



UNIVERSITÉ
DE MONTPELLIER



Syndrome Cardiorénal Aigu

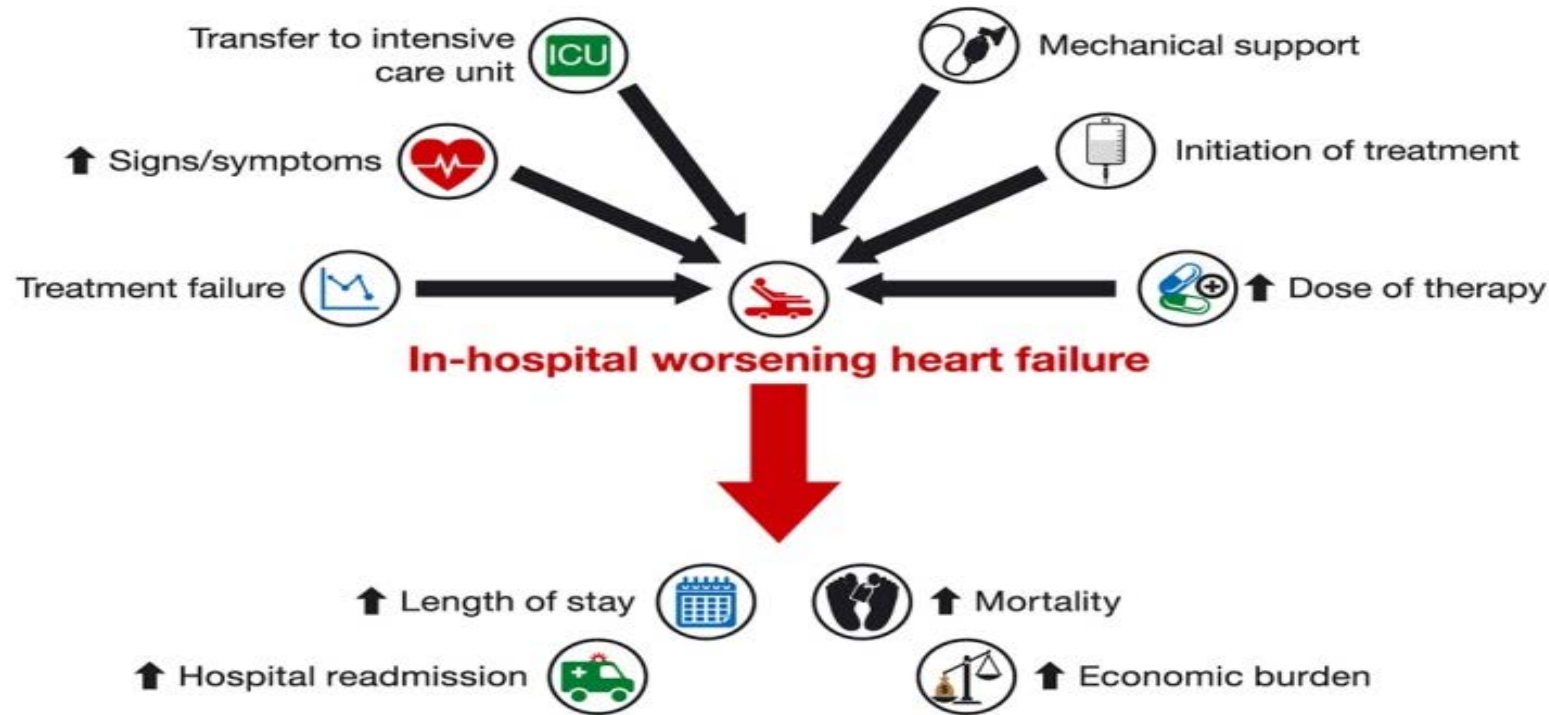
K Klouche

**Département de Médecine Intensive et Réanimation.
CHU Lapeyronie, Montpellier**



☒ Je ne déclare aucun lien d'intérêt

Insuffisance cardiaque



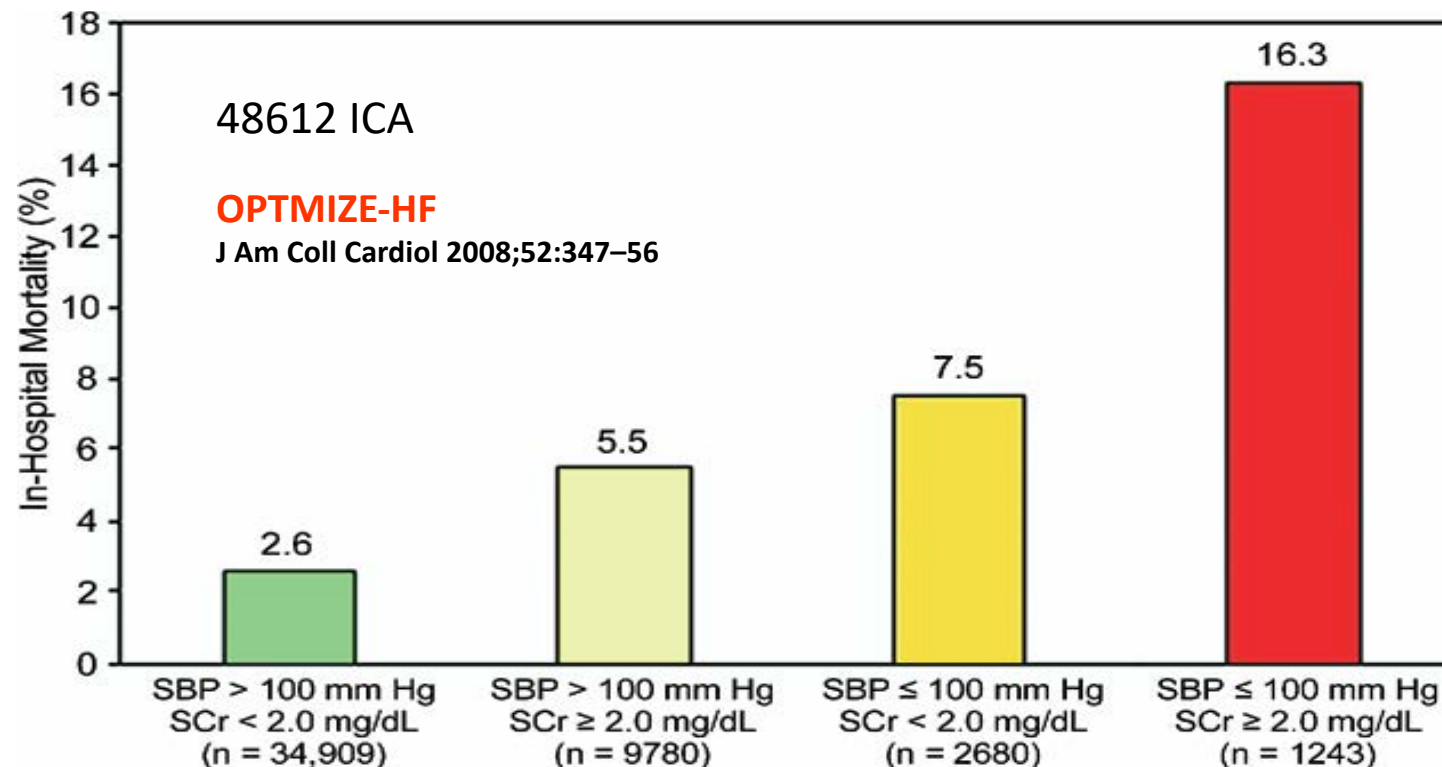
1 M hospitalisations USA, coût 30.7 billion \$
Réadmissions H. 20%,
Mortalité: 5-6%

Insuffisance cardiaque aiguë

Facteur prédictif de mortalité: **Dysfonction rénale**

Etude ADHERE: (JAMA 2005, 32229 ICA)

creat > 2.75 mg/dL, urée > 43 mg/dL, PAS < 115 mmHg → mortalité > 20%



The bidirectional strategy in Cardio-renal

Syndrome

LV Dysfunction



Increase Morbidity
and Mortality

Diuretic Inotropic or
Vasodilator Therapy

Neurohormonal activation
Angiotensin increase
Vasoconstriction

Development of
Diuretic-resistance
Increased cardiac work
and remodelling

CROSSTALK

Impaired renal Flow
and GFR with flow
redistribution

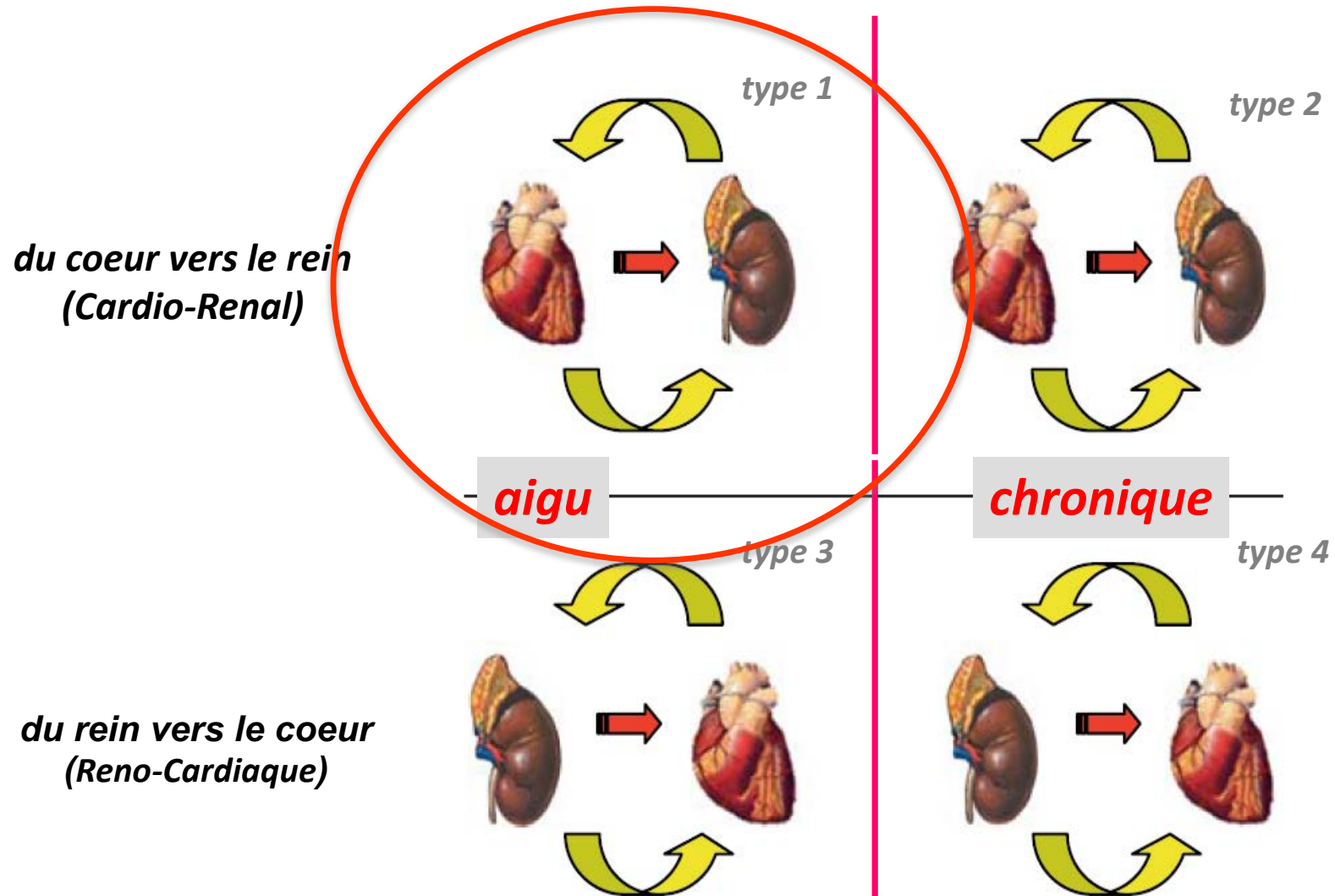
Reduced Renal perfusion,
increased fluid retention and
plasma volume

Renal Dysfunction
Increased venous pressure
and Na resorption



Le(s) Syndrome(s) cardio-rénal (ux)

Ronco C et al. J Am Coll Cardiol 2008;52:1527-39, Blood Purif 2009;27.



SYNDROME CARDIORENAL de TYPE I

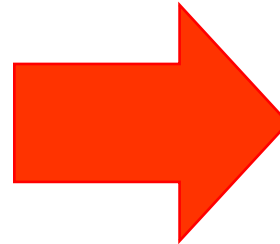
SCR aigu

Ins. Card. Aiguë

Décompensation aiguë inaug.
Exacerbation aiguë ICC
Ins. Card. Réfractaire

Clinique

OAP
Anasarque /rétention hyd.sodée
Choc cardiogénique (30%)
IVD



Atteinte rénale aigue

facilitée par IRC sous-jacente
incidence et sévérité dépend de l'atteinte cardiaque
(>70% en cas de choc cardiogénique)
facteur indépendant de risque de morbi/talité

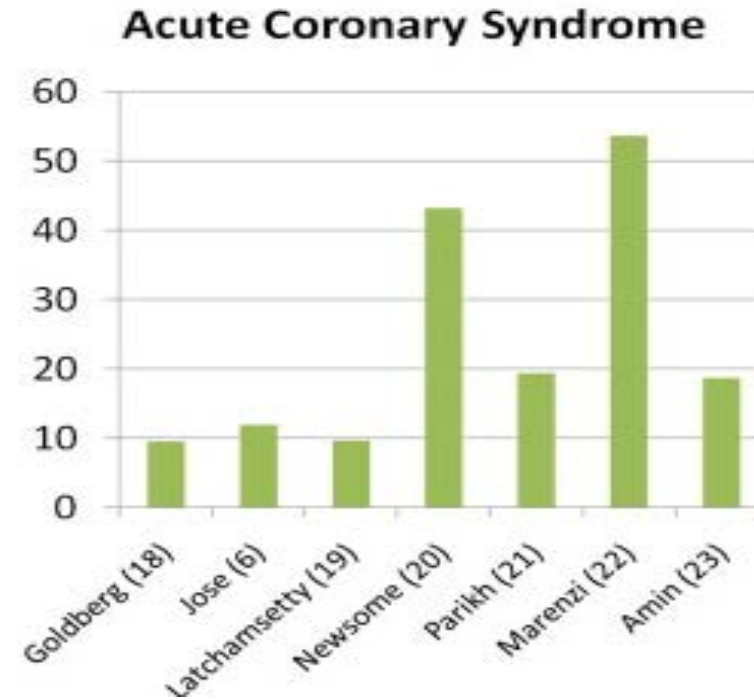
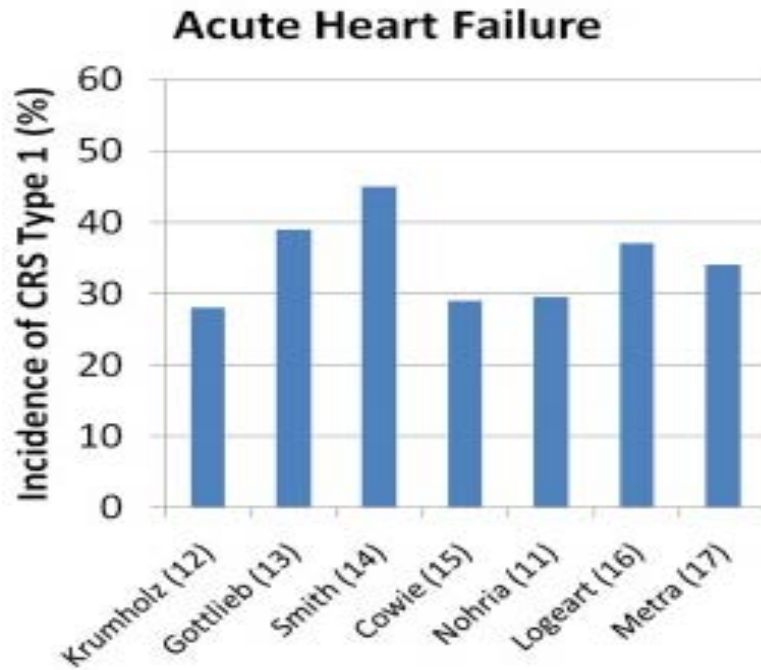
IRF

Hypoperfusion rénale
bas débit cardiaque associé à une élév. de la
précharge
(congestion veineuse)

EFNa <1%, Na_u <20 mmol/l,
dissociation urée/créat...
Résistance ou réponse diminuée aux
diurétiques

Syndrome cardiorénal de type I

Prévalence



Clinical Prediction Scores for Type I Cardiorenal Syndrome

Derived and Validated in Chinese Cohorts

Hong Cheng and Yi-pu Chen
Cardiorenal Med 2015;5:12–19

Cohorte 5000 patients, mortalité

	With type 1 CRS	Without type 1 CRS	p value
AHF	16.5%	1.9%	<0.01
AMI	9.0%	0.5%	<0.01
Cardiac surgery	5.2%*	0.5%	<0.01
Coronary angiography	3.4%	0.3%	<0.01

* The mortality of the patients requiring dialysis was 50.7%.

