000 ml de ClNa 0,9% y administrar al paciente 150 ml en 30x /12h.
Suero salino hipertónico al 1.4%	>145 mEq/L	Diluir 3 ampollas de ClNa 20% en 1000 ml de ClNa 0.9% y administrar al paciente 150 ml en 30x /12

Suero Salino Hipertónico
150 ml/12 horas en 30 minutos

+

Dosis de furosemida entre 250-500 mg/12 horas en 30 minutos.

Administración de ClK (20-40 mEq/día)

Eur J Heart Fail. 2000; 2 :305-13

4ª Edición. Manual práctico de manejo integral del paciente con insuficiencia cardíaca crónica

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Short-Term Effects of Hypertonic Saline Solution in Acute Heart Failure and Long-Term Effects of a Moderate Sodium Restriction in Patients With Compensated Heart Failure With New York Heart Association Class III (Class C) (SMAC-HF Study)

Salvatore Paterna, MD, Sergio Fasullo, MD, Gaspare Parrinello, MD, Sergio Cannizzaro, MD,

Charact.	Furosemide+HSS n=953	Furosemide n=974
Age	74.7±11	73.4±13
Creatinine	1.65±0.05	1.61±0.05
eGFR ml/min	52.2±2.2	52.1±2.3
Captopril	953 (100%)	974 (100%)
Carvedilol	659 (69.1%)	679 (69.7%)
Furosemide 125 mg/12 h	363 (38%)	670 (69.7%)
Furosemide 50 mg/12 h	590(61.9%)	620(62.9%)
Espironolactona 25mg	811(85%)	825(84.7%)

N= 1297, IC sin respuesta a tto (250 mg furosemida) y tto óptimo

FG <60, FEV <40%, diuresis < 800 cc/24 h

Randomizado simple ciego

Furo+HSS (dieta 120 mmol Na)
vs
Furo (dieta 80 mmol Na)

Objetivo primario: muerte o primer ingreso por IC

Am J Med Sci 2011;342(1):27–37

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Estancia media más corta
Mejor clase funcional

Menos efectos adversos

TABLE 3. Clinical results at discharge in both groups

	Furosemide with HSS	Furosemide without HSS	*P*
Side effects (tinnitus)	0	71 (7.2%)	<0.0001
NYHA class II	736 (77.2%)	813 (83.4%)	<0.29
NYHA class I	217 (22.8%)	161 (16.5%)	<0.006
Hospitalization time (days)	3.5 ± 1	5.5 ± 1	<0.0001
Ejection fraction (%)	37.3 ± 5	36.4 ± 6	<0.0001
BNP (pg/mL)	355 ± 105	385 ± 115	<0.0001
Creatinine clearance	55.4 ± 3.3	48.7 ± 2.1	<0.0001

NYHA, New York Heart Association; BNP, brain natriuretic peptide; HSS, hypertonic saline solution.

Mejoría filtrado glomerular

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Am J Med Sci 2011;342(1):27–37

