THE 29TH INTERNATIONAL CONFERENCE ON
ADVANCES IN CRITICAL CARE NEPHROLOGY

AKI & CRRT 2024

Jointly Provided by
UC San Diego
SCHOOL OF MEDICINE
and
CRRT, INC.

MARCH 12-15, 2024 MANCHESTER GRAND HYATT SAN DIEGO, CALIFORNIA

WORKSHOP D12
(Thursday March 14, 2024)

Managing the Heart Failure Patient with Worsening Renal Function (WRF)

Amir Kazory, MD, FASN, FAHA
Division of Nephrology, Hypertension, and Renal Transplantation
University of Florida

Disclosures

Baxter, Inc. – Cardiology Advisory Board
DCI, Inc. – Directorship Fee
Daxor - Consultant
Elsevier – Editorial Fee
Horizon Therapeutics USA, Inc. – Advisory Board
NuWellis, Inc. - Scientific Advisory Board
Relypsa, Inc. - Consultant
W.L. Gore Inc. - Consultant

Heart Failure

Common
Costly
Deadly

- Lifetime prevalence: 2
- Currently, over 6.5 mil … than 8 million by 2030)
- ADHF : the leading cau … nts over 65
- ADHF: the highest rate … among all medical conditions
- ADHF: the 3-month re-
- ADHF: the 1-year mortality rate of over 30%

- Total costs for HF: $31 billion in 2012, estimated at $70 billion in 2030

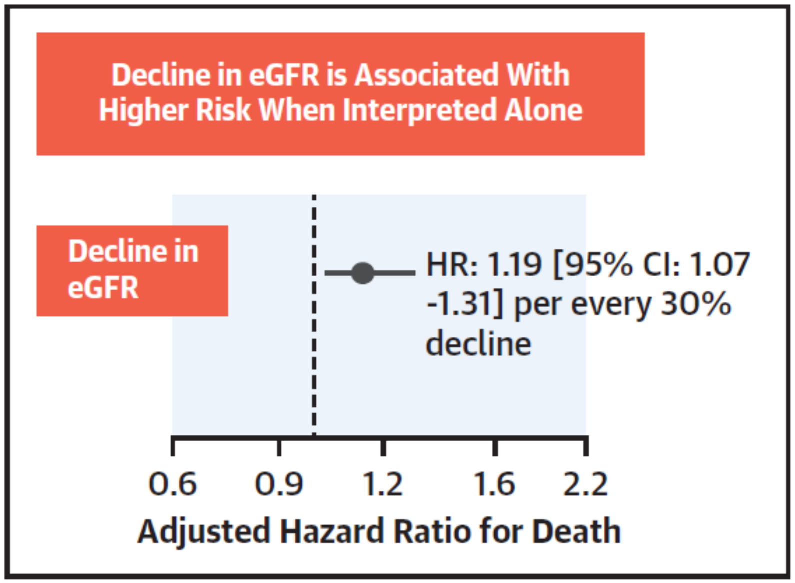
(80% due to hospitalization) – *Major Financial Burden on Healthcare*

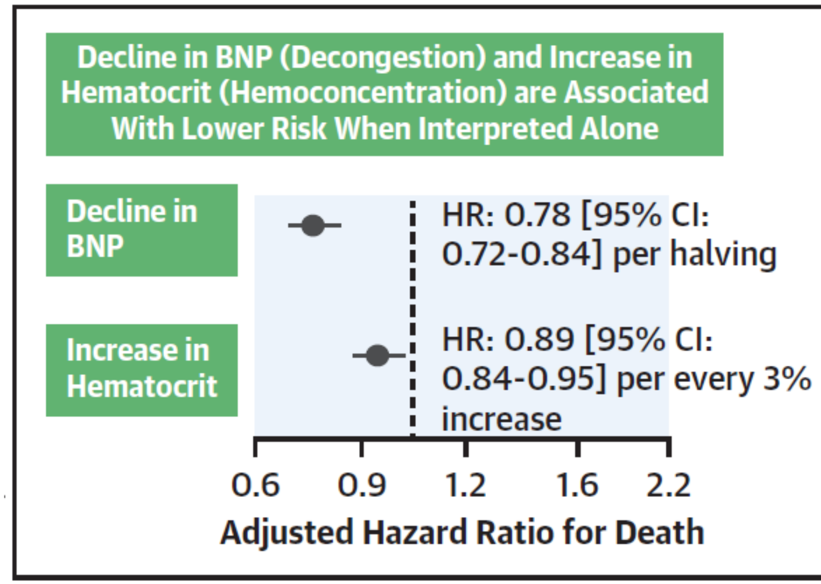
Let’s take a look at “WRF” (worsening renal function) first…

Congestion Modulates the Impact of ↑Scr in ADHF

3715 patients

EVEREST ad hoc



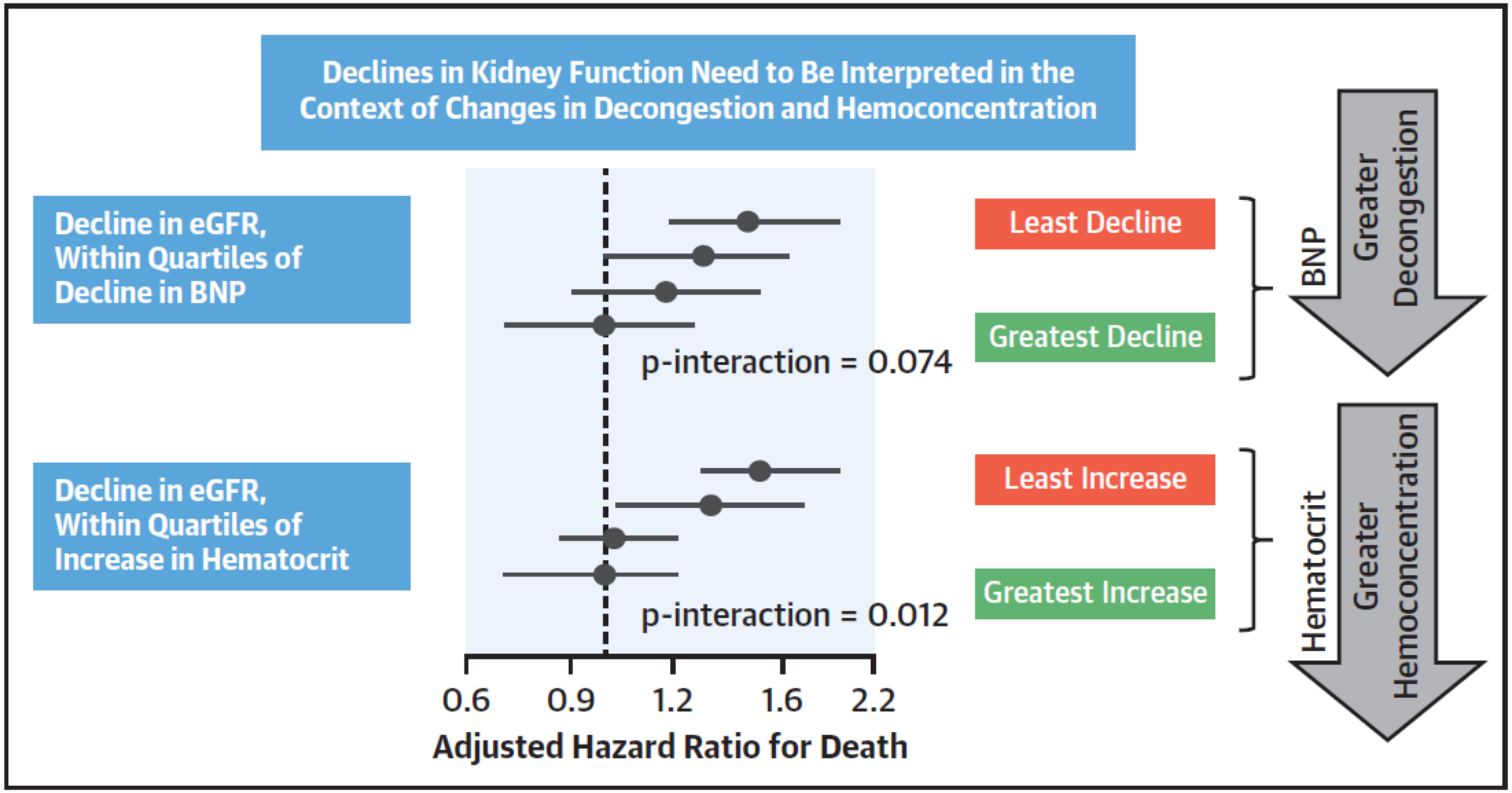


[MaCallum W et al. JACC Heart Fail 2020;8:537]