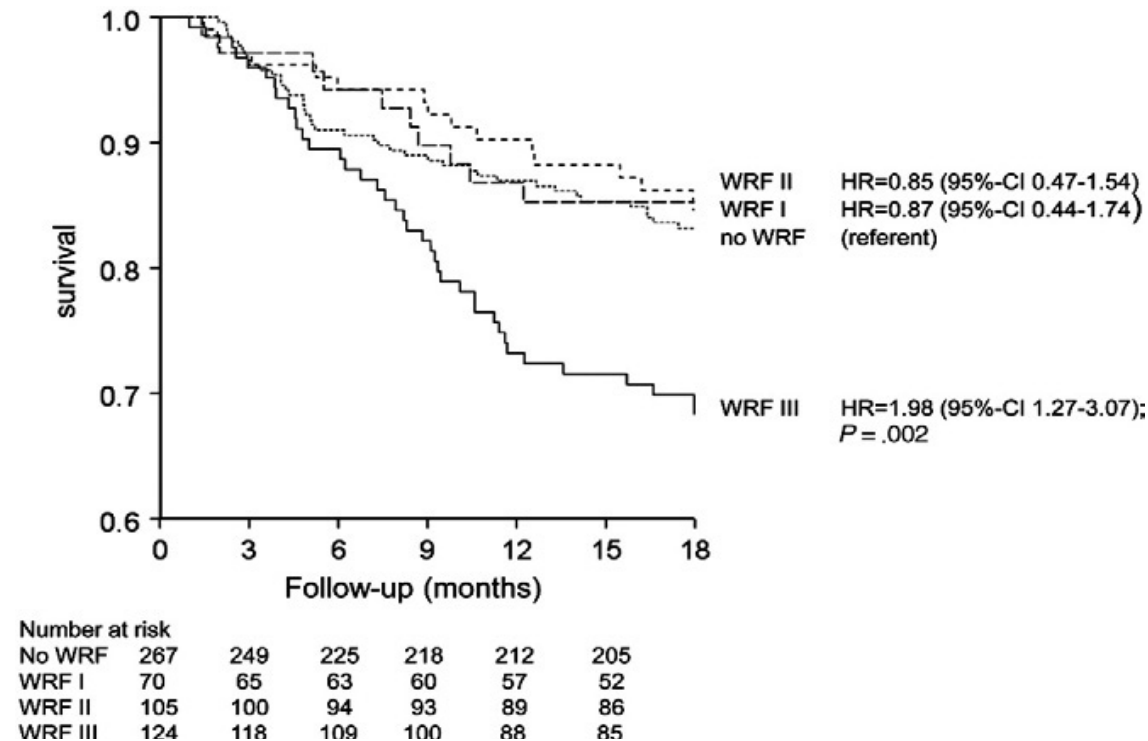
L'altération de la F. Rénale prédictive: mortalité dans l'ICC.

La congestion veineuse est un facteur aggravant de mortalité.

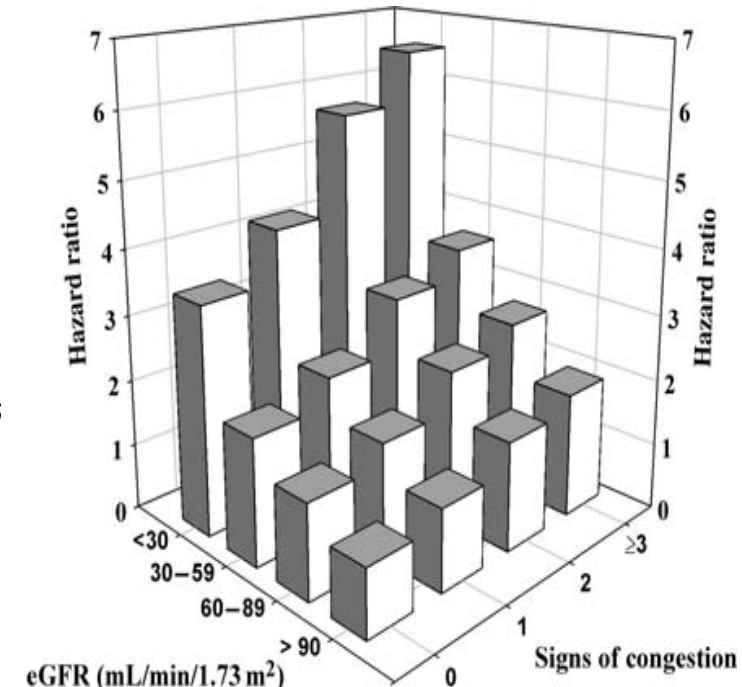
**566 pts ICC 12%,
Worsening Renal Function I: 12%
II: 19%, III: 22%**



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SOCIETY OF
CARDIOLOGY®



Am Heart J 2012;163:407-414.



EJHF 2010; 12, 974-982

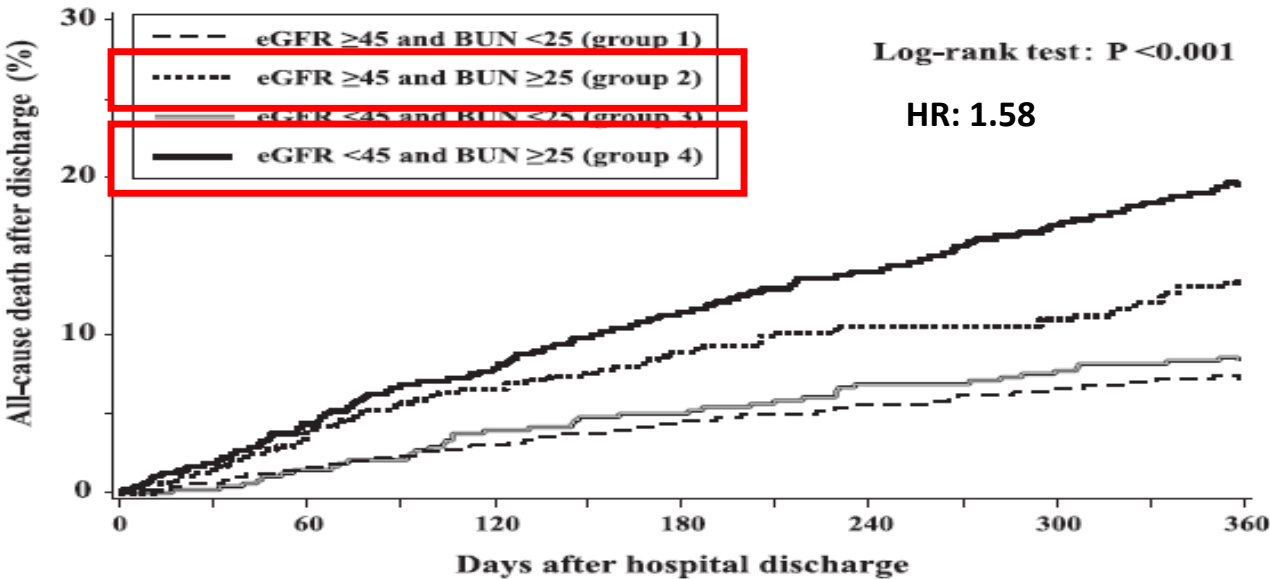
eGFR and Outcomes in Patients with Acute Decompensated Heart Failure with or without Elevated BUN

Katsuya Kajimoto,* Naoki Sato,[†] and Teruo Takano[‡] on behalf of the ATTEND investigators
Clin J Am Soc Nephrol 11: 405–412, 2016.

4449 ICA suivis 1 an après sortie Hosp: Mortalité: 19.1%.
DFG et Urée plasmatique à sortie hosp.

Urée plasmatique

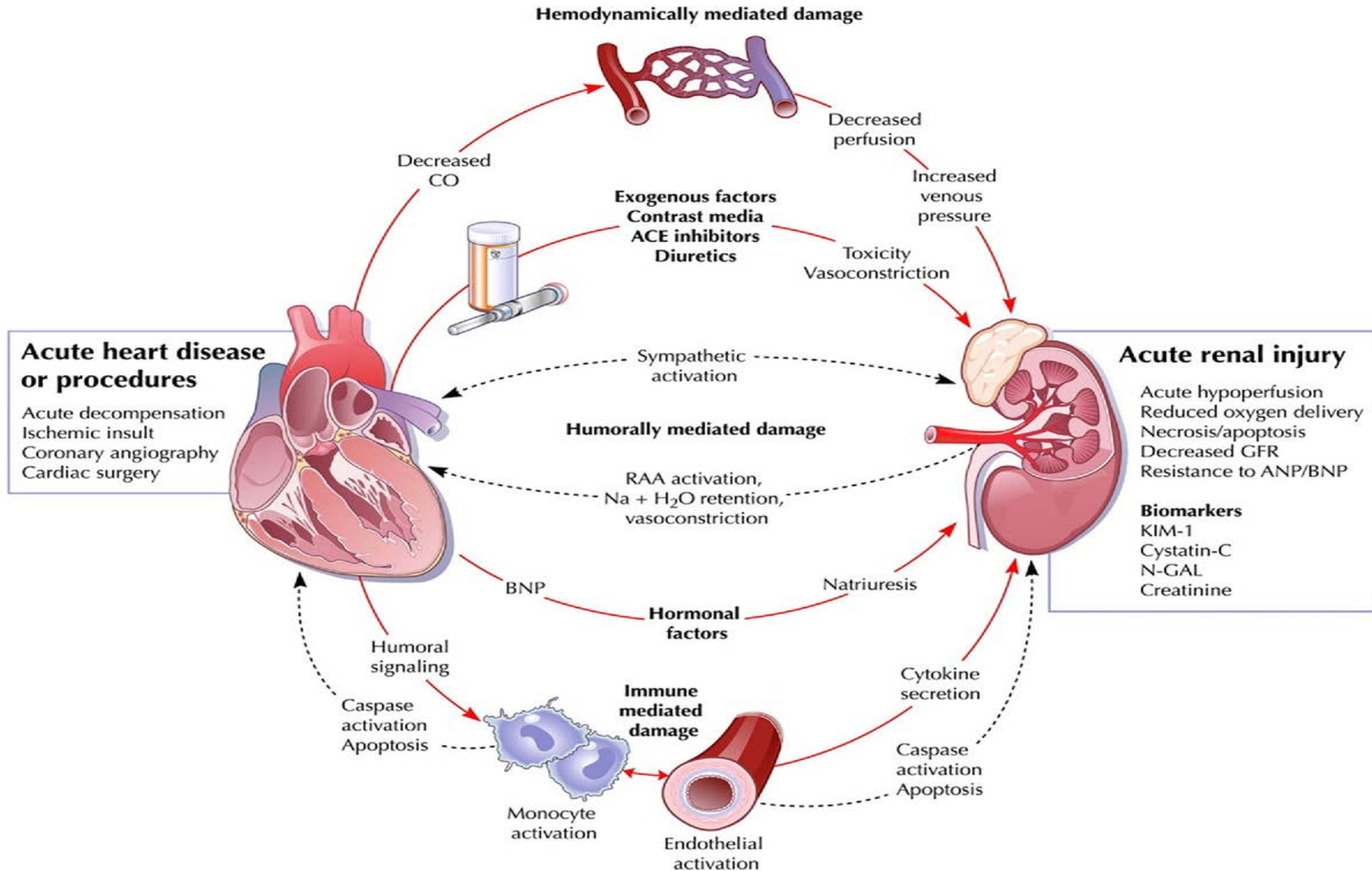
Réab. Prox; dista.
Act. neuroH
Débit Ur.
AVP



Number at risk							
eGFR ≥45 and BUN <25:	1981	1928	1888	1846	1778	1749	1718
eGFR ≥45 and BUN ≥25 :	418	397	384	369	341	337	323
eGFR <45 and BUN <25 :	569	556	537	525	504	495	486
eGFR <45 and BUN ≥25 :	1481	1398	1333	1271	1200	1146	1092

Syndrome cardiorénal (CRS) type I (aigu)

physiopathologie

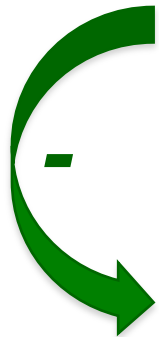


Mécanismes de l'altération de la fonction rénale dans l'ICA

baisse IC, volémie intra-artérielle (15%)

au niveau systémique

Stim Tonus Symp
SRAA
ADH



stim. Fact Natr,
inhib. ADH, tonus symp

au niveau rénal

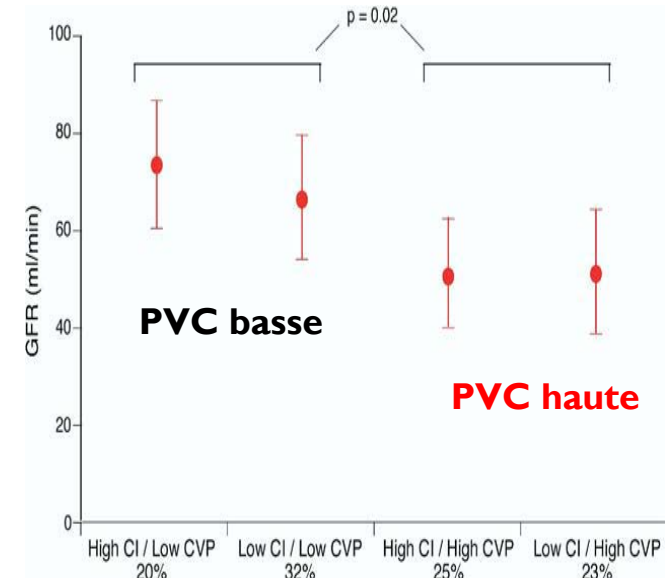
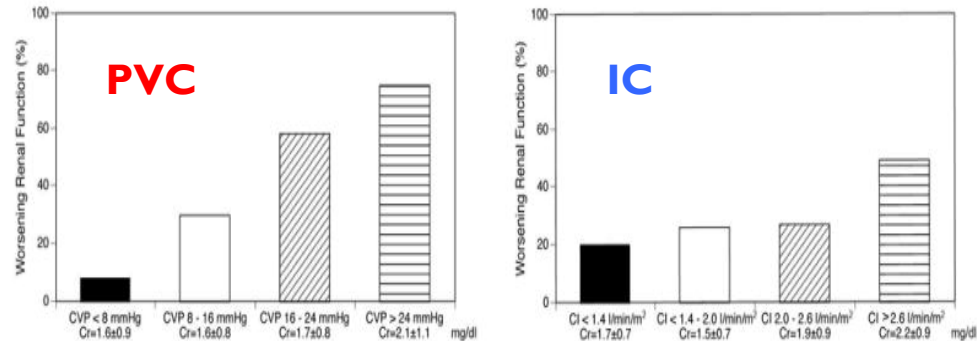
élévation ATII
vasoc a ef, baisse FPR, aug. FF
augm. réabsorp. Na prox, dist

Aug. Retour veineux, PVC, p aur.