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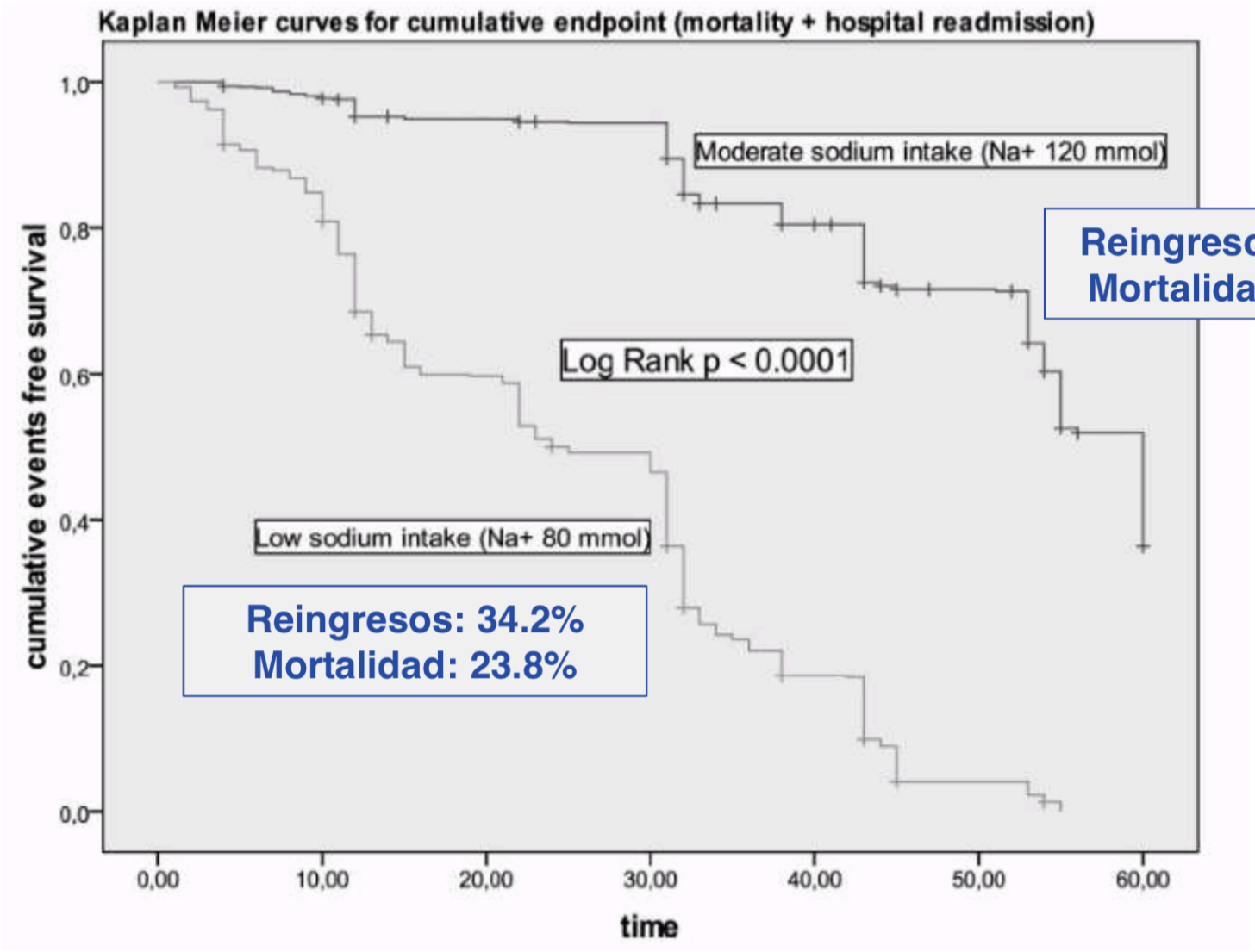

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Am J Med Sci 2011;342(1):27–37

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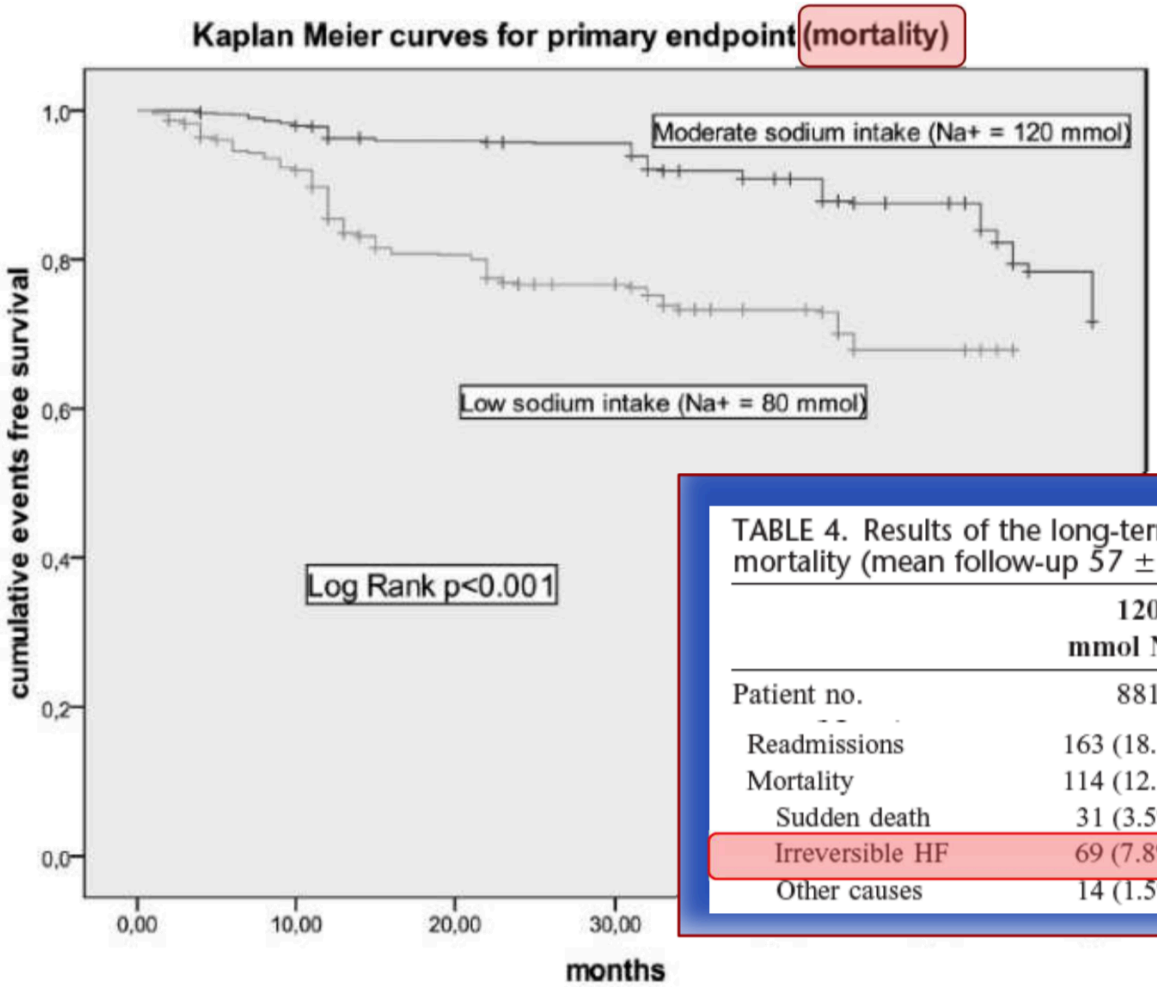