Congestion Modulates the Impact of ↑Scr in ADHF

3715 patients

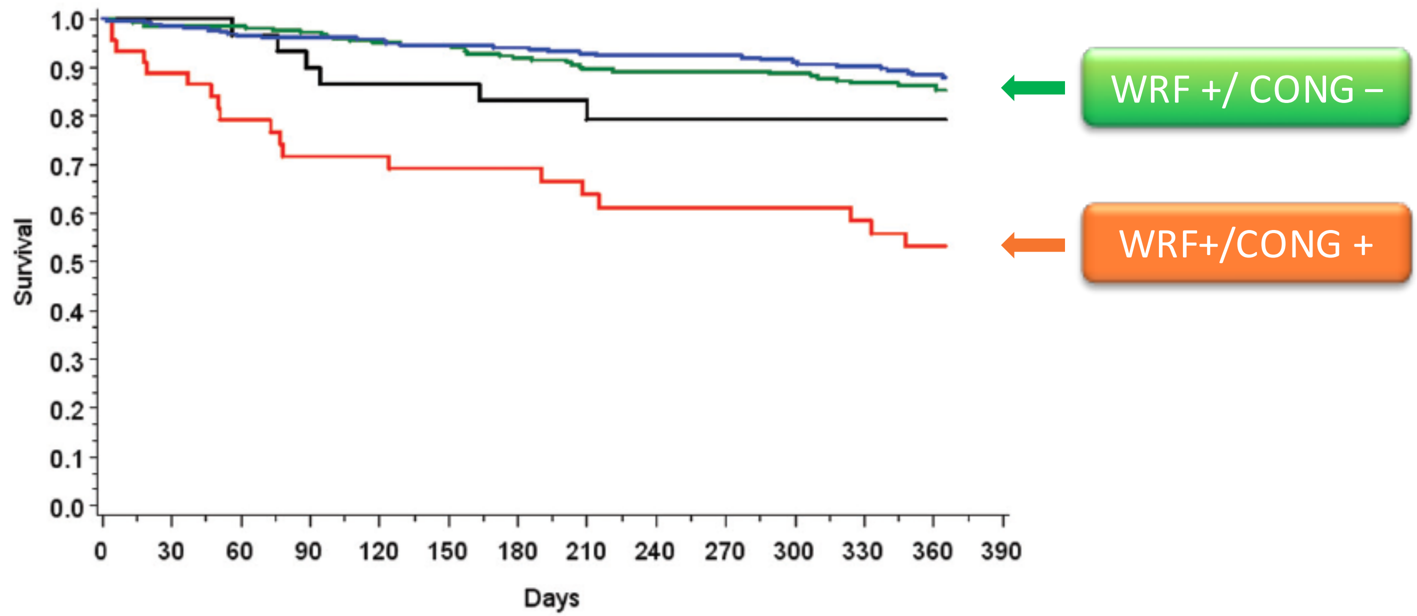
EVEREST ad hoc



[MaCallum W et al. JACC Heart Fail 2020;8:537]

RSC (WRF) and De(-Congestion)

599 patients



WRF/Cong	45	40	32	29	28	26	26	24	23	23	23	22	20
No WRF/Cong	31	31	29	27	26	26	24	22	20	19	19	19	18
WRF/No Cong	253	247	243	235	218	216	204	195	189	188	185	178	170
No WRF/No Cong	265	259	249	244	237	229	227	223	217	214	208	202	197

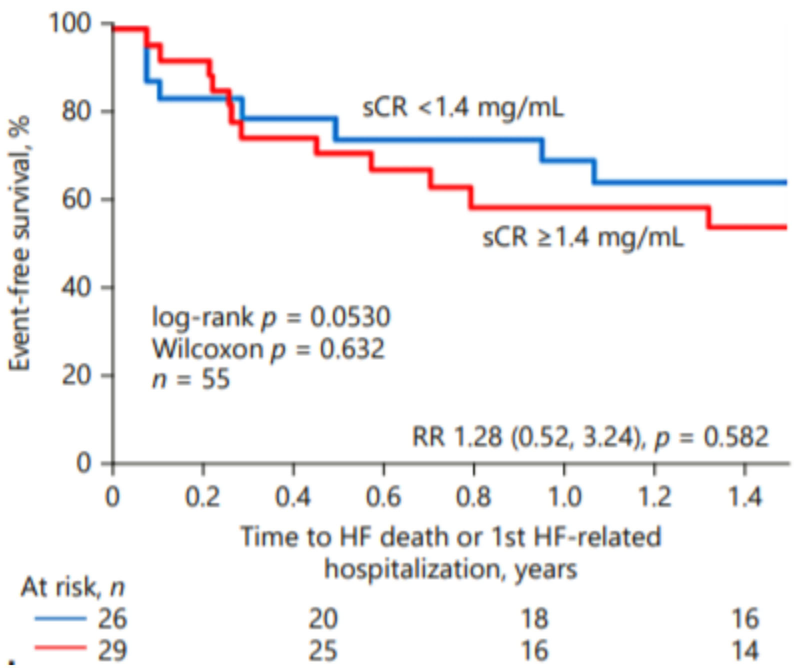
Endpoints: 1 year death or urgent transplantation

[Metra M. Circ Heart Fail 2012; 5: 54]

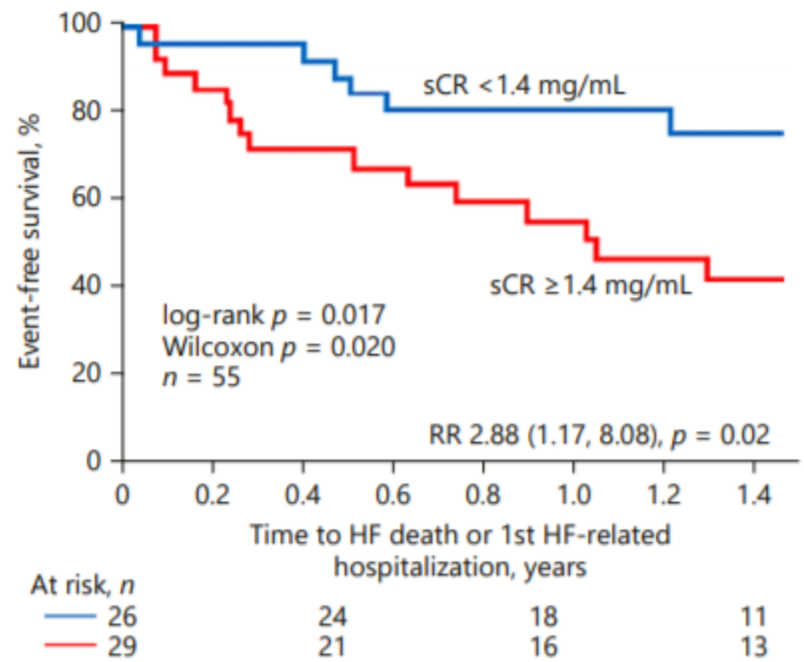
Congestion Modulates the Impact of ↑Scr in Chronic HF