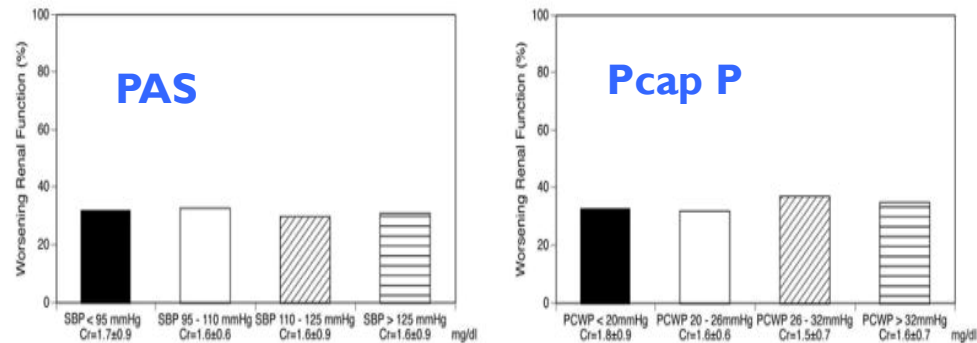
surchage hydrosodée, augm. PVC et p OD
Congestion veineuse

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

Mullens W et al. JACC 2009, 53:589



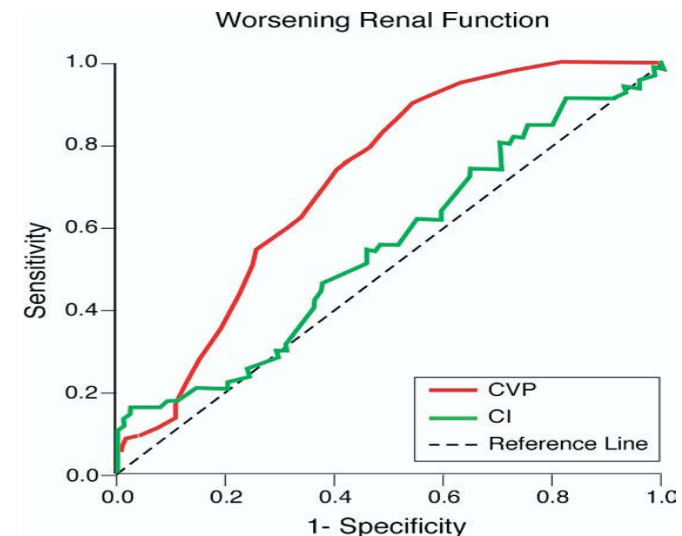
145 pts en Insf. Card. Aigue



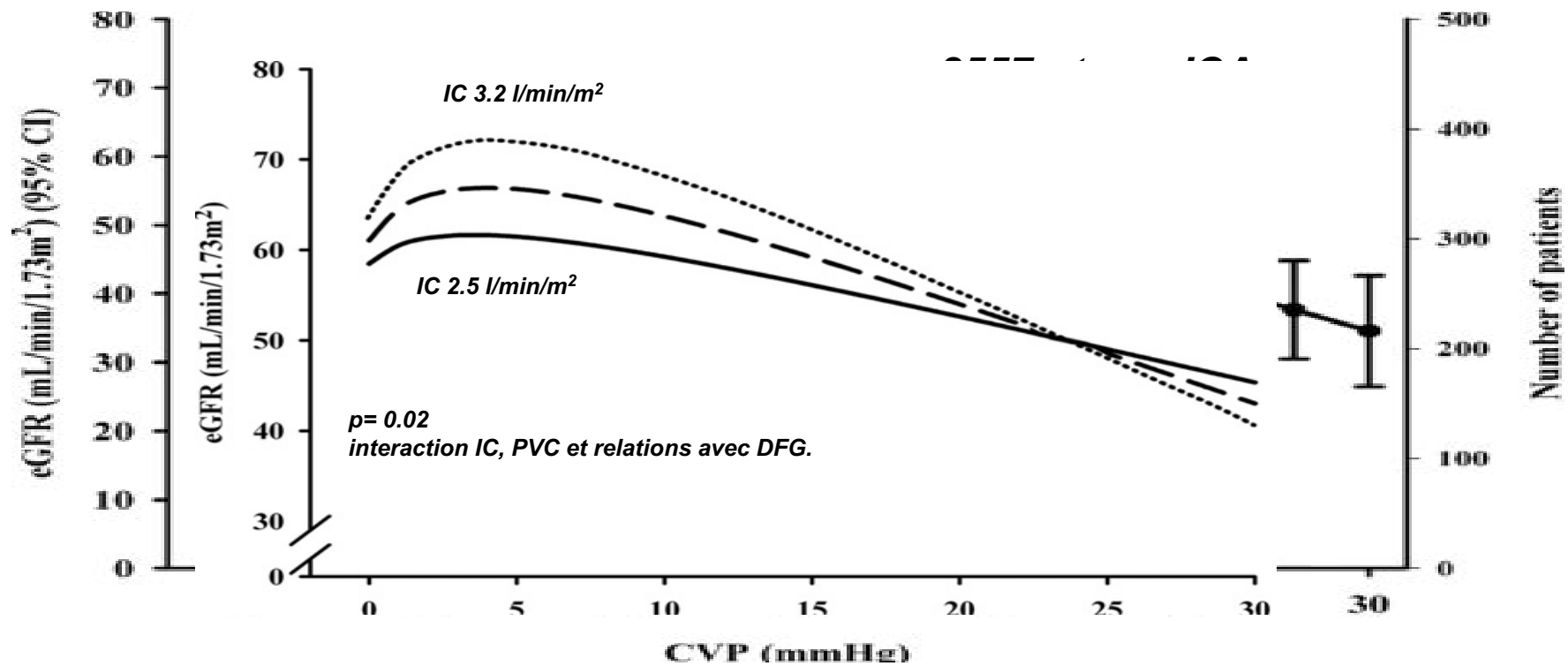
Déterminants de l'altér. de la fonct. rénale

PVC augm. à admision et baisse insuffisante

IC peu d'effets sur la fonction rénale

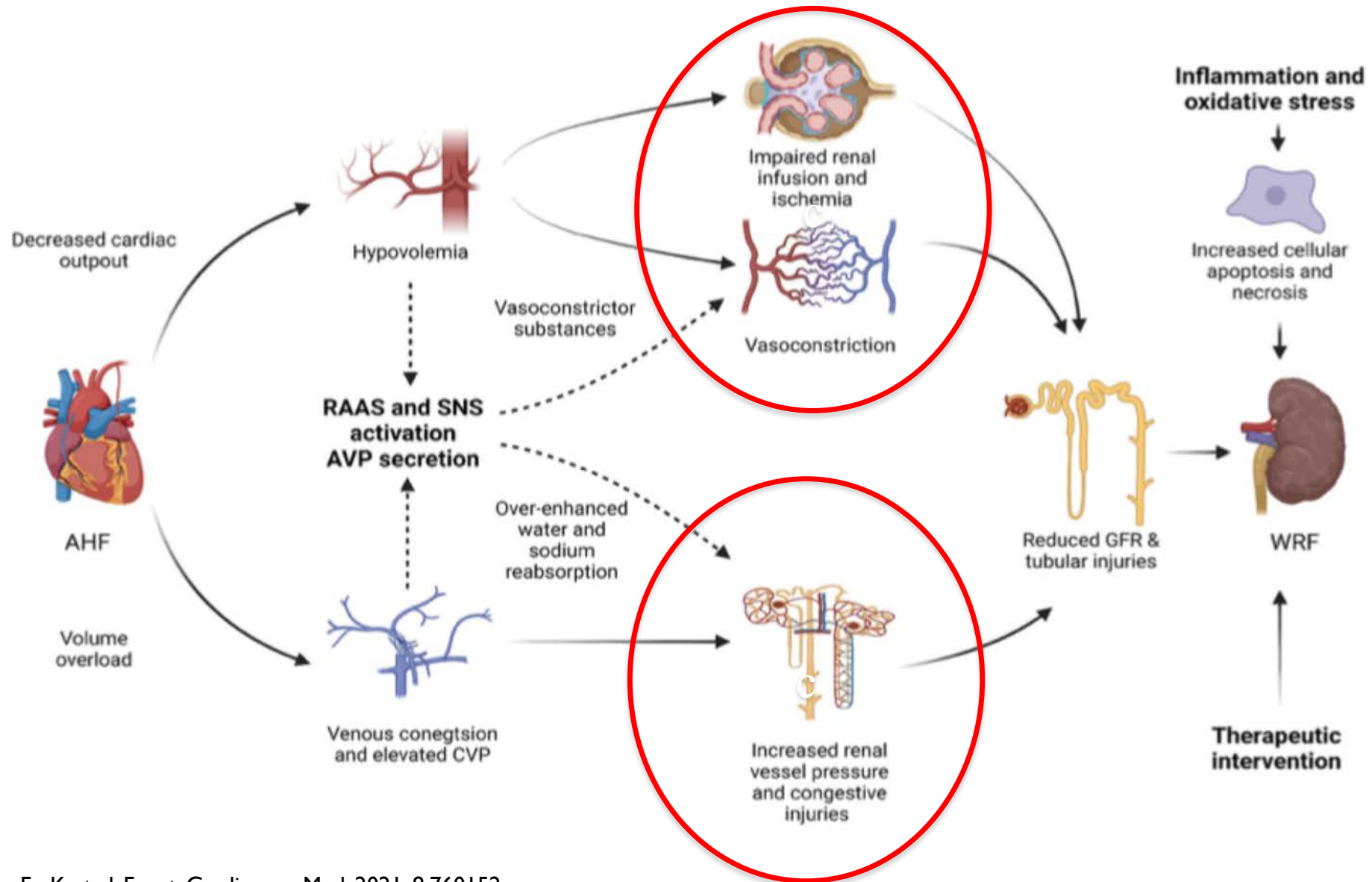


Relation entre la pression veineuse centrale et le débit de filtration glomérulaire

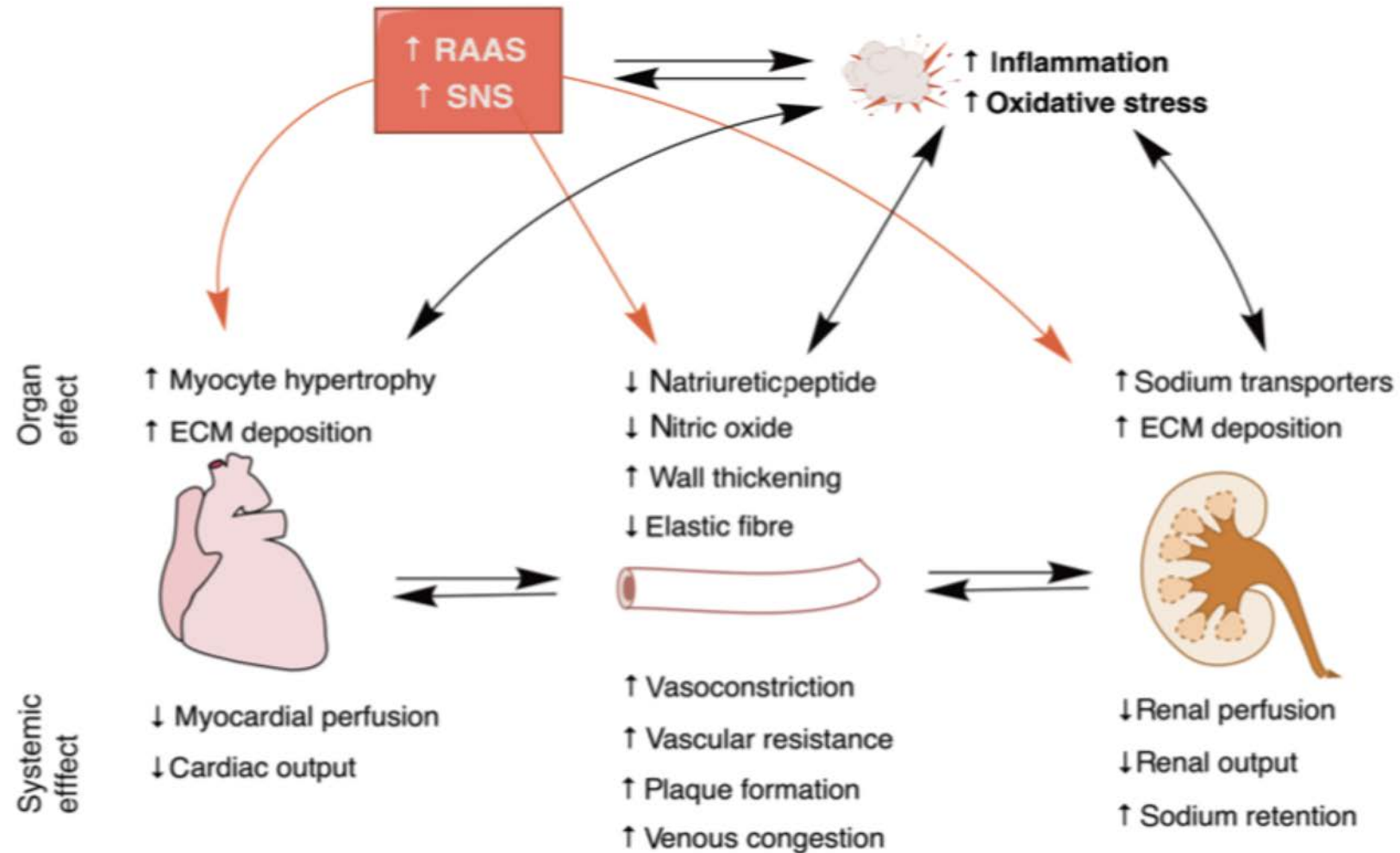


La PVC est corrélée à la dysfonction rénale dans l'insuffisance cardiaque

Pathogenesis mechanisms of worsening renal function in type-I cardiorenal syndrome (CRS-I).



Organ crosstalk in CRS pathophysiology.



SYNDROME CARDIORENAL de TYPE I

SCR aigu

Prise en charge thérapeutique

Traiter la lésion causale si possible

Reperfusion myocardique, valvulopathie aiguë, endocardite...

Evaluer la fonction cardiaque et volémie

Clinique, RX, biomarqueurs, Echo, doppler, Hémodynamique invasive (SwannG: ESCAPE)

Traitement symptomatique

Eviter et corriger toute hypotension artérielle

Améliorer la contractilité myocardique

Vasodilatateurs A et V: nitroprussiate, IEC, ARAI, inhibiteurs de l'aldostérone (surveiller f.ren. et K⁺), Béta-bloquants ?