TABLE 4. Results of the long-term study: Readmissions and mortality (mean follow-up 57 ± 15 months)

	120 mmol Na/d	80 mmol Na/d	*P*
Patient no.	881	890	
Readmissions	163 (18.5%)	305 (34.2%)	<0.0001
Mortality	114 (12.9%	212 (23.8%)	<0.0001
Sudden death	31 (3.5%)	46 (5.1%)	<0.6
Irreversible HF	69 (7.8%)	149 (16.7%)	<0.0001
Other causes	14 (1.5%)	17 (1.9%)	<0.76

Am J Med Sci 2011;342(1):27–37

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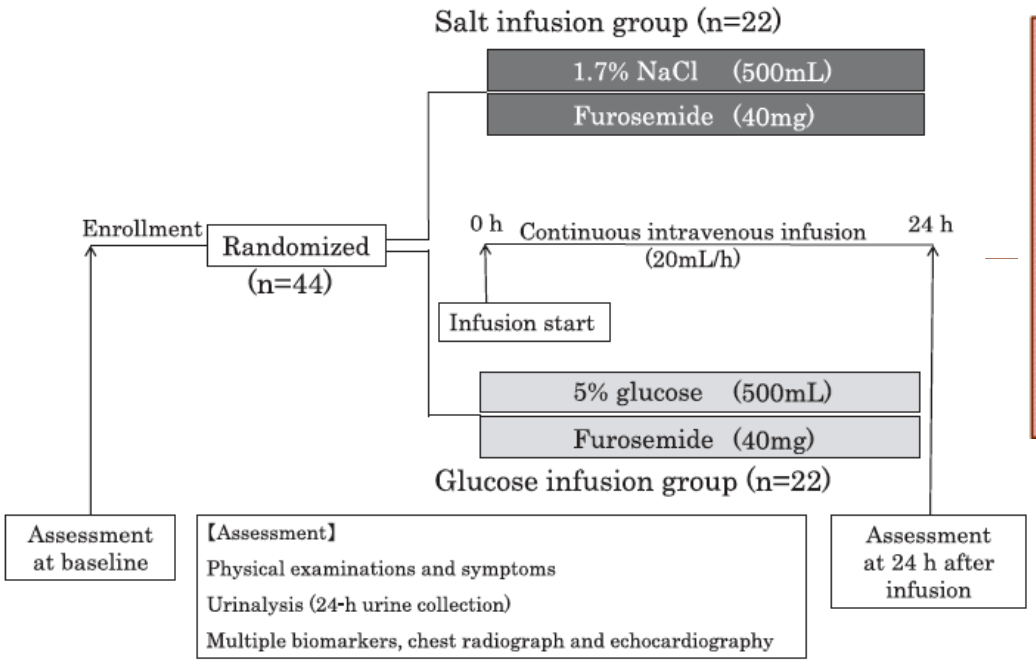
Intravenous Salt Supplementation With Low-Dose Furosemide for Treatment of Acute Decompensated Heart Failure



- Mejoría disnea
- Mayor diuresis
- Mejor filtrado glomerular
- Menores niveles de péptidos natriuréticos y cistatina C.