110 patients

Mild-to-moderate plasma volume expansion



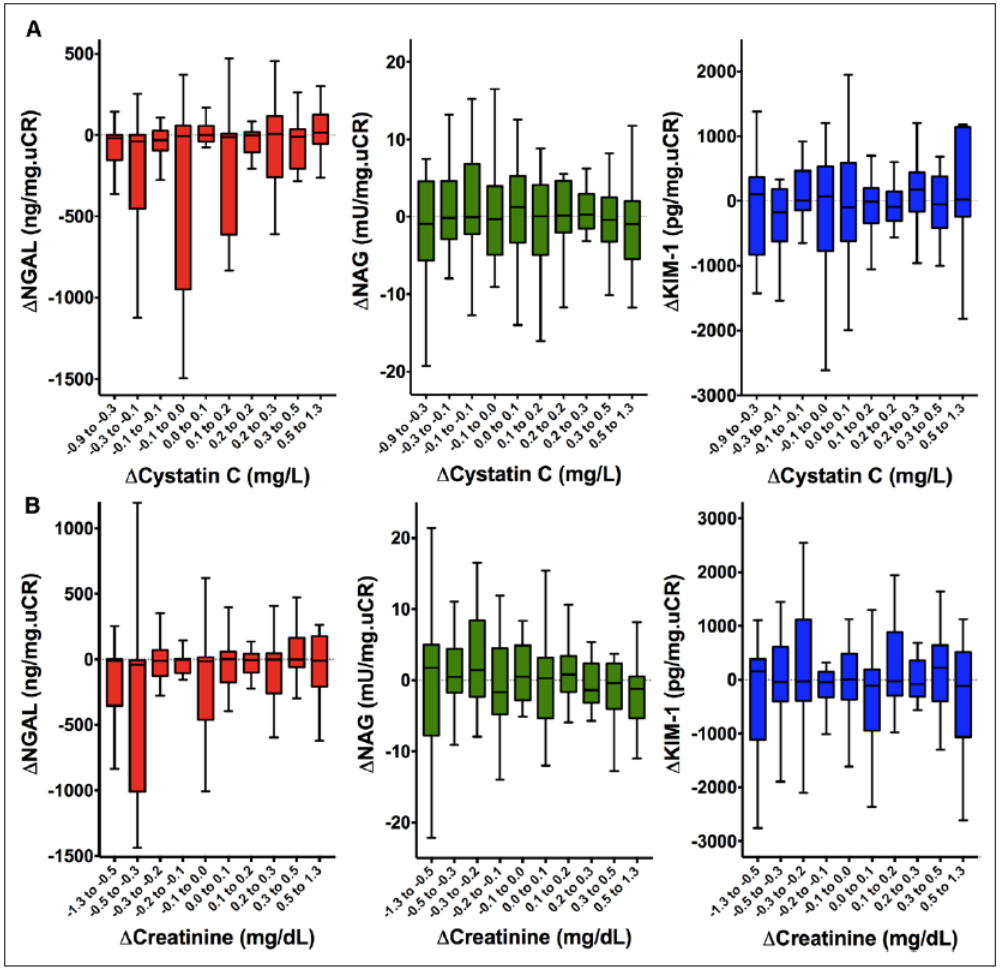
Severe plasma volume expansion



Impact of hypervolemia as objectively assessed through Blood Volume Analysis (BVA)

[Miller WL. Kidney Dis 2020;6:50]

RSC in ADHF Undergoing Aggressive Diuresis; Not Tubular Injury



283 patients in ROSE-AHF

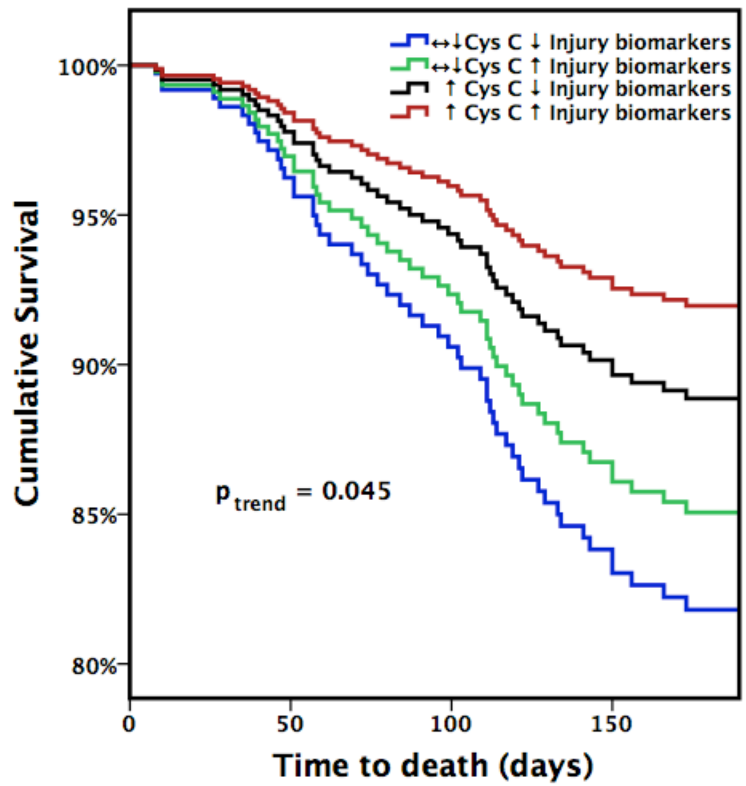
Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

No clear threshold or non-linear relationship between changes in Cystatin C and SCr with biomarkers of tubular injury

[Ahmad T, et al. Circulation 2018;137:2016]

RSC in ADHF Undergoing Aggressive Diuresis; Impact on Outcome

283 patients in ROSE-AHF



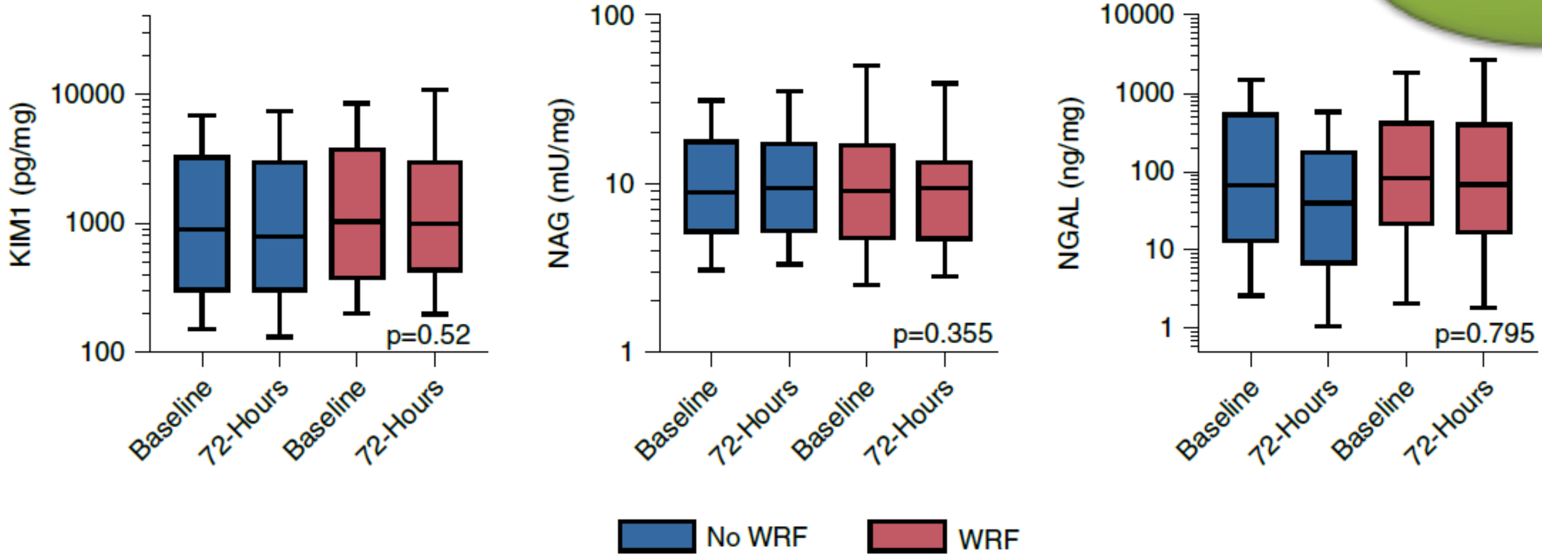
Decline in kidney function and increase in tubular injury markers; the best outcomes
No change or improvement in kidney function/tubular injury biomarkers had the worst outcomes.

Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

[Ahmad T, et al. Circulation 2018;137:2016]

Serum Creatinine and Renal Tubular Injury Biomarkers

270 patients in ROSE-AHF

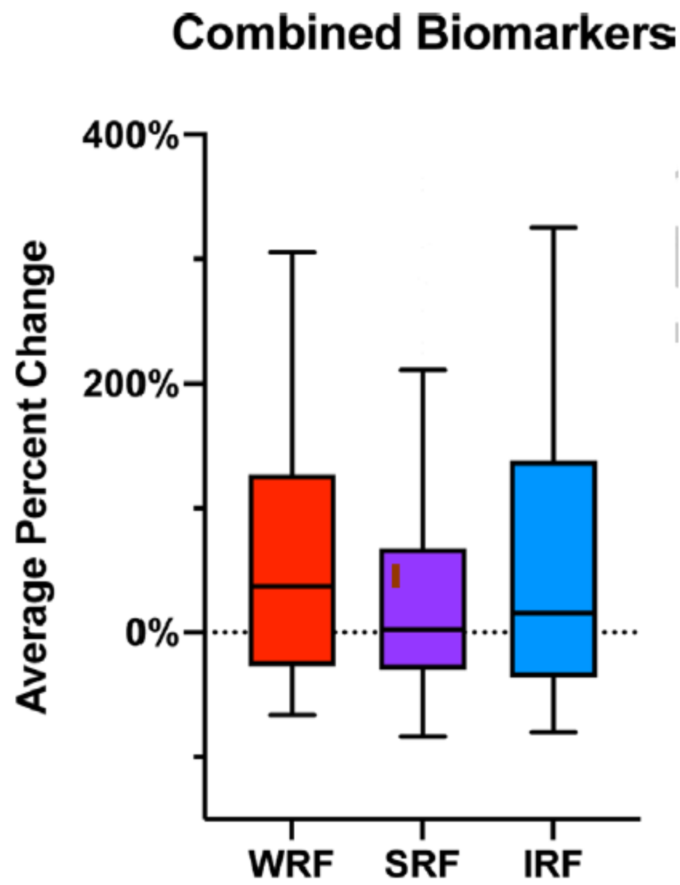


No correlation between biomarkers of tubular injury and changes in serum creatinine during ADHF therapy

Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

[Maulion C, et al. Kidney360 2022; 1003]

Decrease in Serum Creatinine (DSC) in ADHF Undergoing Aggressive Diuresis



$P = 0.24$
$P_{trend} = 0.70$

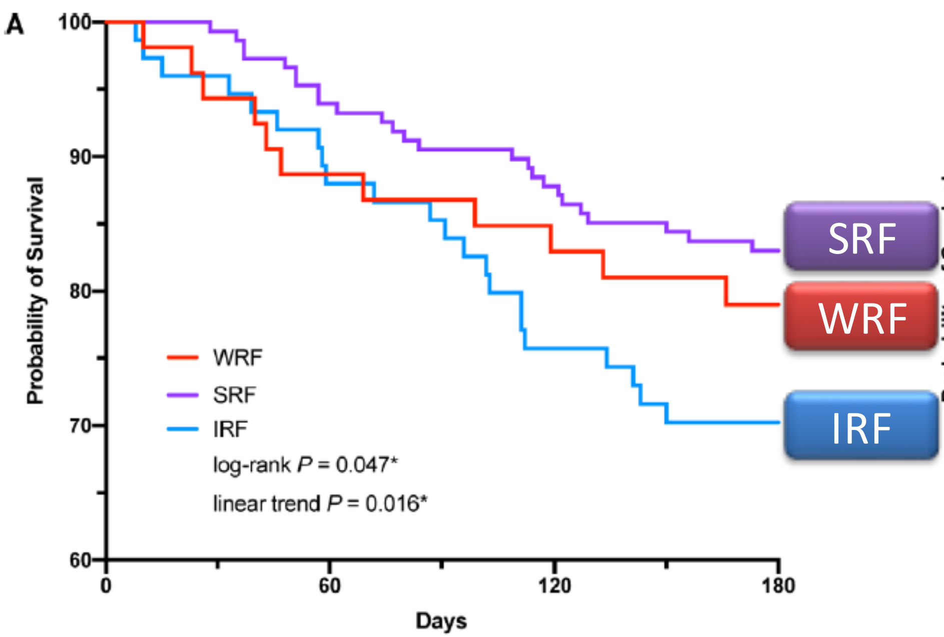
277 patients in ROSE-AHF

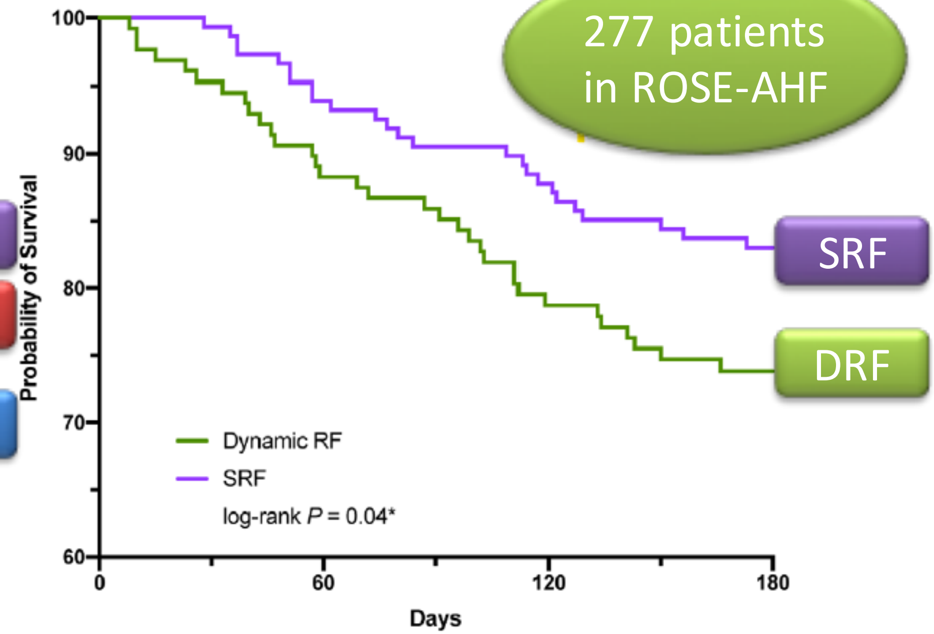
No correlation between markers of tubular injury and changes in serum creatinine during ADHF therapy

Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

[Natov PS, et al. Circ Heart Fail 2023]

Decrease in Serum Creatinine (DSC) in ADHF Undergoing Aggressive Diuresis





277 patients
in ROSE-AHF

Improvement in Renal Function (IRF) associated with worse outcomes than WRF
Stable Renal Function (SRF) better than Dynamic Renal Function (DRF)

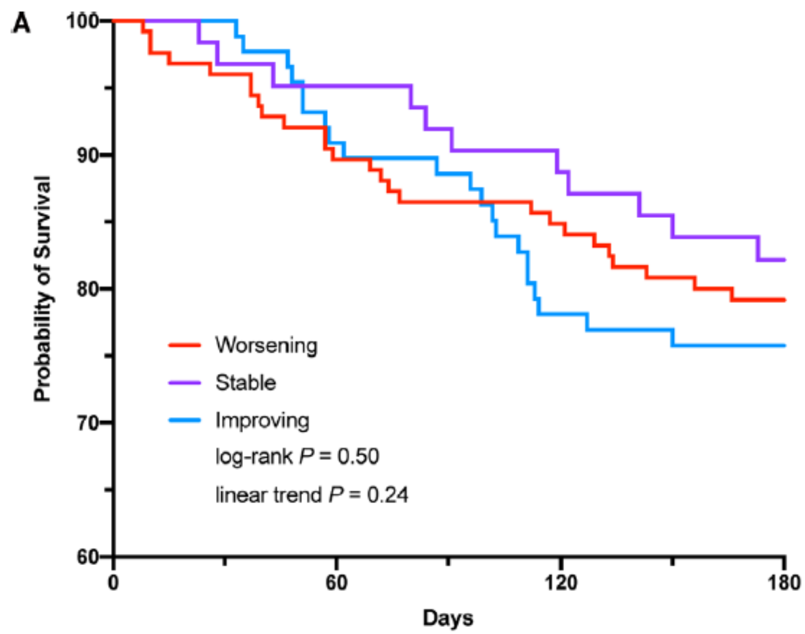
Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