Inotropes: Dobutamine vs Levosimendan

Optimiser la perfusion rénale

étude Protect: Antagonistes sélectifs récepteurs Adénosine A1: Rolofylline

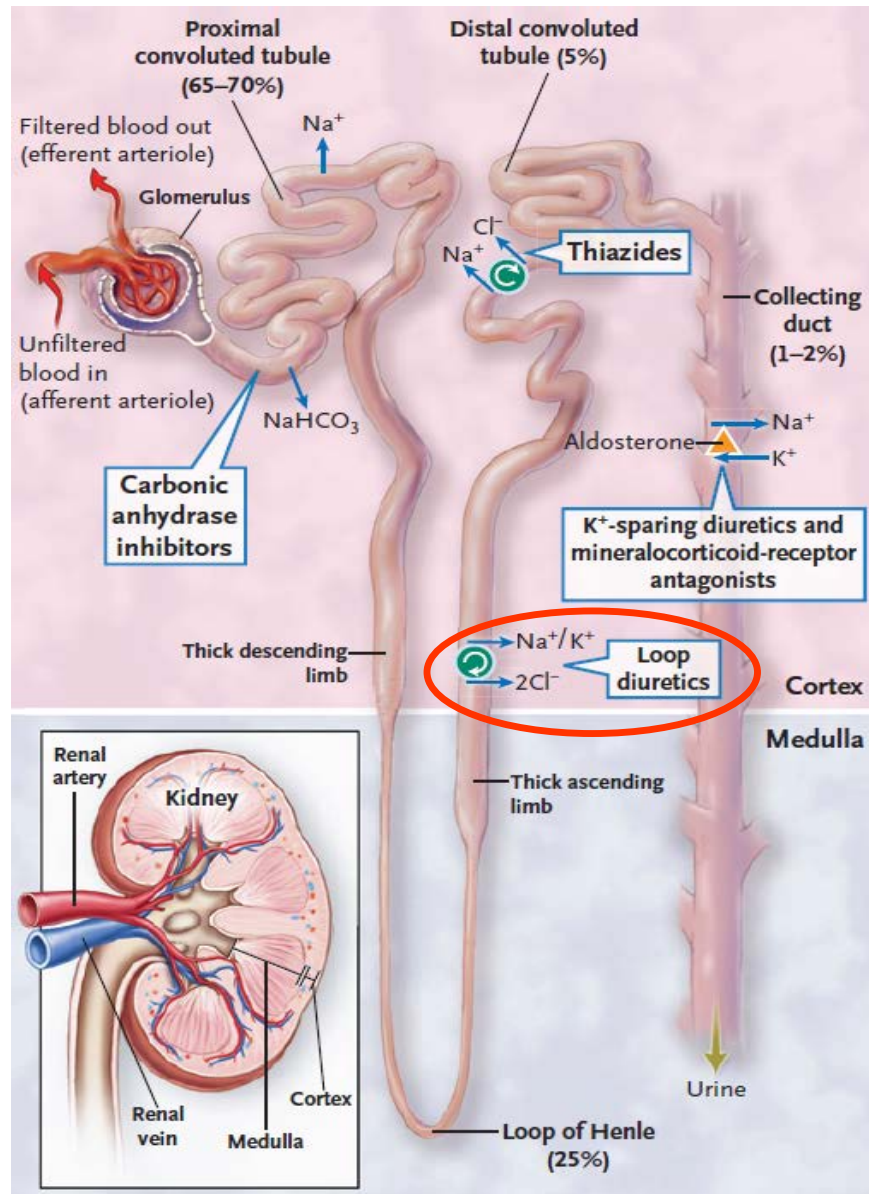
étude Rose: Dopamine

étude Relax-AHF: Relaxin-2

Lutter contre la rétention hydrosodée

diurétiques, UF

Diurétiques de l'anse



Actions

élévation natriurèse et diurèse

Furosémide IV

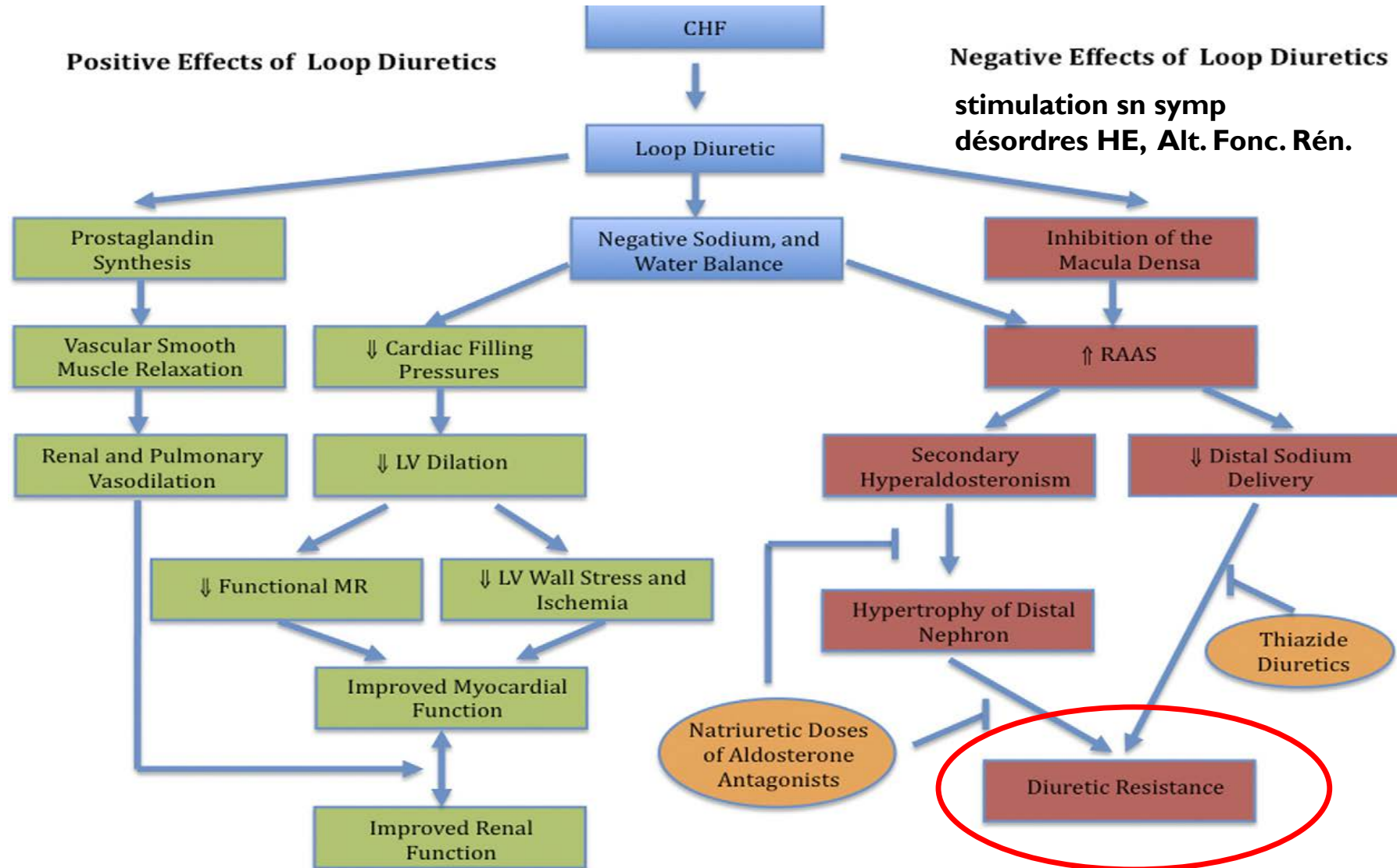
délai d'action: 30 min

pic d'action: 60 min

Bumétamide

Torsemide

Mécanismes des Diurétiques



Résistance aux diurétiques

mécanismes

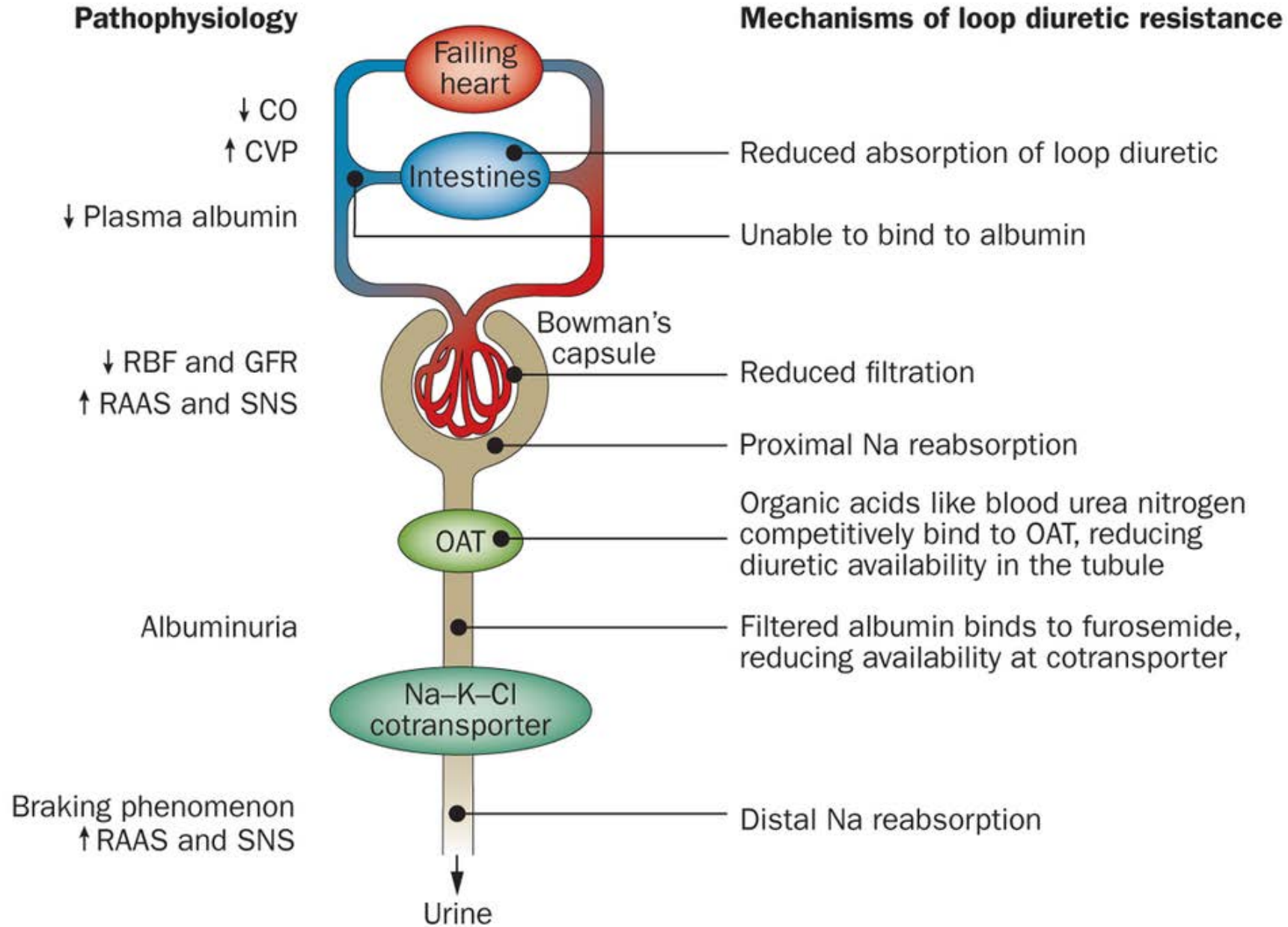
Phénomène « braking »

administration au long cours → réduction de la réponse natriurétique
(stimulation SRAA et sympathique et réabsorption Na tub distale)

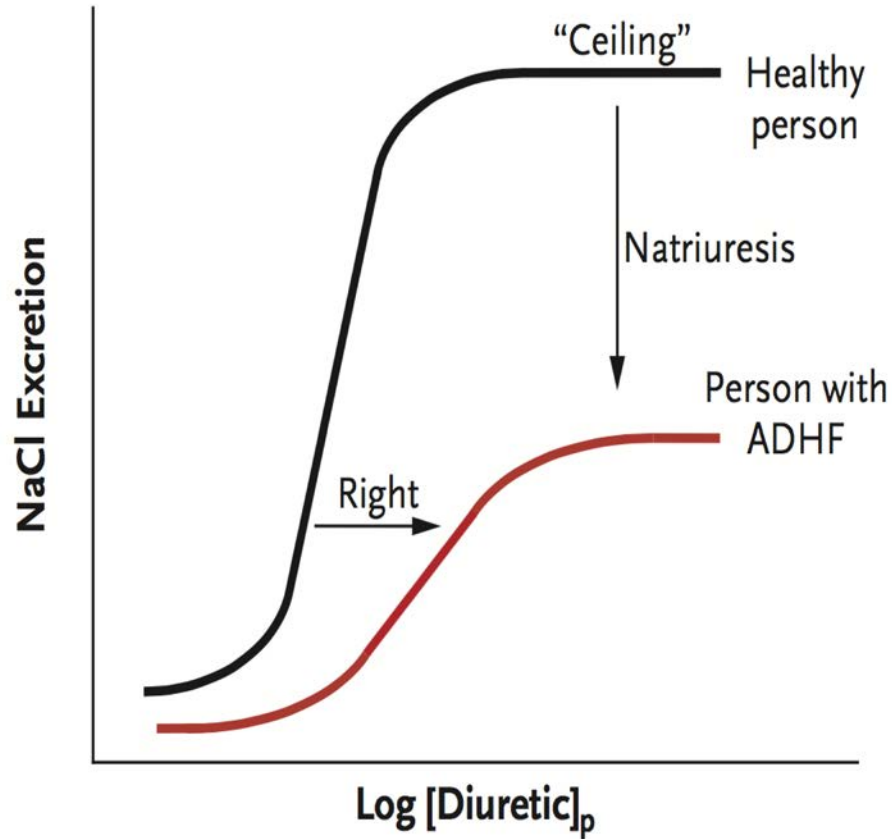
Phénomène de rebond: rétention sodée post-diurétiques

Inadéquation de la dose prescrite

seuil d'efficacité, Insf. Card, Insf ren.
en cas de baisse de [tub] des diurétiques

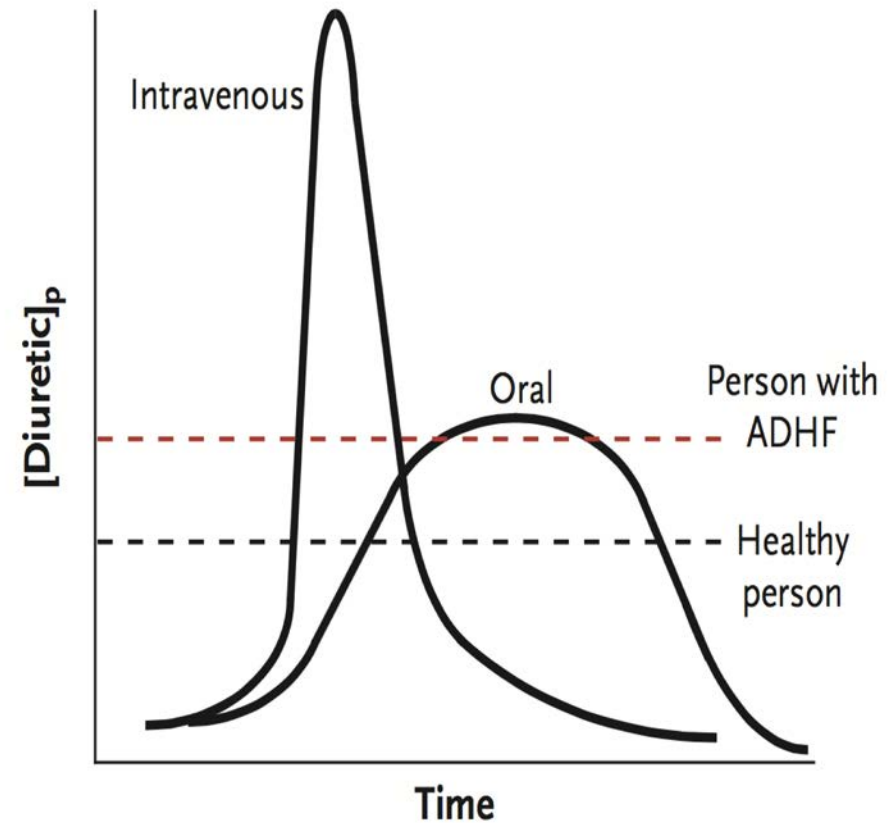


Pharmacokinetic and Pharmacodynamic Properties of Loop Diuretics.



Relation between plasma diuretic concentration and NaCl excretion

D H. Ellison, and G. M Felker. NEJM 2017; 377,20.



$[\text{Diuretic}]_p$ as a function of time after an IV or oral dose.

The natriuretic threshold (dashed lines) is higher in patients with ADHF than in healthy persons. Natriuresis is a function of the time above the natriuretic threshold.

Vaincre la résistance aux diurétiques

Augmenter les doses IV de diurétiques

seuil d'efficacité, Insf. Card, Insf ren.