J Cardiac Fail 2014;20:295-301

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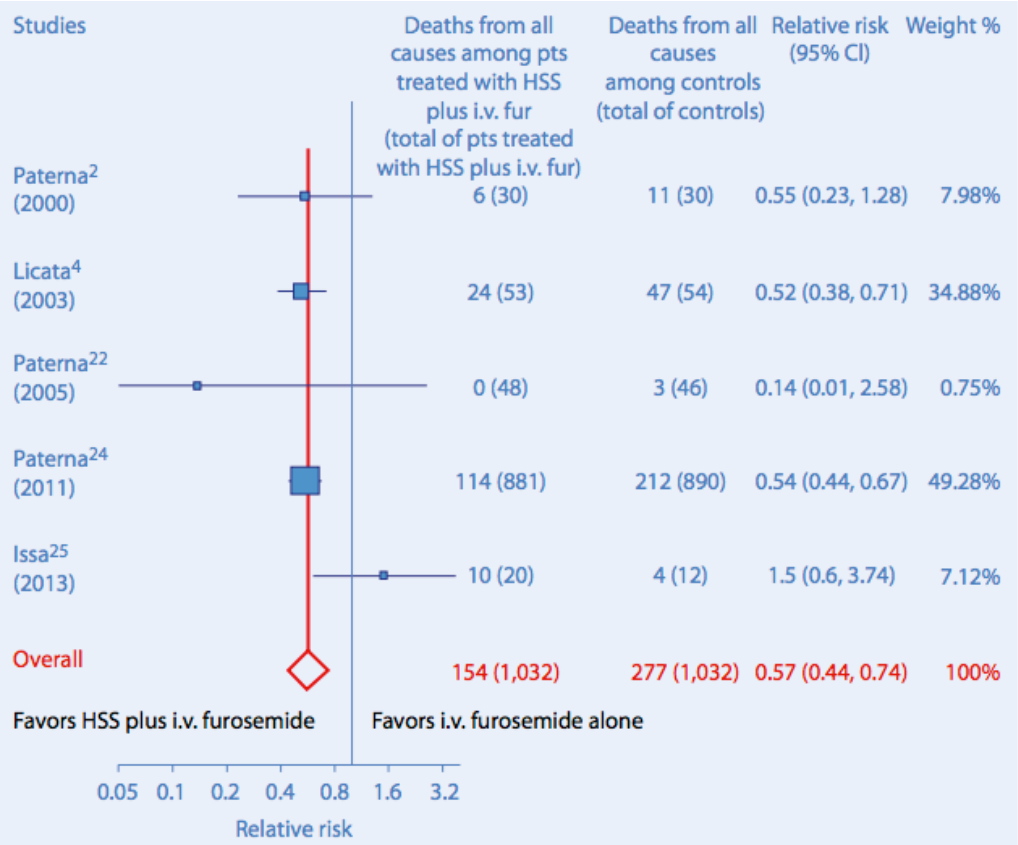
R. De Vecchis[1] · C. Esposito[2] · C. Ariano[1] · S. Cantatrione[1]
[1] Cardiology Unit, Presidio Sanitario Intermedio "Elena d'Aosta", Naples
[2] Institute of Hygiene and Preventive Medicine, Second University of Naples, Naples

Hypertonic saline plus i.v. furosemide improve renal safety profile and clinical outcomes in acute decompensated heart failure

A meta-analysis of the literature



- Menor mortalidad
- Menor estancia media
- Menor rehospitalización
- Mayor pérdida de peso
- Menor deterioro FG glomerular

Herz. 2015 May;40(3):423-35

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¿Qué hacemos con la sal?

Cloruro Sódico – NaCl (40% / 60%)

1 gr sal = 400 mg Na + 600 mg Cl

Recomendaciones

AHA

< 1,5 gr/día – A y B
< 3gr/día – C y D

ESC

< 2 gr/día

Estudio SMAC:

120 mmol/dia + 40 mmol/dia
3,6 gr /dia
vs
80 mmol = 1,84 gr/día

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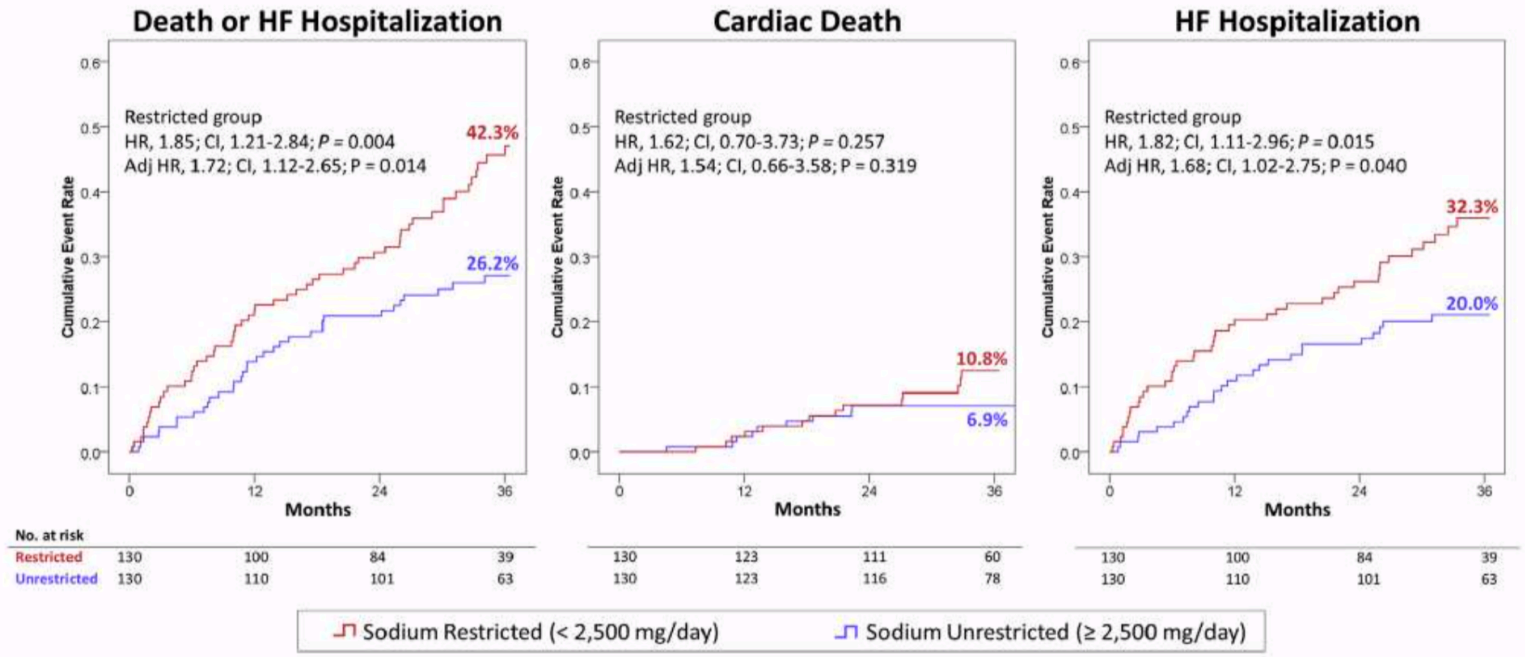
¿Qué hacemos con la sal?

Impact of Dietary Sodium Restriction on Heart Failure Outcomes

FIGURE 2 Impact of Sodium Restriction on Heart Failure Outcomes in the Propensity-Matched Cohort



Adj HR = adjusted hazard ratios for covariates with >10% absolute standardized difference between the propensity-matched groups; CI = confidence interval; HF = heart failure; HR = hazard ratio.

J Am Coll Cardiol HF 2016;4:24–35

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Diuretic treatment in high-risk acute decompensation of advanced chronic heart failure—bolus intermittent vs. continuous infusion of furosemide: a randomized controlled trial

Simone Frea[1] · Stefano Pidello[1] · Alessandra Volpe[1] · Federico Giovanni Canavosio[1] · Alessandro Galluzzo[1] · Virginia Bovolo[1] · Antonio Camarda[1] · Pier Giorgio Golzio[1] · Fabrizio D'Ascenzo[1] · Serena Bergerone[1] · Mauro Rinaldi[1] · Fiorenzo Gaita[1]