[Natov PS, et al. Circ Heart Fail 2023]

Renal Injury Biomarkers in ADHF Undergoing Aggressive Diuresis

277 patients in ROSE-AHF

Survival



SRF

WRF

IRF

No correlation between markers of tubular injury and survival

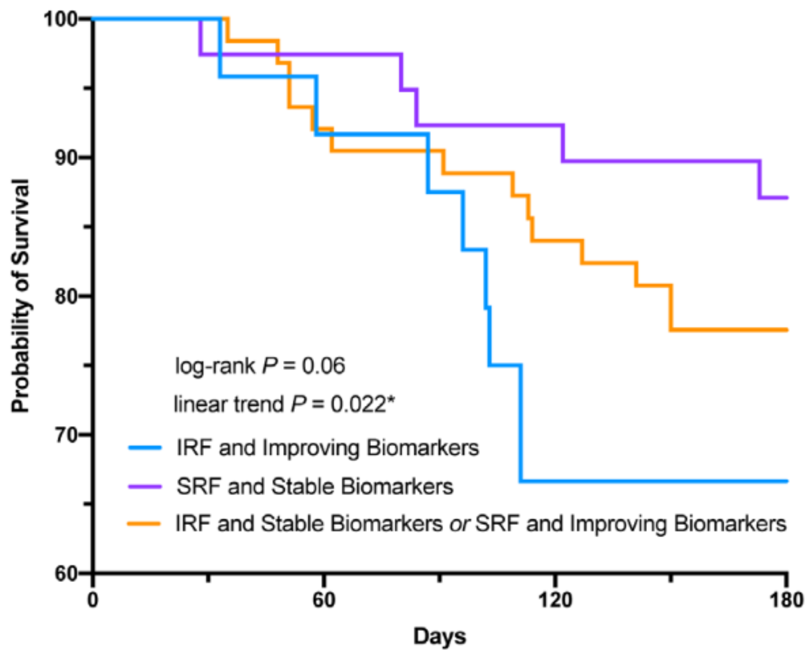
Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

[Natov PS, et al. Circ Heart Fail 2023]

Renal Injury Biomarkers in ADHF Undergoing Aggressive Diuresis

277 patients in ROSE-AHF

Survival



SRF + stable biomarkers

IRF + stable biomarkers
SRF + ↓biomarkers

IRF + ↓biomarkers

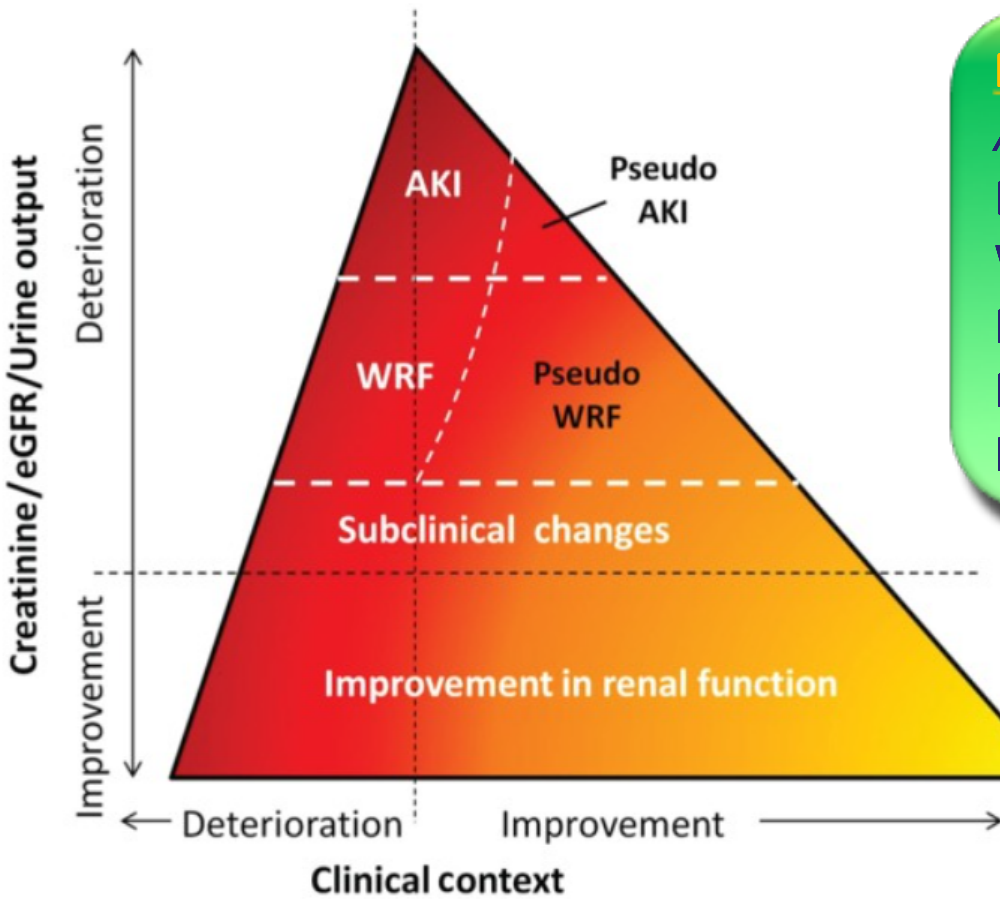
Best outcome: **Stable** Renal Function and **Stable** Biomarkers

Kidney Injury Molecule-1 (KIM-1), neutrophil gelatinase-associated lipocalin (NGAL) and *N*-acetyl-β-d-glucosaminidase (NAG).

[Natov PS, et al. Circ Heart Fail 2023]

Rise in Serum Creatinine (RSC)

What should we call it?



Rise in SCr (RSC)
AKI (tubular Injury)
Benign AKI
WRF
PseudoAKI
PseudoWRF
Hemodynamic AKI

Darker colors indicate higher mortality risk. Suggested cut-off values for WRF (chronic HF): ≥26.5 mmol/L and ≥25% increase in creatinine OR ≥ 20% decrease in eGFR over 1–26 weeks, and AKI (acute HF): increase of 1.5–1.9 times baseline creatinine within 1–7 days before or during hospitalization OR ≥ 26.5 mmol/L increase in creatinine within 48 h OR urine output , 0.5 mL/kg/h for 6–12 h

[Damman K, et al. Eur Heart J 2015;36:1437]