Utiliser infusion continue IV ou multiplier doses IV/j

Associer thiazidiques

une dose 1 h avant diu.anse; risques hypovolémie et hypok/mg

Associer antialdostérones

doses natriurétiques; risques hyperK

Sale hypertonique

IJC 173 (2014) 139–145

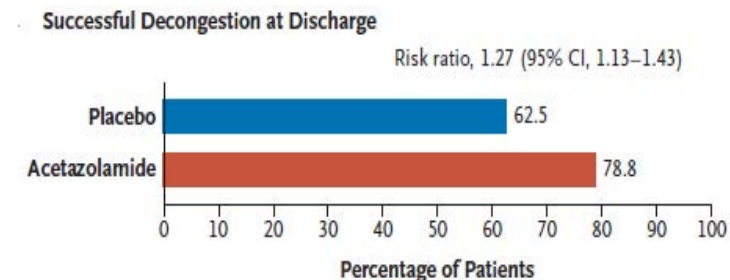
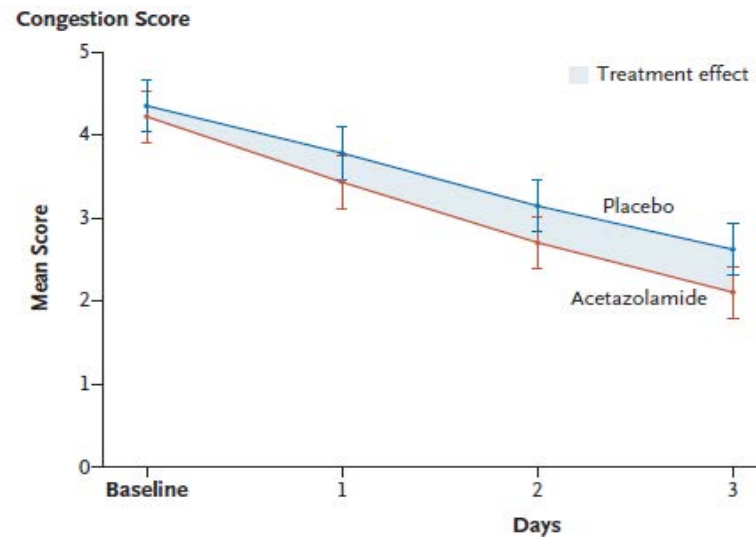
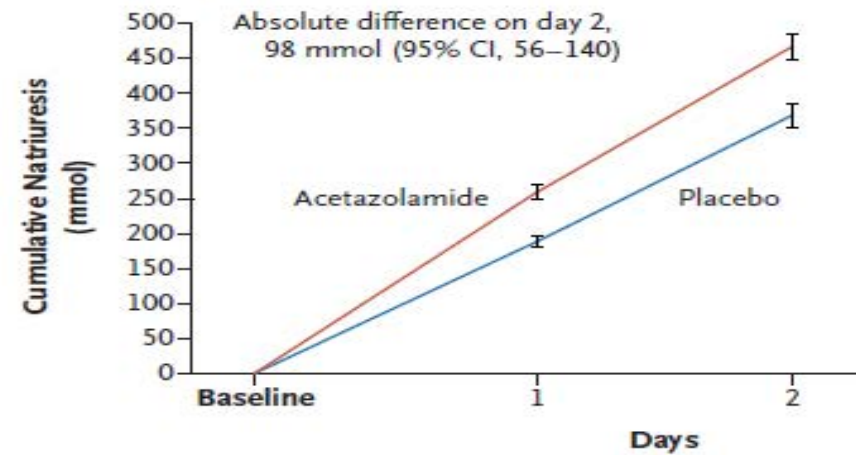
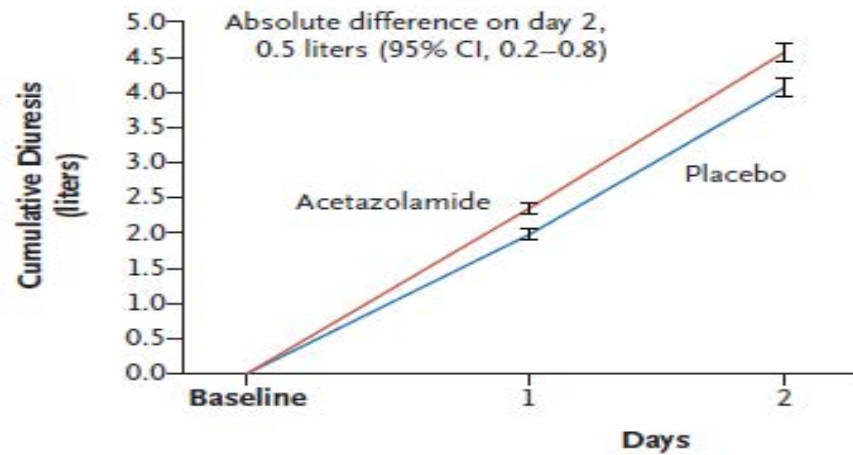
In pts with advanced CHF, hypertonic saline improved weight loss, preserved renal function, and decreased length of hospitalization, mortality and heart failure rehospitalization.

Antagonistes recepteurs vasopressine (V2)

Acetazolamide in Acute Decompensated Heart Failure with Volume Overload

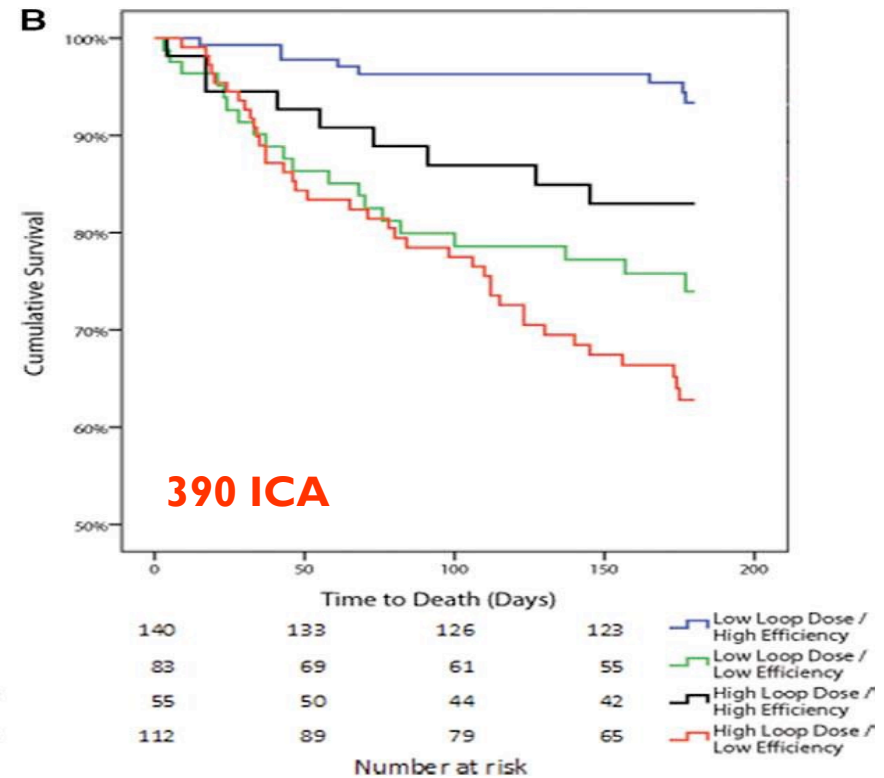
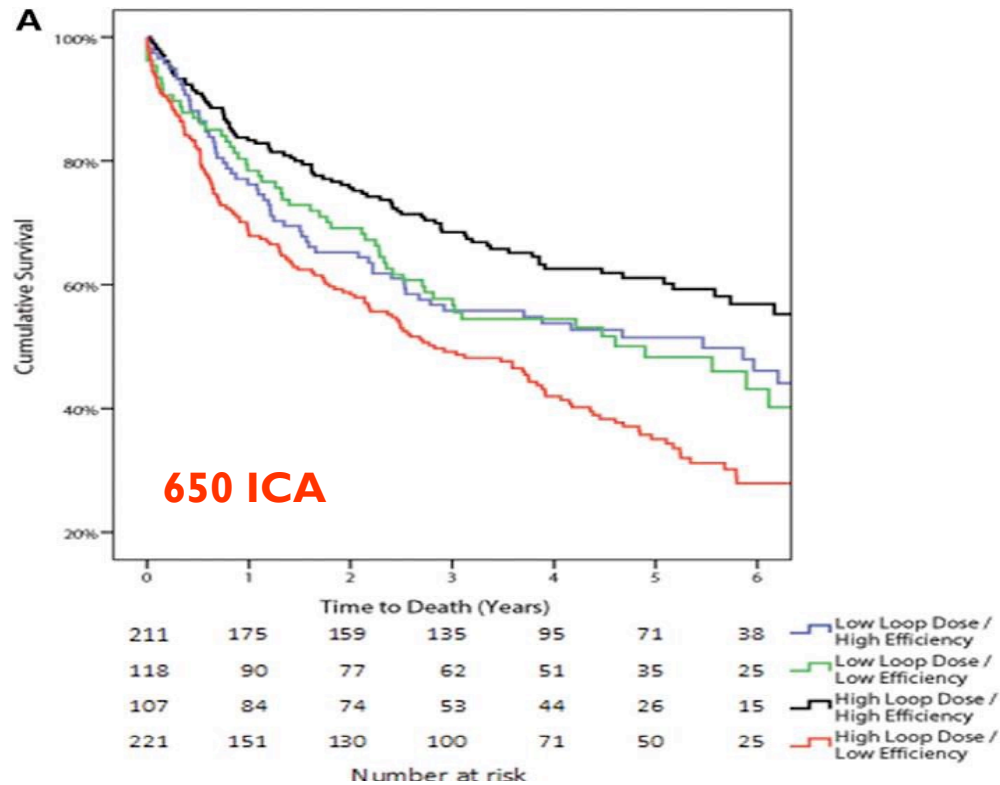
Mullens W et al. NEJM august 2022

519 ICA furo NtproBNP > 1000pg/ml: placebo vs acetaz (500mg/j)



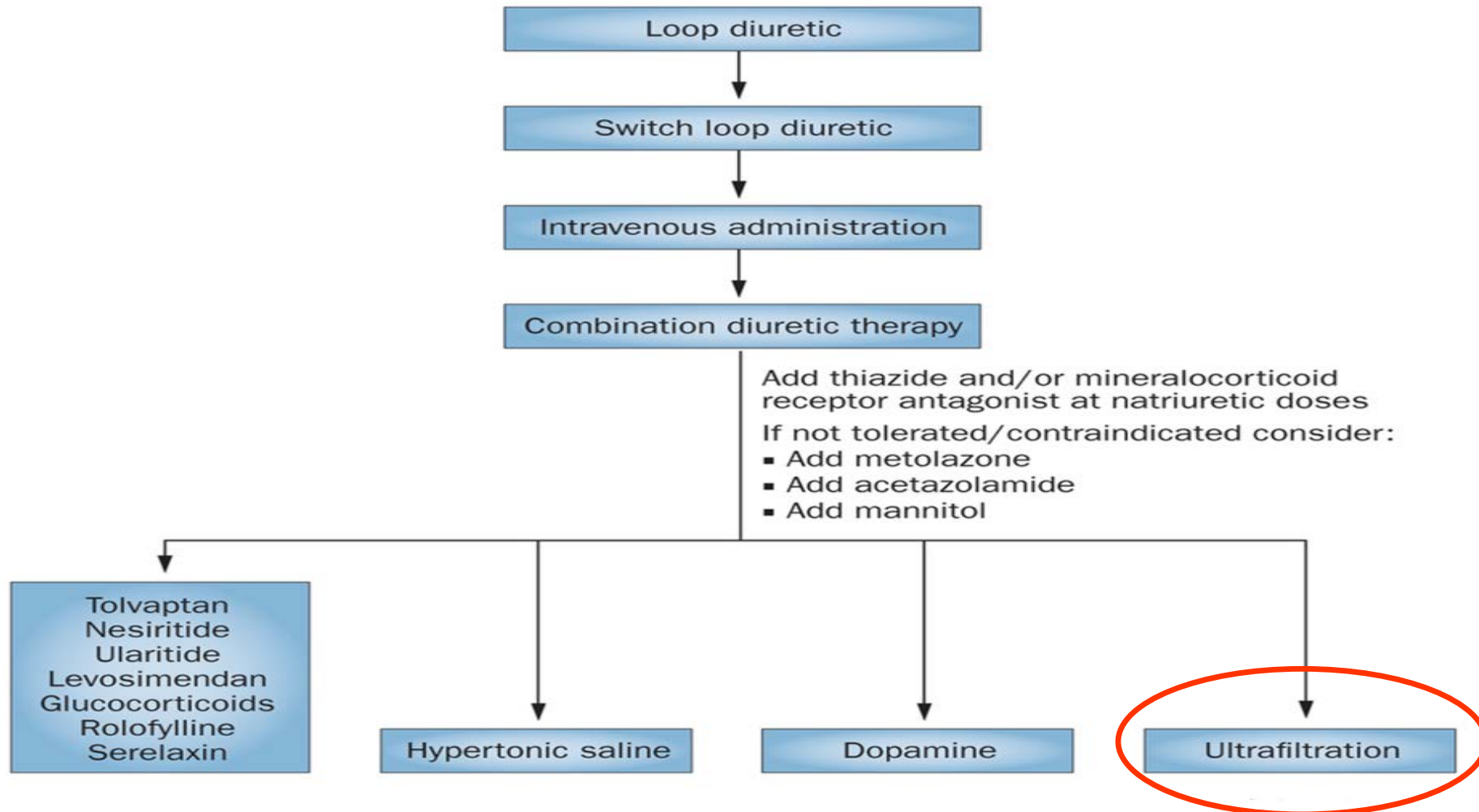
Loop Diuretic Efficiency A Metric of Diuretic Responsiveness With Prognostic Importance in Acute Decompensated Heart Failure

Circ Heart Fail. 2014;7:261-270.

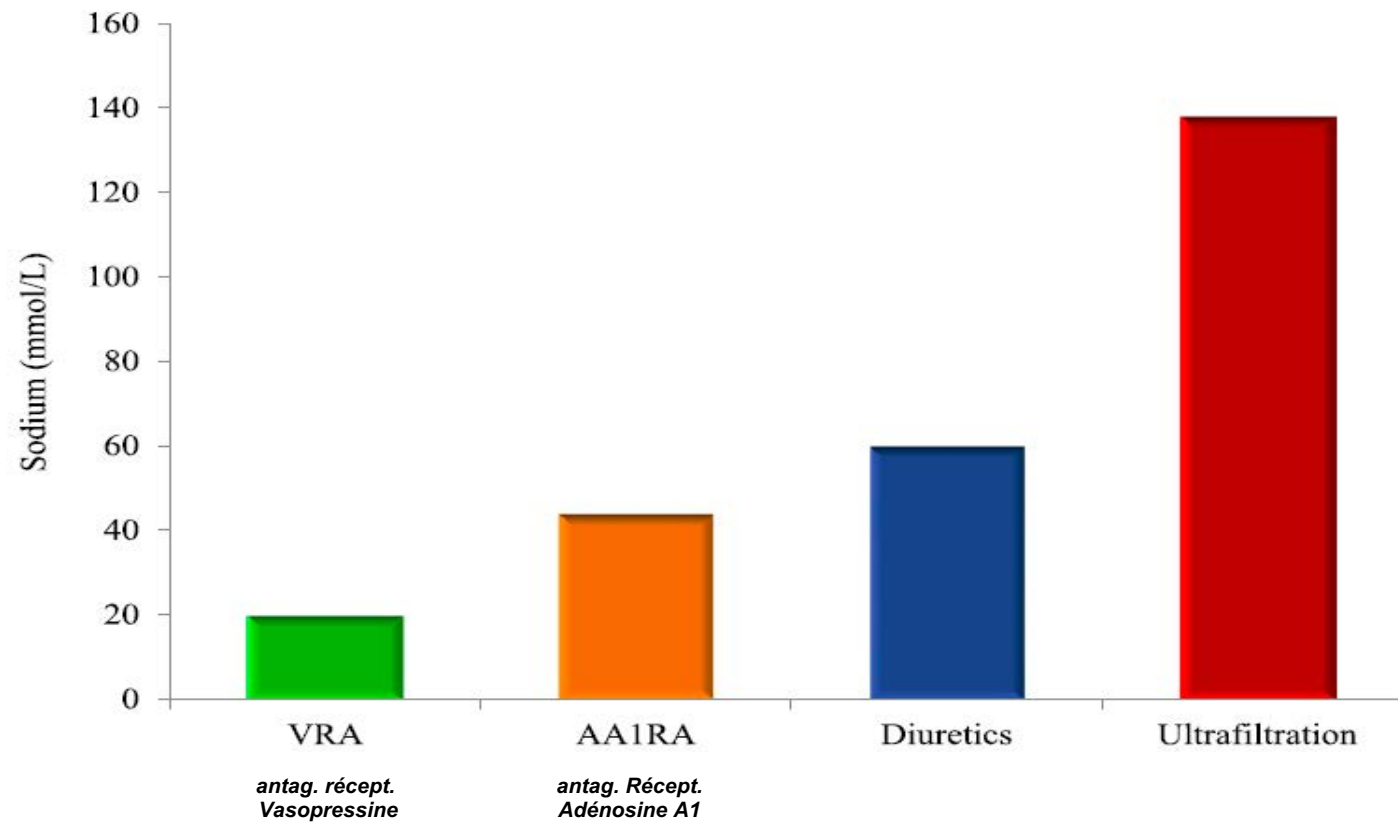


Survie selon dose/efficacité des diur. cohortes Penn (A) et ESCAPE (B).