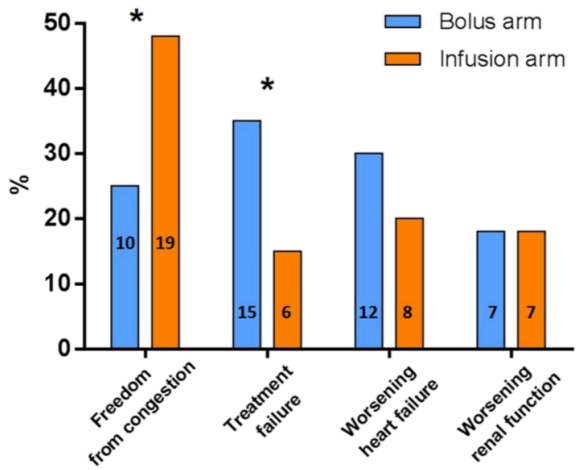

Fig. 2 Outcomes after 72 h according to treatment arm. *$p < 0.05$

Table 4 Endpoints

	Bolus intermittent ($N=40$)	Continuous infusion ($N=40$)	p value	OR (95% CI)*
Primary endpoint at 72 h				
Freedom from congestion—N (%)	**10 (25)**	**19 (48)**	**0.04**	**2.71 (1.05–7.00)**
Secondary endpoints at 72 h				
Total urinary output (ml)	**8612 ± 2984**	**10,020 ± 3032**	**0.04**	**1.2 (1.03–1.4)****
Treatment failure—N (%)	**15 (38)**	**6 (15)**	**0.02**	**0.29 (0.10; 0.87)**
Increase in diuretic dose—N (%)	15 (38)	6 (15)	0.02	0.29 (0.10; 0.87)
Ultrafiltration—N (%)	1 (3)	1 (3)	> 0.99	1
Worsening renal function—N (%)	7 (18)	7 (18)	> 0.99	1
Worsening or persistent heart failure—N (%)	12 (30)	8 (20)	0.44	0.59 (0.18; 1.83)
Diuretic response (Δ weight kg/40 mg furosemide)	**−0.6 ± 0.6**	**−1.0 ± 0.7**	**< 0.01**	**0.41 (0.17–0.87)**
ΔNT-proBNP (pg/ml)	−307 (IQR −2830 to 3749)	−738 (IQR −5564 to 1739)	0.42	1.00 (0.98–1.02)

Bold stands for significant ($p < 0.05$)

*OR: infusion/bolus

**OR per 1000 ml increase

Clinical Research in Cardiology https://doi.org/10.1007/s00392-019-01521-y

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Alternativas – Terapia Secuencial

JAMA Cardiology | Original Investigation

Efficacy and Safety of Spironolactone in Acute Heart Failure
The ATHENA-HF Randomized Clinical Trial

Safety and Efficacy of the Combination of Loop With Thiazide-type Diuretics in Patients With Decompensated Heart Failure (CLOROTIC)

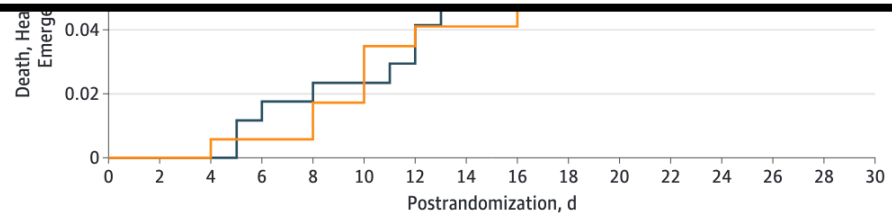
This study is currently recruiting participants. (see Contacts and Locations)

Verified May 2015 by Spanish Society of Internal Medicine

www.clorotic.org

ClinicalTrials.gov Identifier:
NCT01647932

First received: June 28, 2012
Last updated: May 18, 2015
Last verified: May 2015



No. at risk																
Usual care	178	176	171	166	165	164	163	159	159	158	156	155	153	152	147	137
High-dose spironolactone	182	175	173	171	171	167	164	163	163	161	159	156	156	155	153	141

There were no significant differences noted in the postdischarge outcomes among patients randomized to receive the usual care alone vs the group who received high-dose spironolactone. Receiving high-dose spironolactone vs usual care had a hazard ratio of 1.22 (95% CI, 0.68-2.19; P = .50).

JAMA Cardiol. 2017;2(9):950-958

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Medicina Interna

Alternativas – Terapia Secuencial

JAMA The Journal of the American Medical Association

Low Dose Dopamine or Low Dose Nesiritide in Acute Heart Failure with Renal Dysfunction: The ROSE Acute Heart Failure Randomized Trial

Horng H. Chen, MBBCh1, Kevin J. Anstrom, PhD2, Michael M. Givertz, MD3, Lynne W.