Editorial

Blood Purification

Blood Purif 2019;48:193–195
DOI: 10.1159/000500409

Published online: June 19, 2019

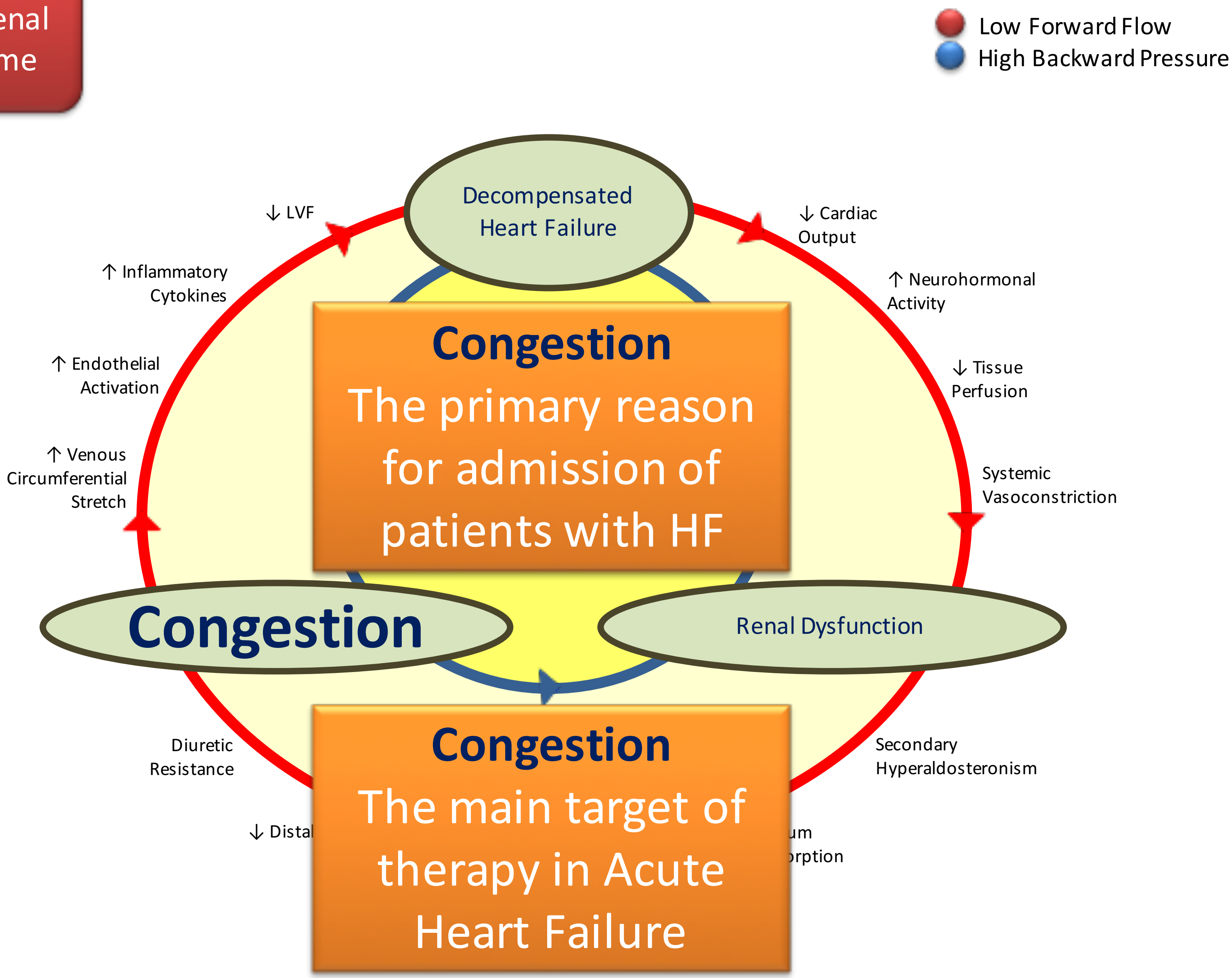
Are We Barking Up the Wrong Tree? Rise in Serum Creatinine and Heart Failure

Amir Kazory[a] Claudio Ronco[b, c]

[a]Division of Nephrology, Hypertension, and Renal Transplantation, University of Florida, Gainesville, FL, USA; [b]Department of Nephrology, San Bortolo Hospital, Vicenza, Italy; [c]International Renal Research Institute of Vicenza, San Bortolo Hospital, Vicenza, Italy

Now, let's take a look at de- "congestion" in Acute HF

Cardiorenal Syndrome

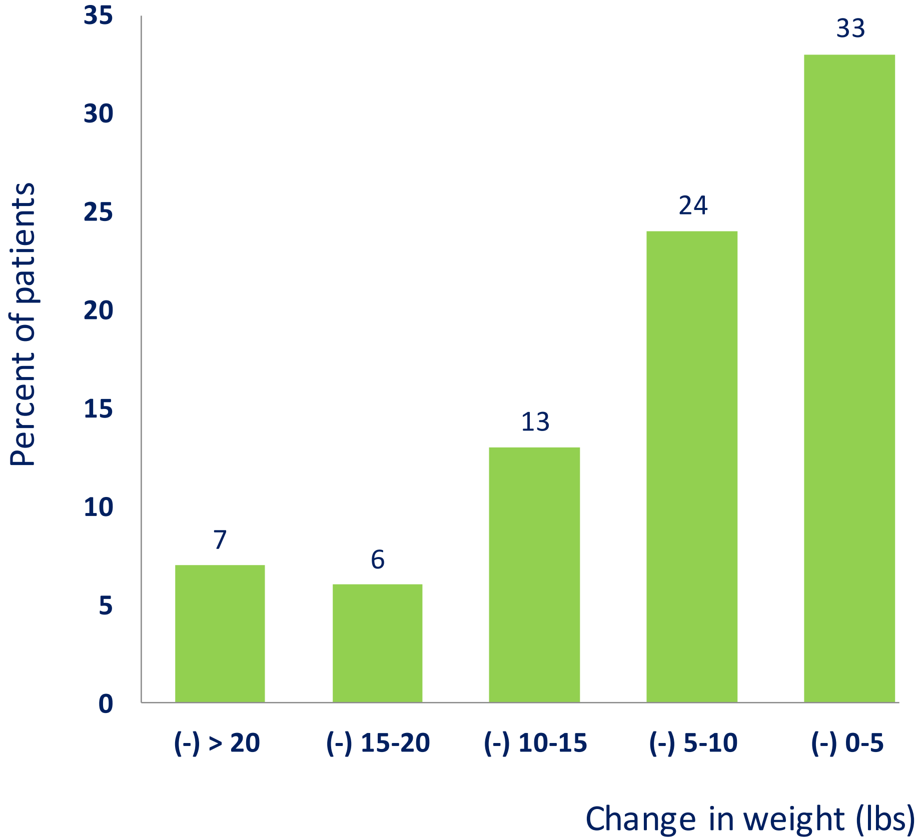


Kazory A. cJASN 2016;11:1463

How Well Are We Treating Acute HF?

Change in Body Weight at Discharge

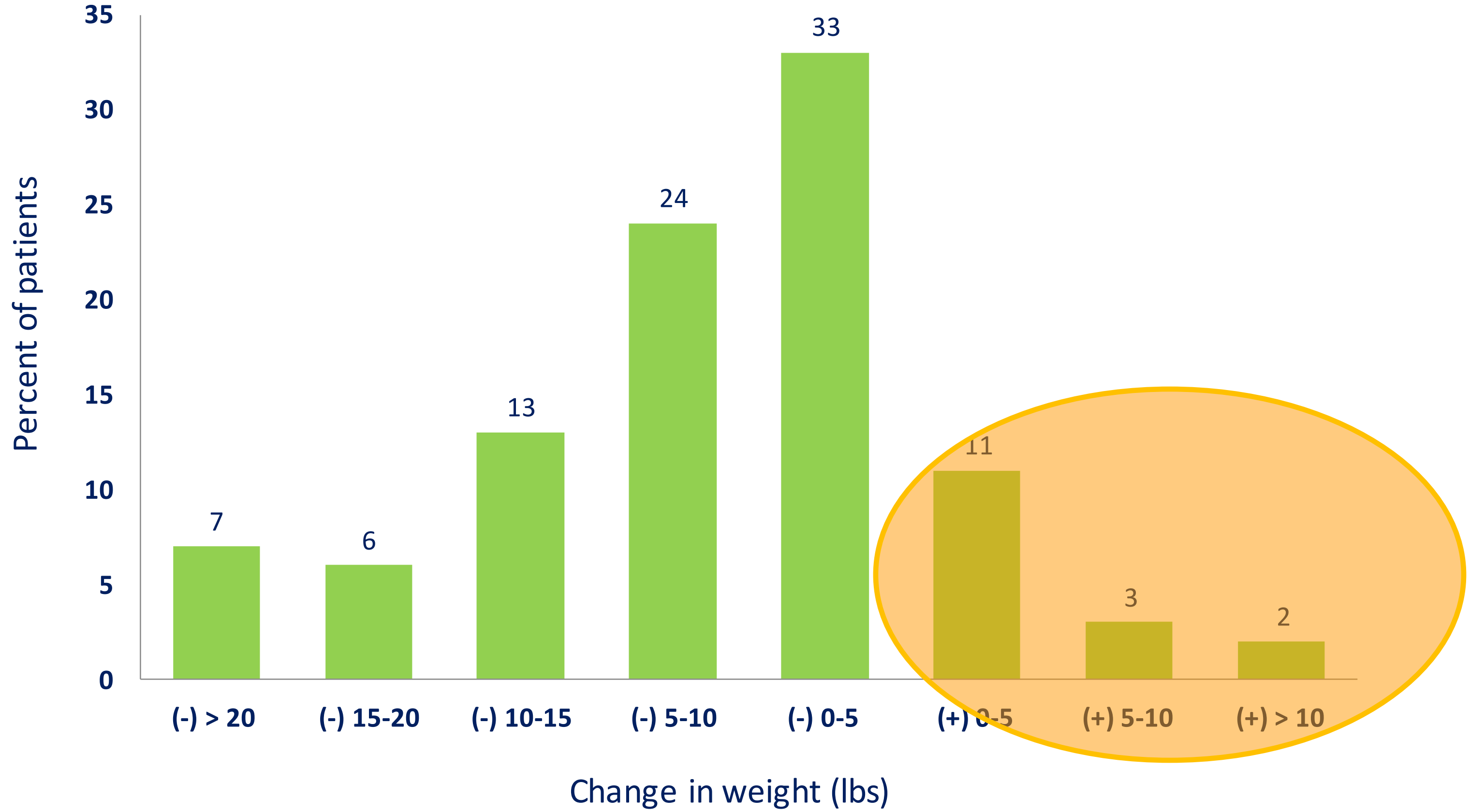
ADHERE Database (n= 51,013)