Prise en charge du syndrome cardiorénal aigu



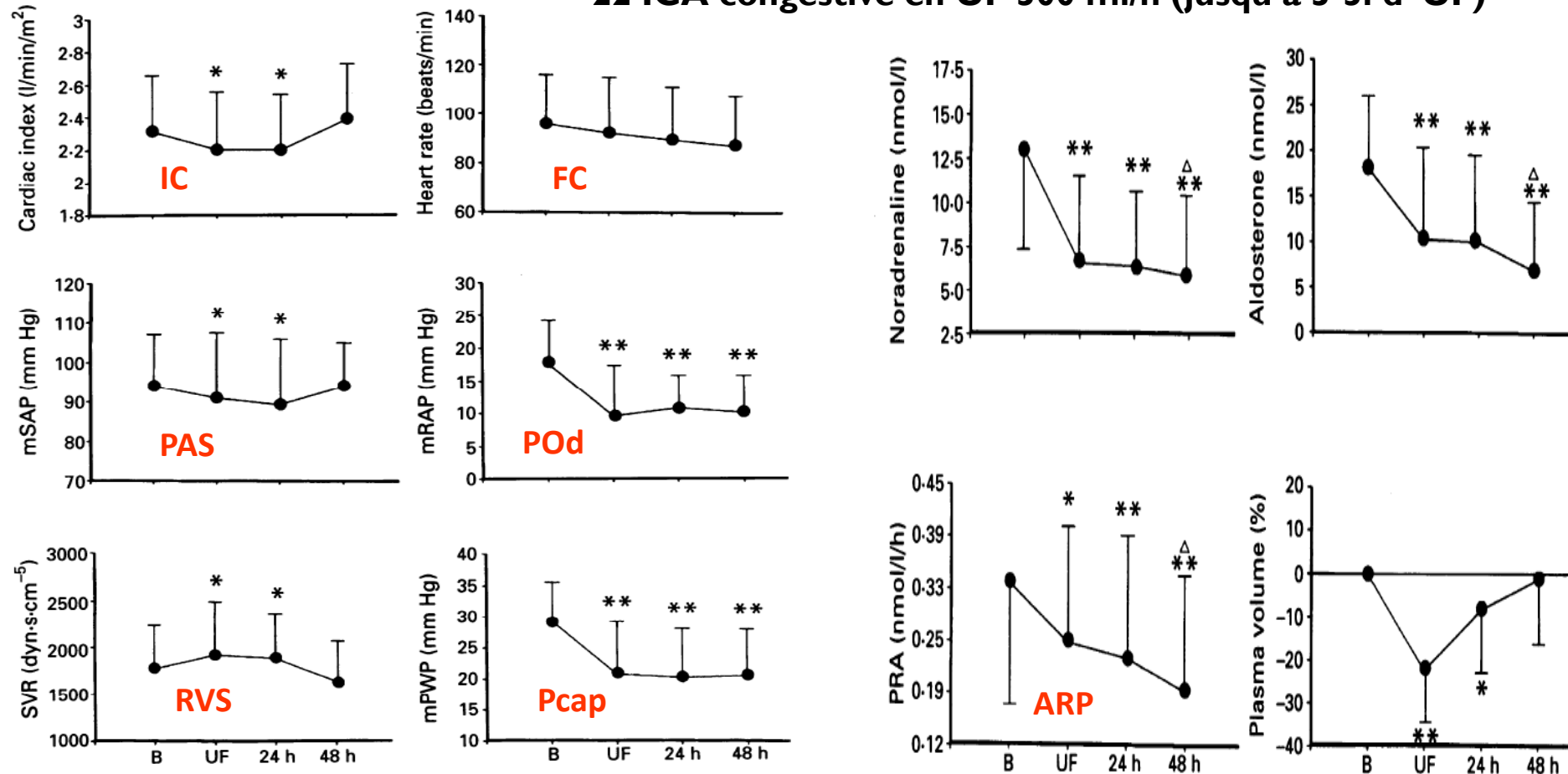
Quantité de Na⁺ éliminée selon la modalité thérapeutique



Apparent paradox of neurohumoral axis inhibition after body fluid volume depletion in patients with chronic congestive heart failure and water retention

Br Heart J 1994;72:534-539

22 ICA congestive en UF 500 ml/h (jusqu'à 3-5l d'UF)



Haemodynamic variables before (B), immediately after UF, and 24 and 48 h later.

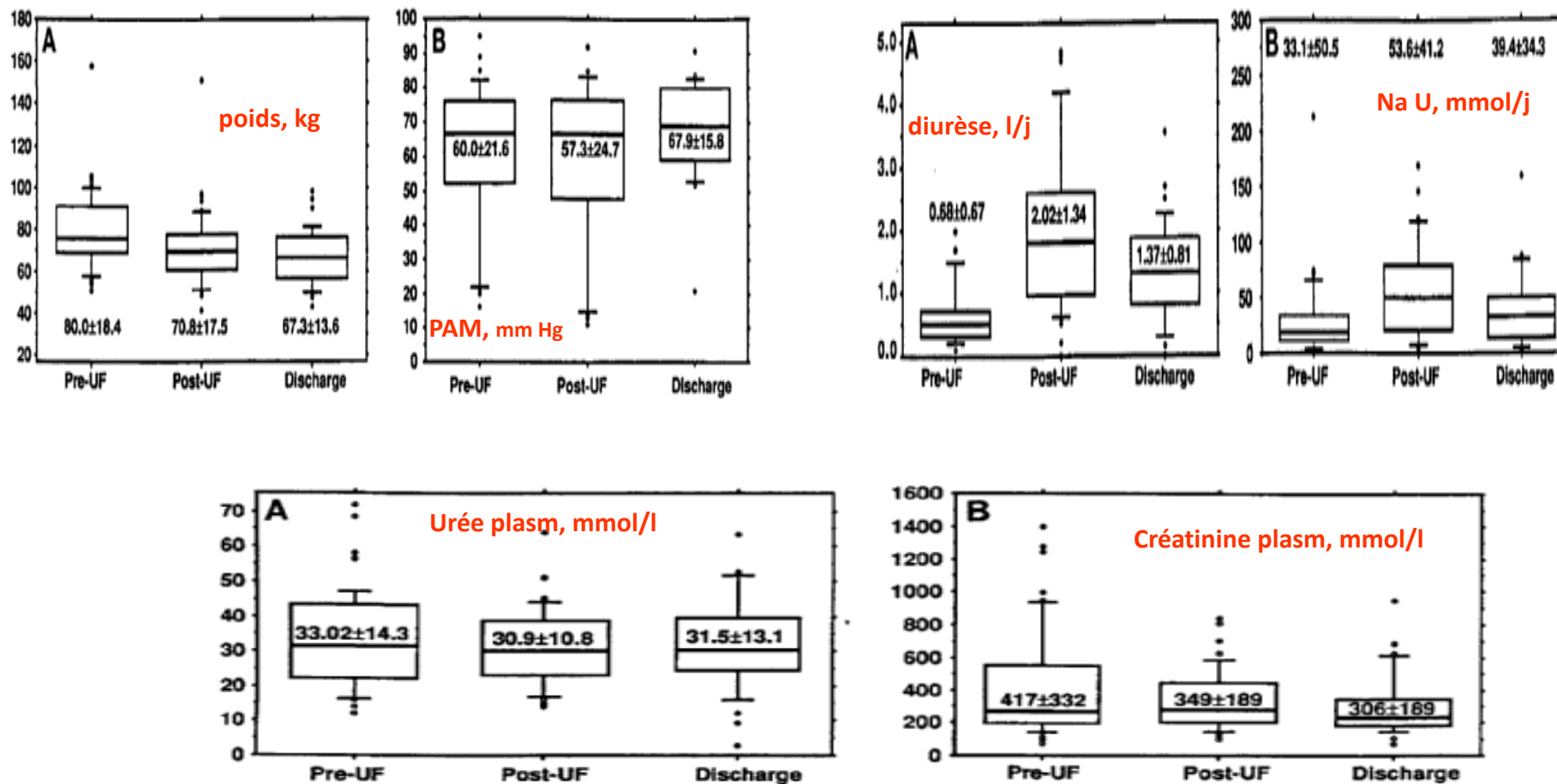
Slow continuous ultrafiltration: a means of unmasking myocardial functional reserve in end-stage cardiac disease.

Canaud B, Cristol JP, Klouche K, Béraud JJ, Du Cailar G, Ferrière M, Grolleau R, Mion C.

Nephrology-Intensive Care Unit, Lapeyronie University Hospital, Montpellier, France.

Am J Kid Dis 1996;28:S67-73 et Contrib. Nephrol 1991;93:79-85

51 pts en ICA réfractaire traités par UFCVV isolée

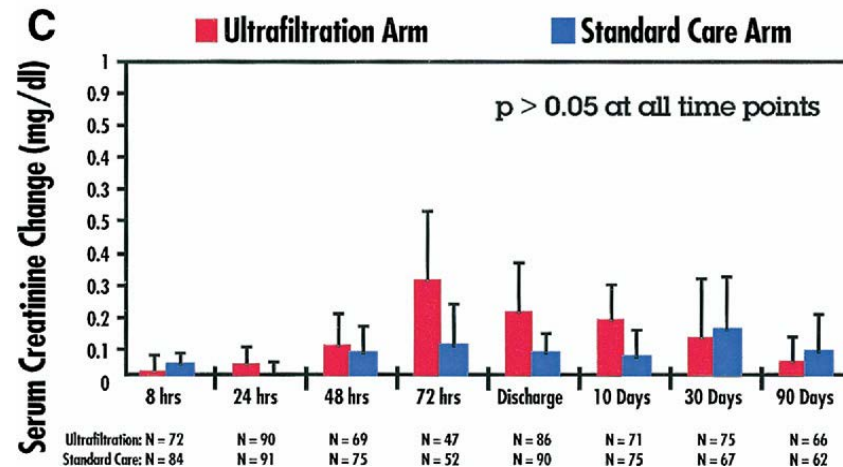
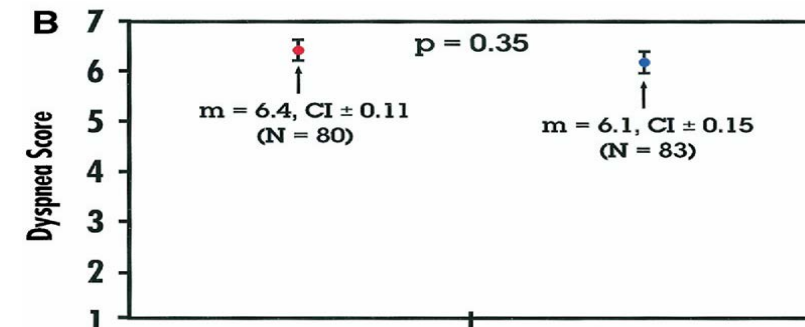
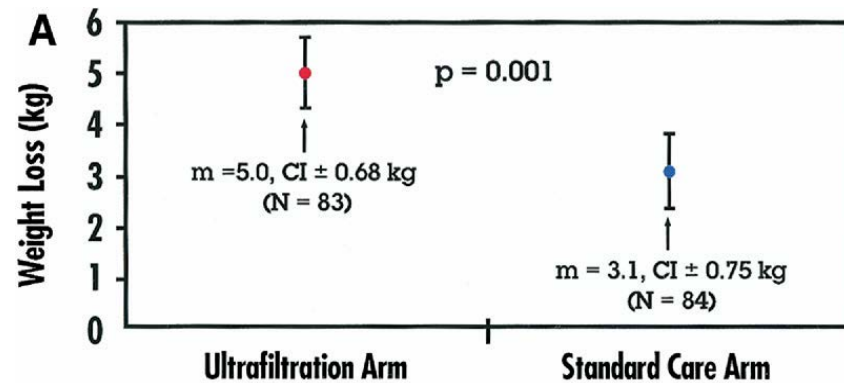


Uf vs IV Diuretics for Acute Decompensated Heart Failure

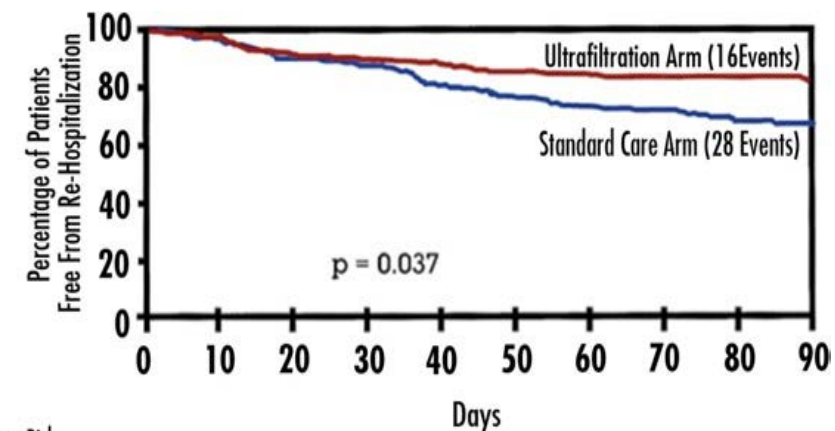
J Am Coll Cardiol 2007;49:675-83

étude randomisée 200 pts ICA (pas de nécessité d' IC refrac.)

Diurétiques (pas de standardisation de la prescription) vs UF



moins d' hypoK avec UF



No. Patients at Risk

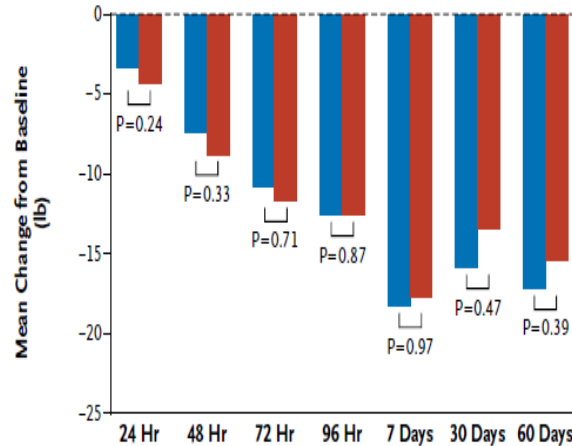
Ultrafiltration Arm	88	85	80	77	75	72	70	66	64	45
Standard Care Arm	86	83	77	74	66	63	59	58	52	41

UF in Decompensated Heart Failure with Cardiorenal Syndrome

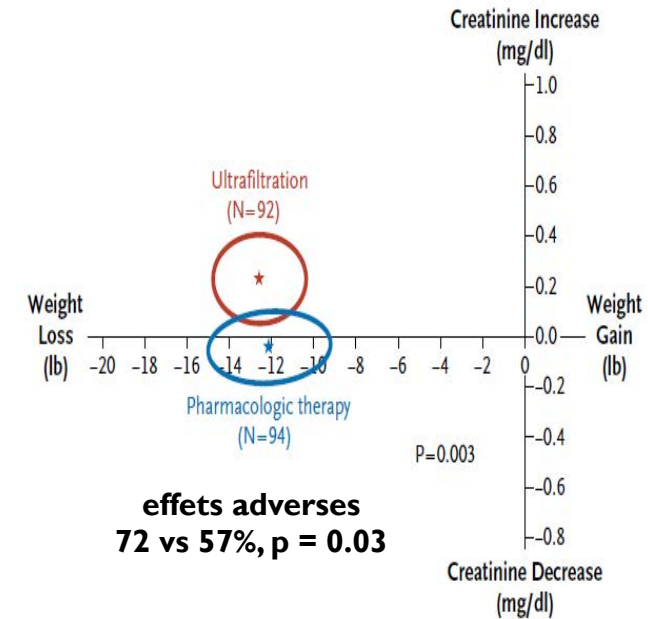
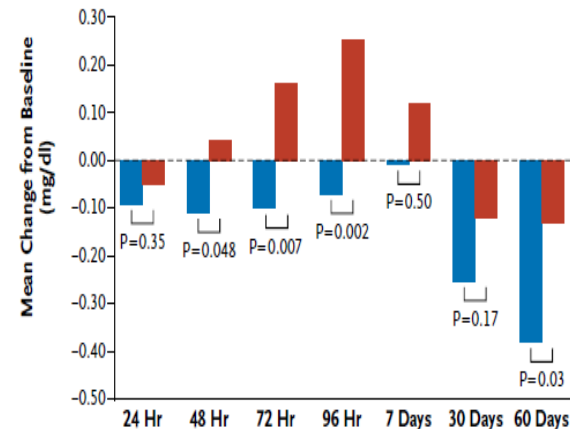
N Engl J Med 2012. CARESS-HF