JAMA. 2013 18;310:2533-43

N= 360 con IC agudizada y FG entre 15-60 ml/min

Doble ciego, multicéntrico, Randomizado : Dopamina 2µg /kg/min vs Neseritide 0.005 µg /kg/min vs Placebo (80 mg si naive , x2.5 furosemida)

Objetivo principal:
Descongestión: volumen de orina en 72 h
Función renal: cambio en cistatina a las 72 h

Table 2. Coprimary End Points: Effect of Low-Dose Dopamine vs Placebo or Low-Dose Nesiritide vs Placebo on Cumulative Urine Volume During 72 Hours and Change in Cystatin C Level From Baseline to 72 Hours

	Mean (95% CI)			
	Placebo	Drug	Treatment Difference	*P* Value
Dopamine strategy	Placebo (n = 119)	Dopamine (n = 122)		
Cumulative urine volume from randomization to 72 h, mL	8296 (7762 to 8830)	8524 (7917 to 9131)	229 (−714 to 1171)	.59
Change in cystatin C level from randomization to 72 h, mg/L	0.11 (0.06 to 0.16)	0.12 (0.06 to 0.18)	0.01 (−0.08 to 0.10)	.72
Nesiritide strategy	Placebo (n = 119)	Nesiritide (n = 119)		
Cumulative urine volume from randomization to 72 h, mL	8296 (7762 to 8830)	8574 (8014 to 9134)	279 (−618 to 1176)	.49
Change in cystatin C level from randomization to 72 h, mg/L	0.11 (0.06 to 0.16)	0.07 (0.01 to 0.13)	−0.04 (−0.13 to 0.05)	.36

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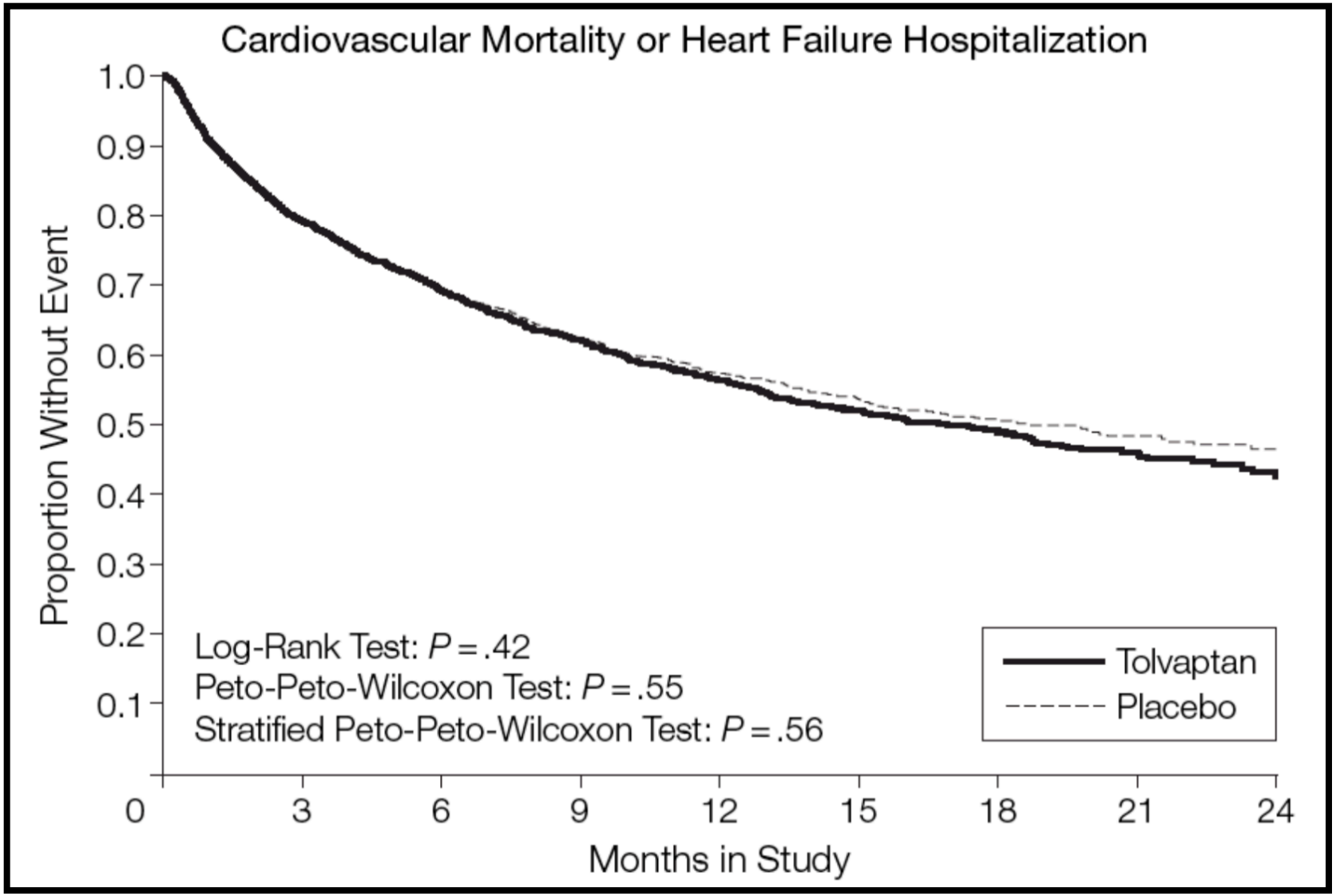
Alternativas – Terapia Secuencial