[Gheorghiade M and Filippatos G. Eur Heart J 2005; 7: B13-B19]-Adapted

Change in Body Weight at Discharge

ADHERE Database (n= 51,013)



[Gheorghiade M and Filippatos G. Eur Heart J 2005; 7: B13-B19]-Adapted

Change in Body Weight at Discharge

ADHERE Database (n= 51,013)

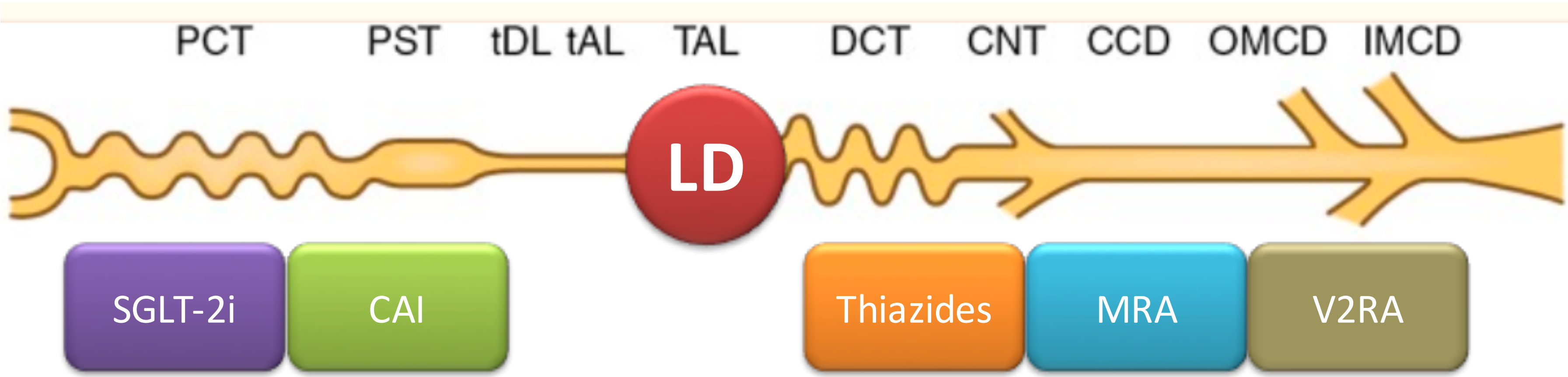
Heart Failure: The highest re-admission rate among all medical conditions (23% at 1 month, 40% at 3 months)

[Gheorghiade M and Filippatos G. Eur Heart J 2005; 7: B13-B19]-Adapted

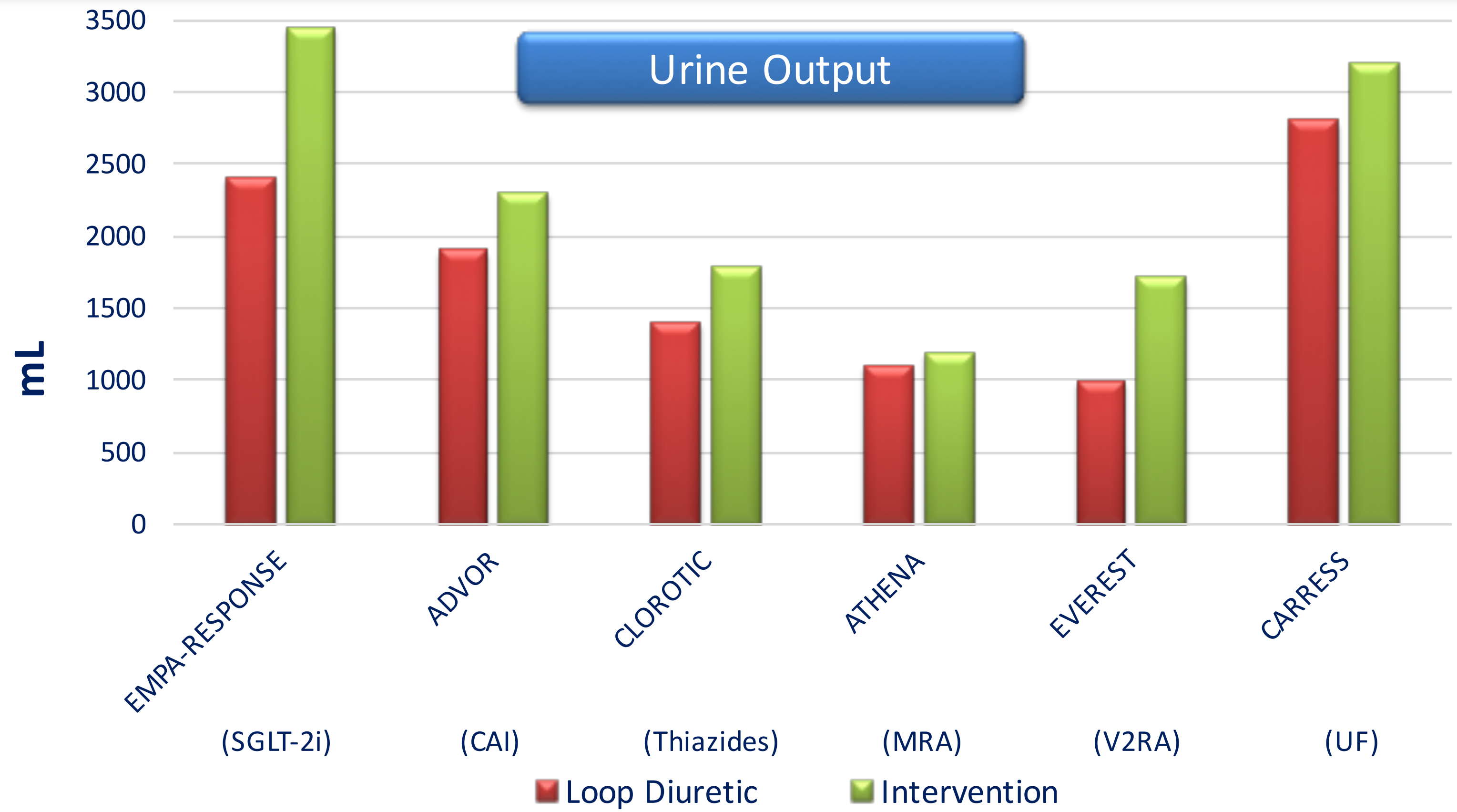
Strategies to Counter Diuretic Resistance

Nesiritide	X
Dopamine	X
Hypertonic Saline	?
Extracorporeal Ultrafiltration	+
Sequential Nephron Blockade	+