Etude multicentrique (22 centres USA, Canada) prospective randomisée contrôlée sans aveugle
188 pts ICA congestive (pas d'inotropes, PAS >90) et altération fonction rénale (créat < 300 µmol/l)
apports limités à 2l/j, 2g NaCl/j

B Body Weight



A Serum Creatinine



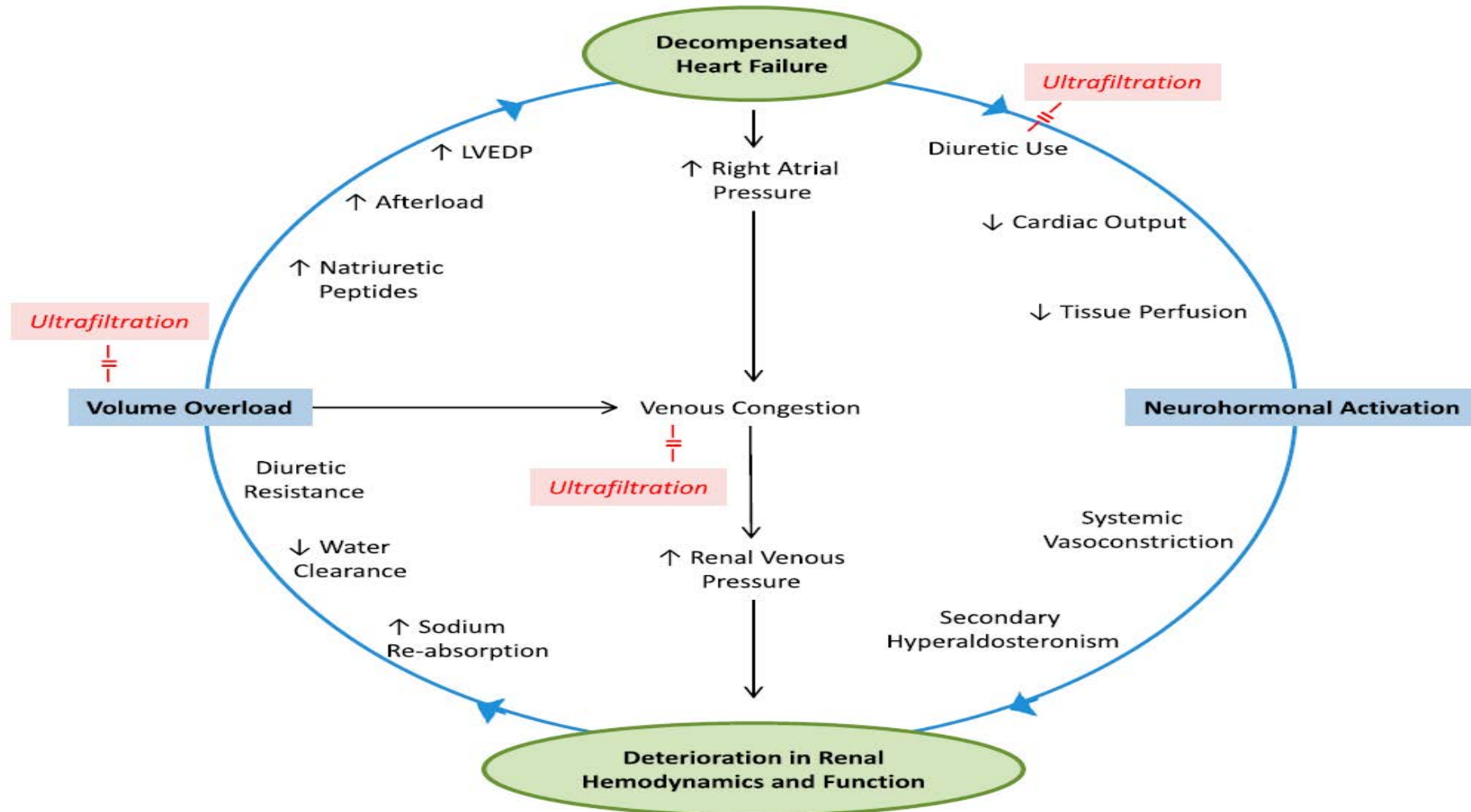
■ Pharmacologic therapy ■ Ultrafiltration (vvp, 200ml/h, 40h, arrêt Diu.)

Obj: diurèse 3-5 l/j

Mortalité à 60j et réhospitalisations identiques dans les 2 groupes

Mécanismes du syndrome cardio-rénal aigu

Intérêt de l'ultrafiltration



Prise en charge du SCR aigu

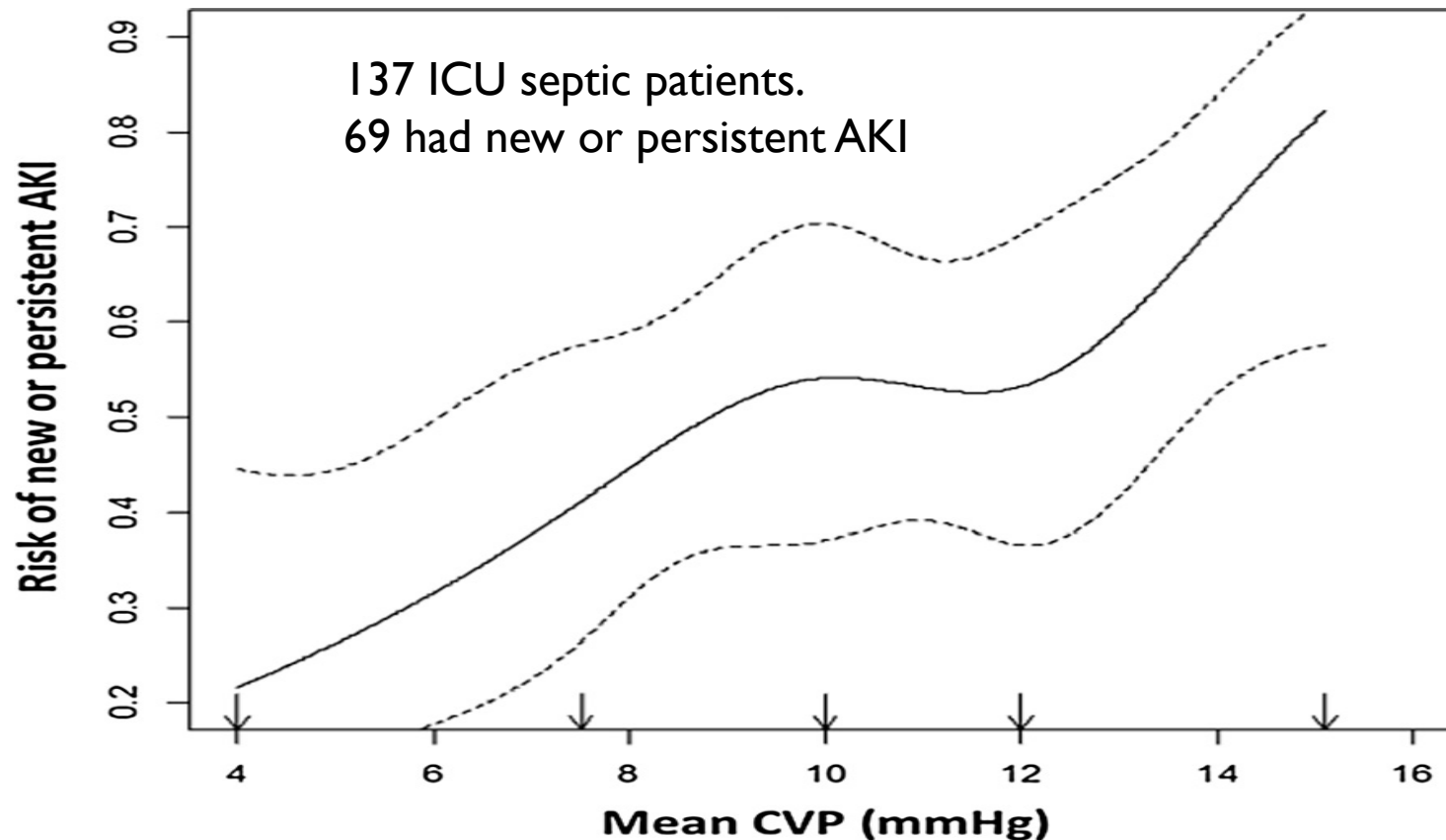
Réduire la congestion veineuse (PVC, pressions droites)
et

Préserver la perfusion rénale (PAM, PPM)

Monitorer PAS, PVC, Diurèse, lactate

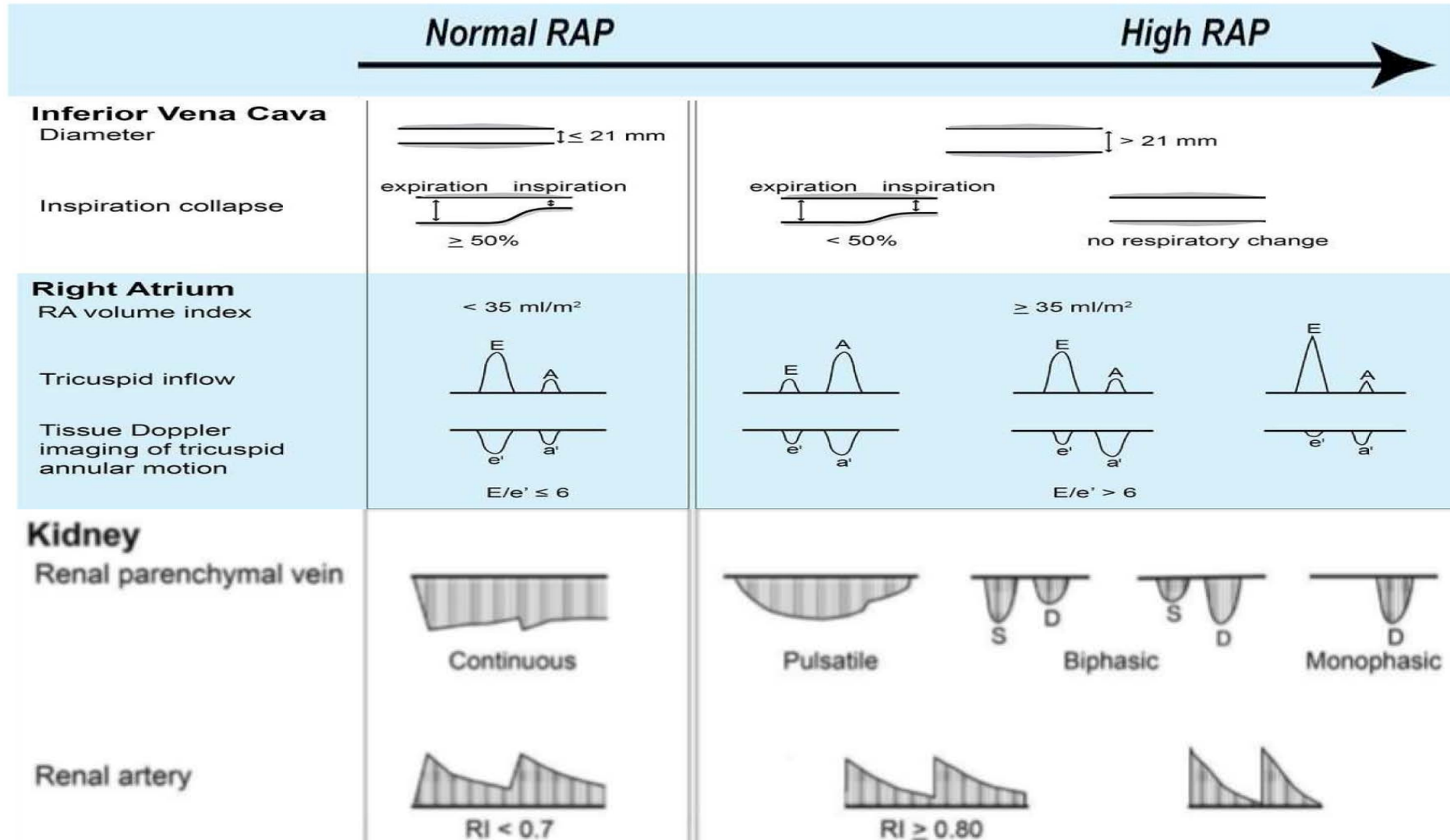
Réduire la congestion veineuse

Relationship between **central venous pressure** and the probability of new or persistent acute kidney injury.



Réduire la congestion veineuse

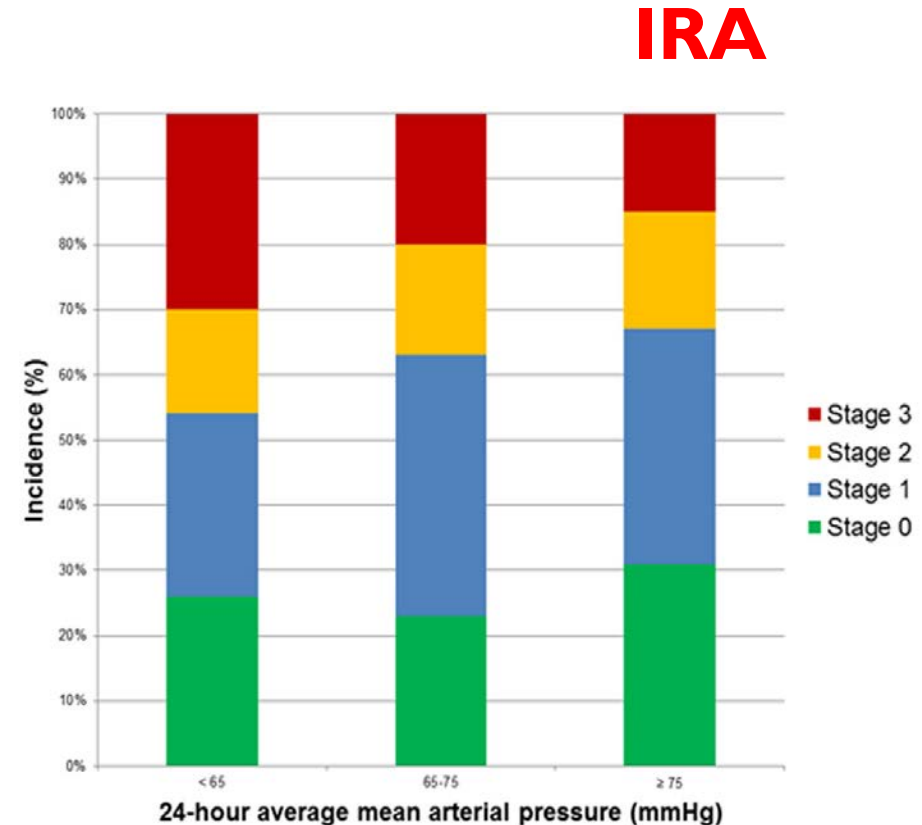
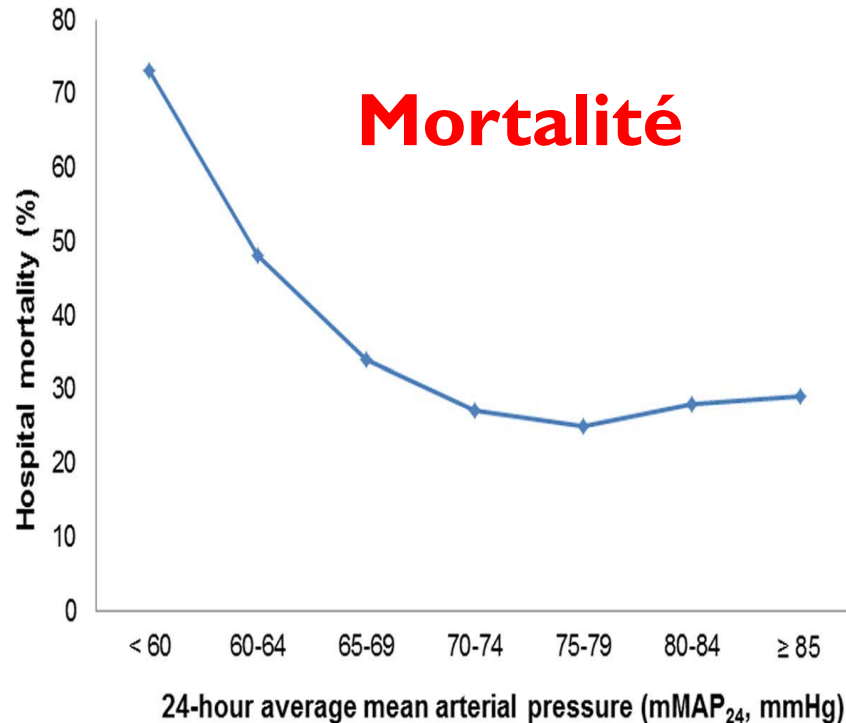
Ultrasound Profiles Across the Spectrum of Elevated Right Atrial Pressure As Indication for Cardio-Renal Syndrome in Right Heart Failure.