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Alternativas

European Journal of Heart Failure (2012) **14**, 540–548
doi:10.1093/eurjhf/hfs013

Continuous ambulatory peritoneal dialysis as a therapeutic alternative in patients with advanced congestive heart failure

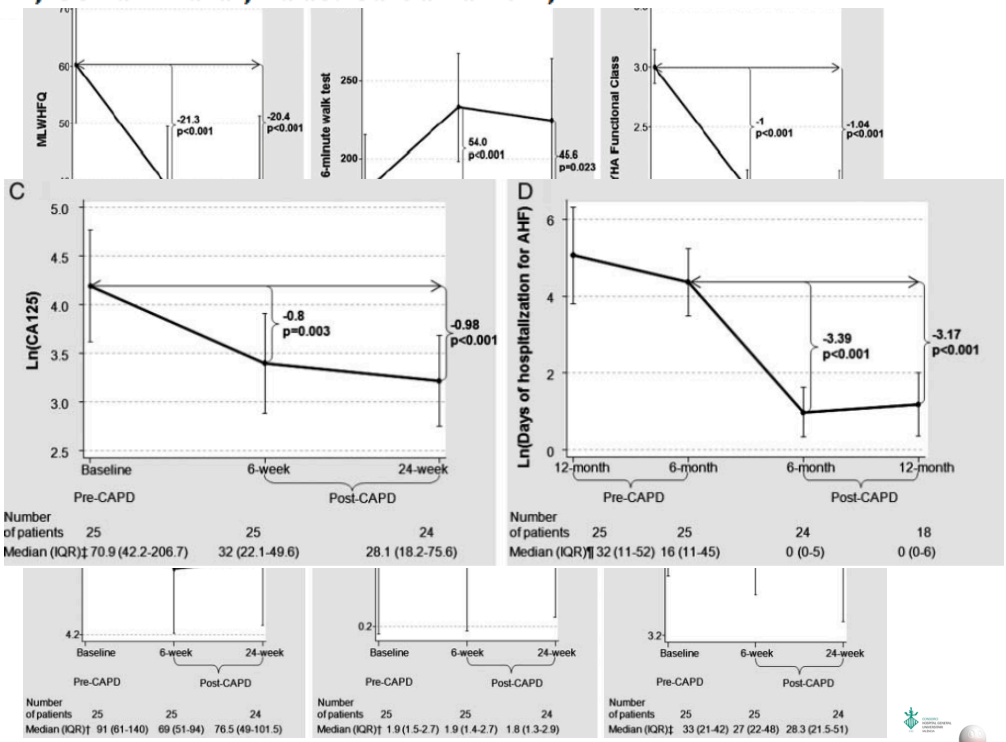
Julio Núñez[1*†], Miguel González[2†], Gema Miñana[3], Rafael Garcia-Ramón[2],

N= 25 con IC clase III-IV NYHA +≥2 ingresos IC en 6 meses + congestión a pesar de tto diurético + insuf renal <60 ml/min en 12 meses previos

Prospectivo-descriptivo

Diálisis peritoneal 2-3 veces/día

Objetivo principal:
Comparar calidad de vida, capacidad funcional, riesgo de muerte/hospitalización
Días de hospitalización 6 meses



European Journal of Heart Failure (2012) 14, 540–548

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Conclusiones

- La congestión venosa tiene un papel relevante en la insuficiencia renal asociada a IC
- El tratamiento con Salino Hipertónico + Furosemida puede ser una alternativa eficaz a la resistencia a diuréticos
- El manejo de el sodio en la dieta tiene un papel relevante en el pronóstico de la IC.
- Perfusión mejor que bolos
- Terapia alternativa secuencial (tiazidas?, diálisis peritoneal, ultrafiltración)

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