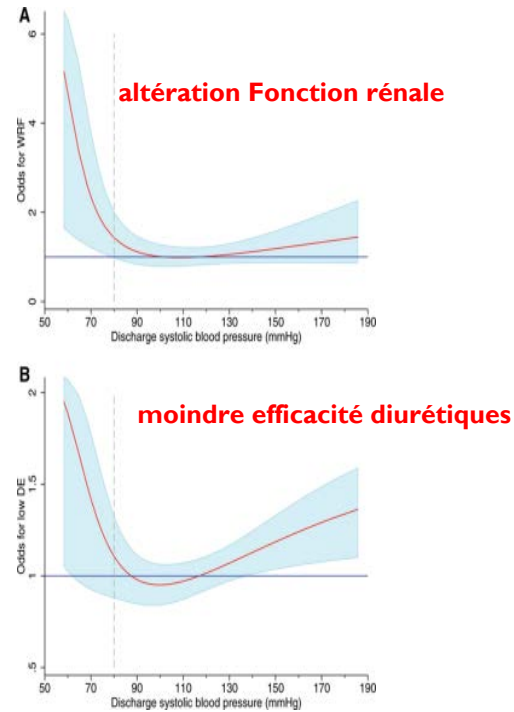
Préserver la perfusion rénale

Association between mean arterial pressure during the first 24 hours and hospital mortality in patients with cardiogenic shock

Burstein et al. Critical Care (2020) 24:513



Relationship between discharge blood pressure and worsening renal function (A) and low diuretic efficiency (B).

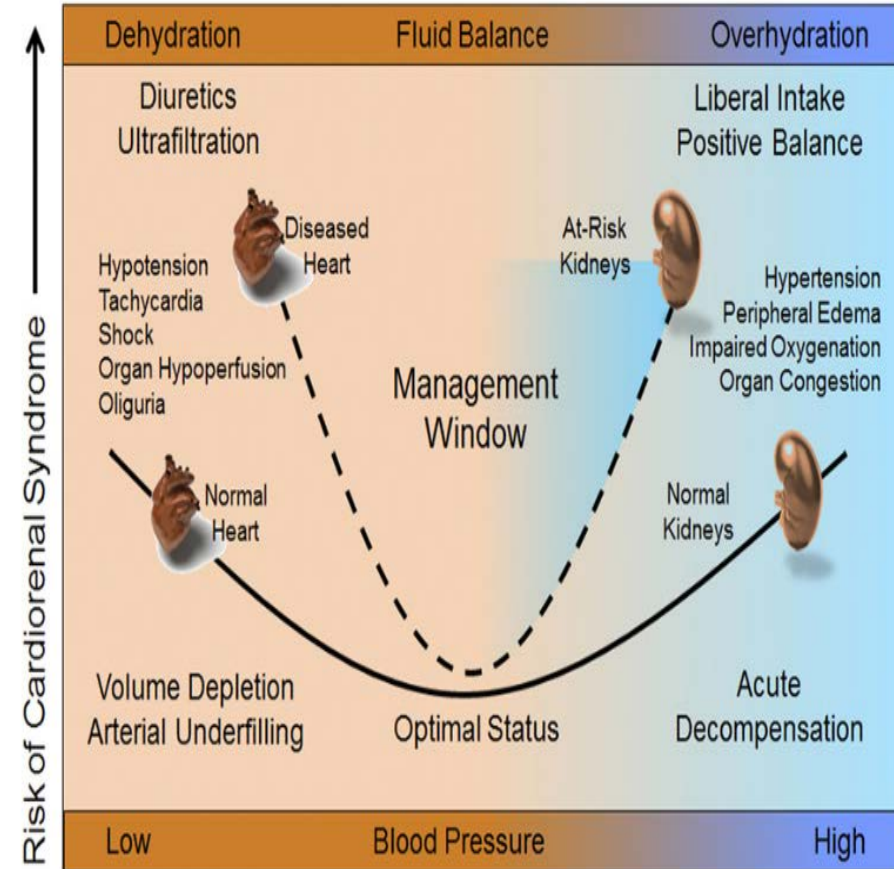


Alexander J. Kula et al. Circ Heart Fail. 2016;9:e002333



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Volume and Blood Pressure Management Window



J Am Coll Cardiol 2012;60:1031–42

La pression de perfusion (**PAM-POD**) optimale ?

Low mean perfusion pressure is a risk factor for progression of acute kidney injury in critically ill patients – A retrospective analysis

BMC Nephrology

Ostermann et al. BMC Nephrology (2017) 18:151

Multivariable analysis: Risk factors for progression from AKI I to AKI III (205 AKI I, évolution vers 3)

Parameter	OR (95% CI) ^a	p-value
First arterial lactate following diagnosis of AKI I [mmol/L]	1.45 (1.12–1.89)	0.005
SOFA score on day of AKI I	1.20 (1.05–1.37)	0.01
First DO ₂ I in 12 h period after diagnosis of AKI I [ml/min/m ²]	0.997 (0.994–0.99)	0.01
First calculated MPP	0.995 (0.92–0.99)	0.03
Age [years]	1.02 (0.997–1.05)	0.09
Cumulative fluid balance on day of AKI I [ml]	1.00 (0.99–1.00)	0.98
MAP <65 mmHg for >1 h in first 12 h after diagnosis of AKI I	0.97 (0.48–1.96)	0.93

Abbreviations: CI confidence interval, DO₂I oxygen delivery index, MAP mean arterial pressure, MPP mean perfusion pressure, OR odds ratio, SOFA sequential organ failure assessment

^acontrolled for age, oxygen delivery index, arterial lactate concentration, cumulative fluid balance and SOFA score

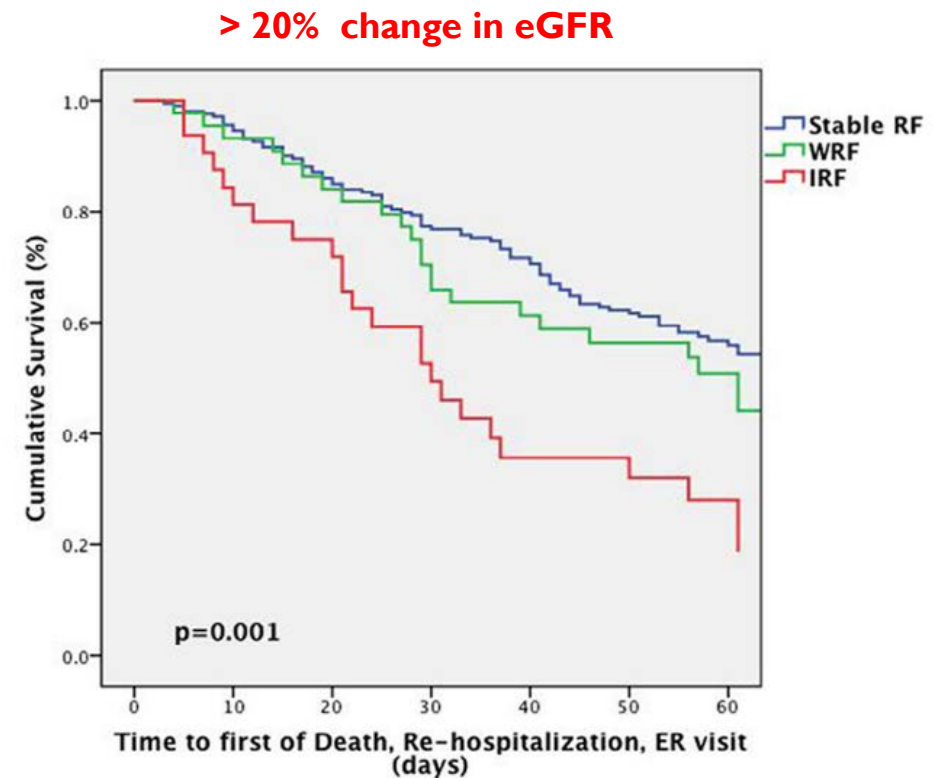
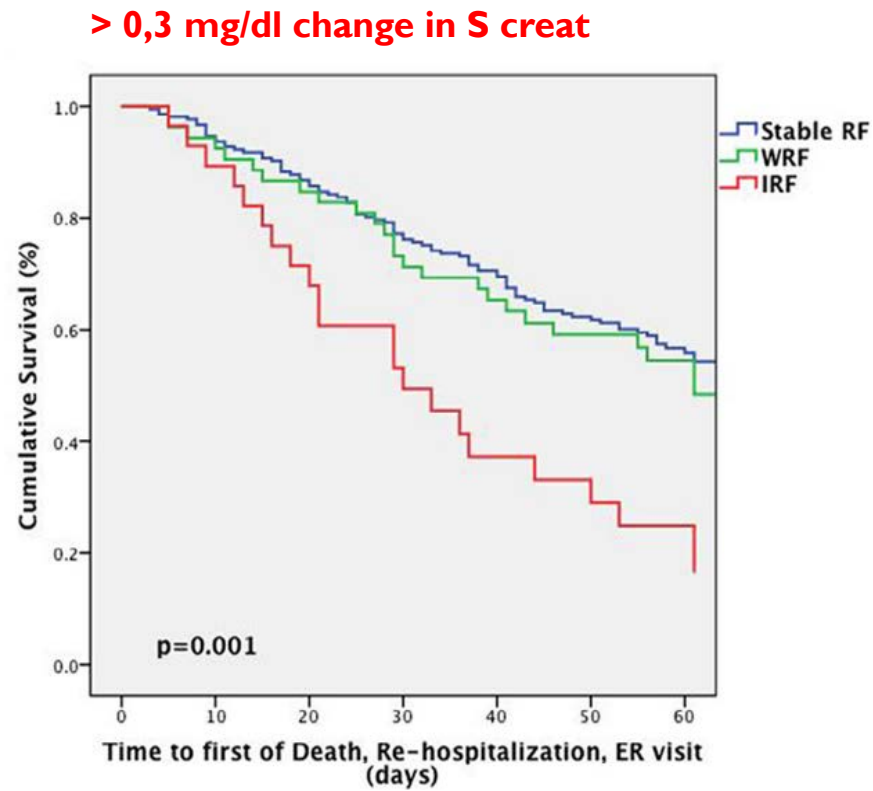
MPP <60 mmHg was independently associated with AKI.
CVP was the key component of MPP.

L'aggravation de la fonct. rénale après tt n'est pas (forcément) associée à un mauvais pronostic

Pseudo-aggravation de la fonction rénale?

J Cardiac Fail 2016;22:753–760

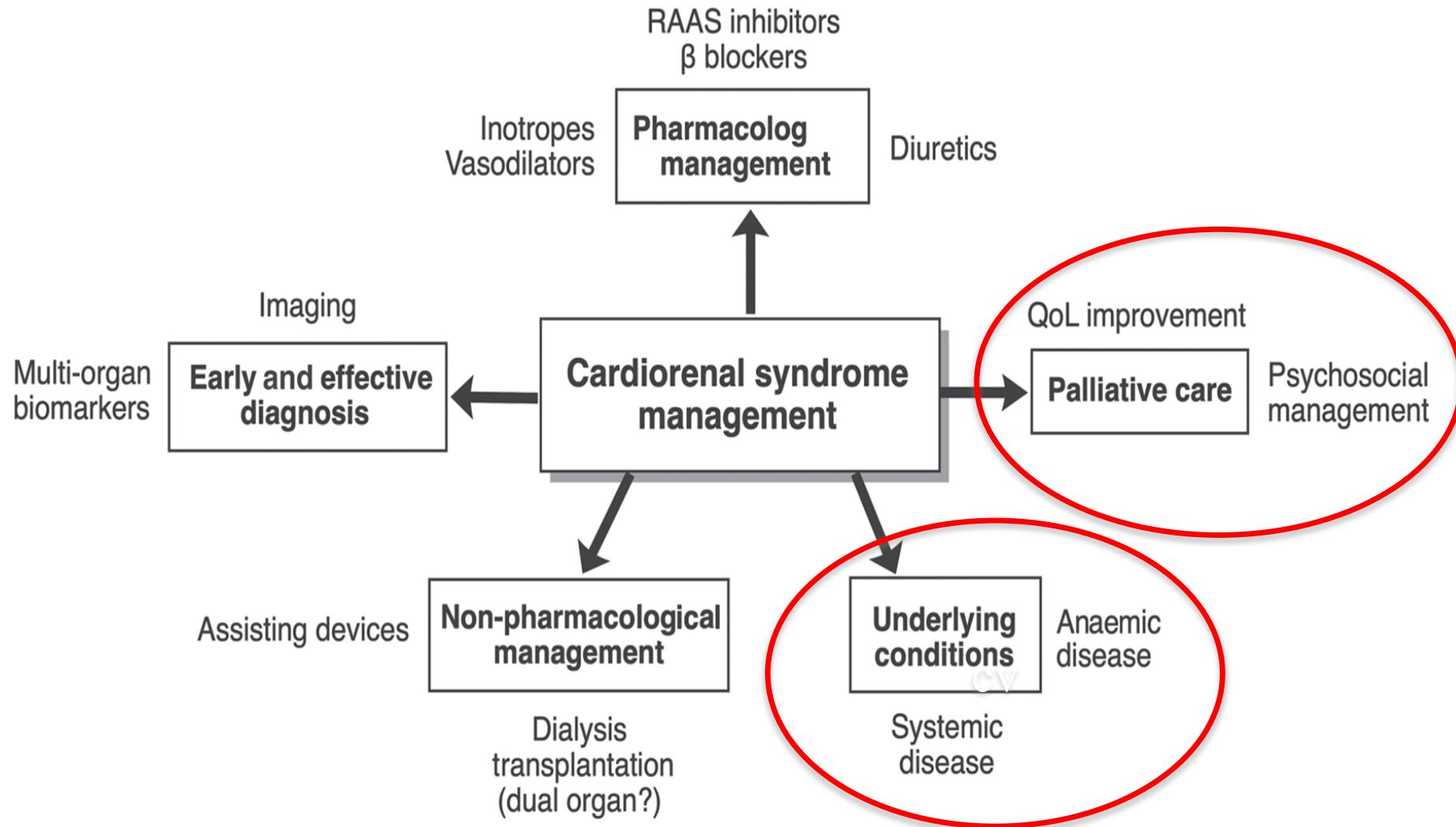
300 ICA, étude DOSE



Survival plots of the risk of death, rehospitalization, or emergency department visit by stable, worsening, or improvement in renal function.

Principle of cardiorenal syndrome management.

F Savira et al. Br J Pharmacol. 2020;177:2906–2922.



CONCLUSION

- Pathologie cardio-rénale fréquente

- Interactions bidirectionnelles cœur→rein

Syndrome multifactoriel: hémodynamique, neuroH et inflammatoire

- Les diurétiques et l'UF: 2 thérapeutiques complémentaires
(utilisées à bon escient)

- UF: nouvelles technologies

Questions non résolues:

indications, timing, effets sur la fonction rénale, à long terme et sur la mortalité

- Intérêt des biomarqueurs? SGLT2 inhibiteurs?

Multidisciplinarité cardiologues, néphrologues, internistes, réanimateurs



Merci de votre attention