Sequential Nephron Blockade



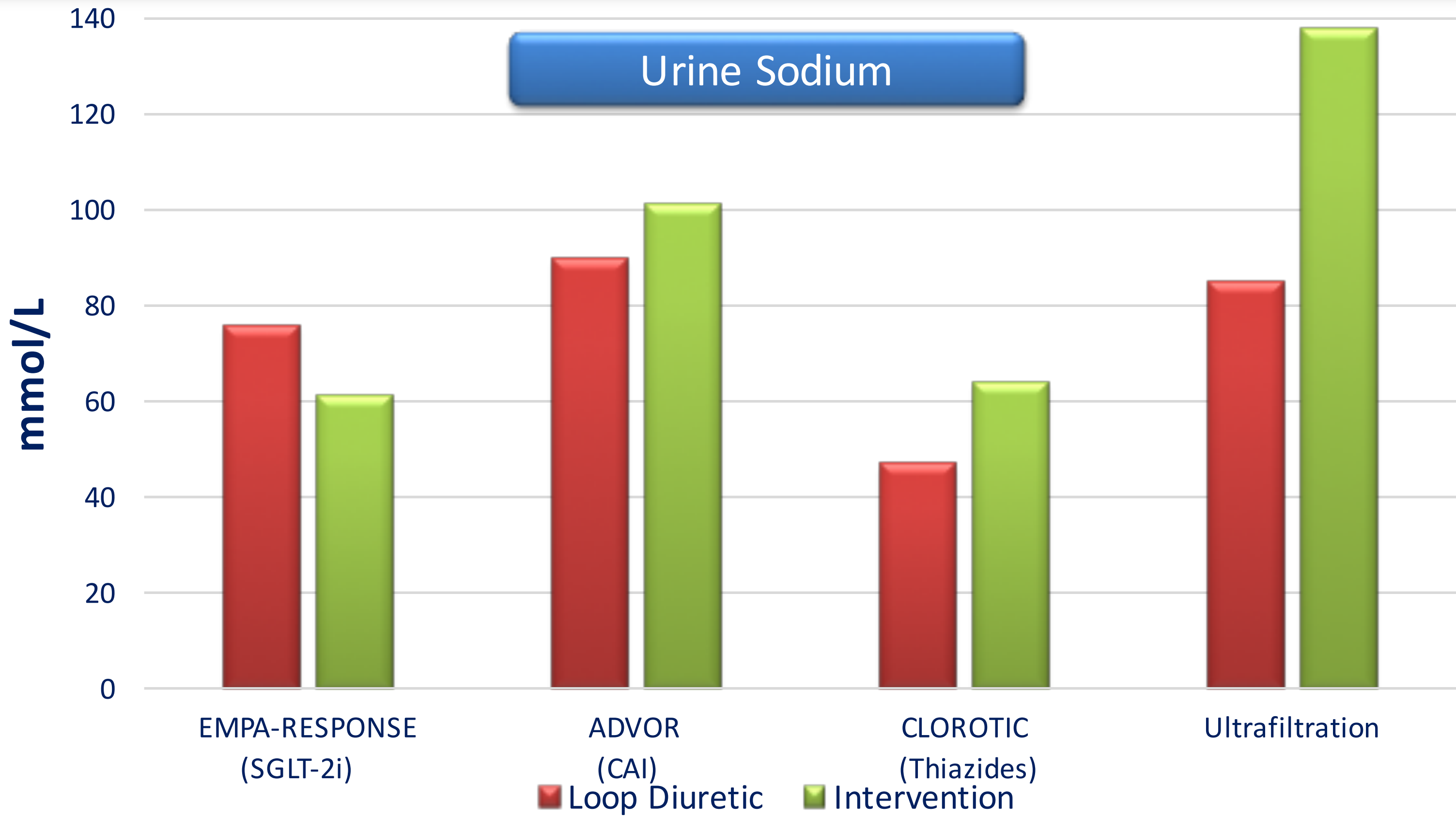
CDT and Urine Volume



The difference in UOP is more pronounced for SGLT-2i and V2RA

Kazory A. cJASN 2023

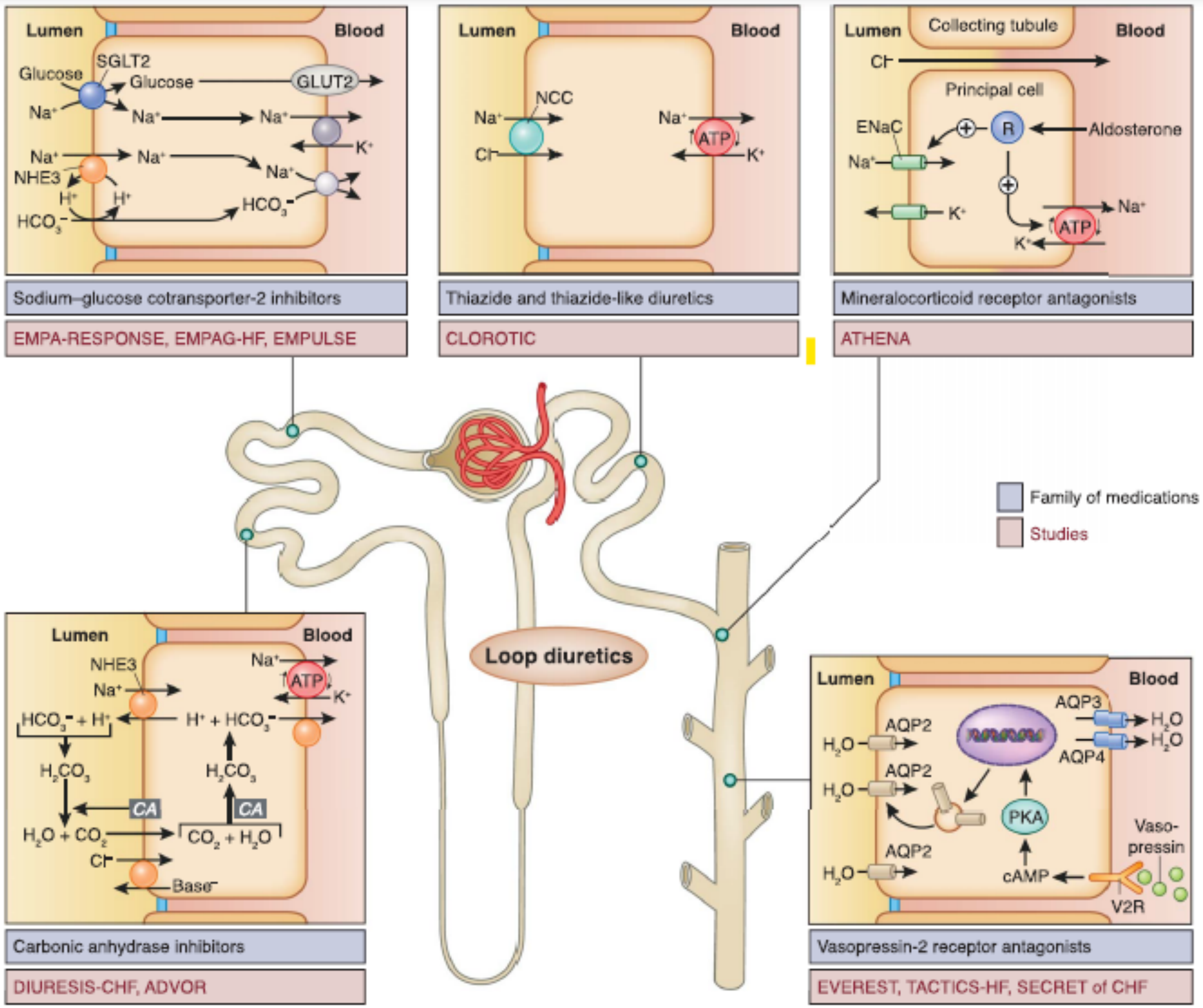
CDT and Urine Sodium



The difference in sodium concentration is more pronounced for Thiazides and ultrafiltration

Kazory A. cJASN 2023

Sequential Sodium Blockade



Kazory A, cJASN 2023

So, What's the Verdict?

Cardiorenal Medicine

Expert Opinion

Cardiorenal Med 2023;13:184–188
DOI: 10.1159/000529646

Received: January 6, 2023
Accepted: January 30, 2023
Published online: February 14, 2023

Tackling Congestion in Acute Heart Failure: Is It the Primetime for "Combo Diuretic Therapy?"

Amir Kazory[a] Claudio Ronco[b, c]

[a]Division of Nephrology, Hypertension, and Renal Transplantation, University of Florida, Gainesville, FL, USA; [b]Department of Nephrology, San Bortolo Hospital and International Renal Research Institute of Vicenza (IRRIV), Vicenza, Italy; [c]Department of Medicine, University of Padova, Padova, Italy

Congestion

The main reason for hospitalization patients H

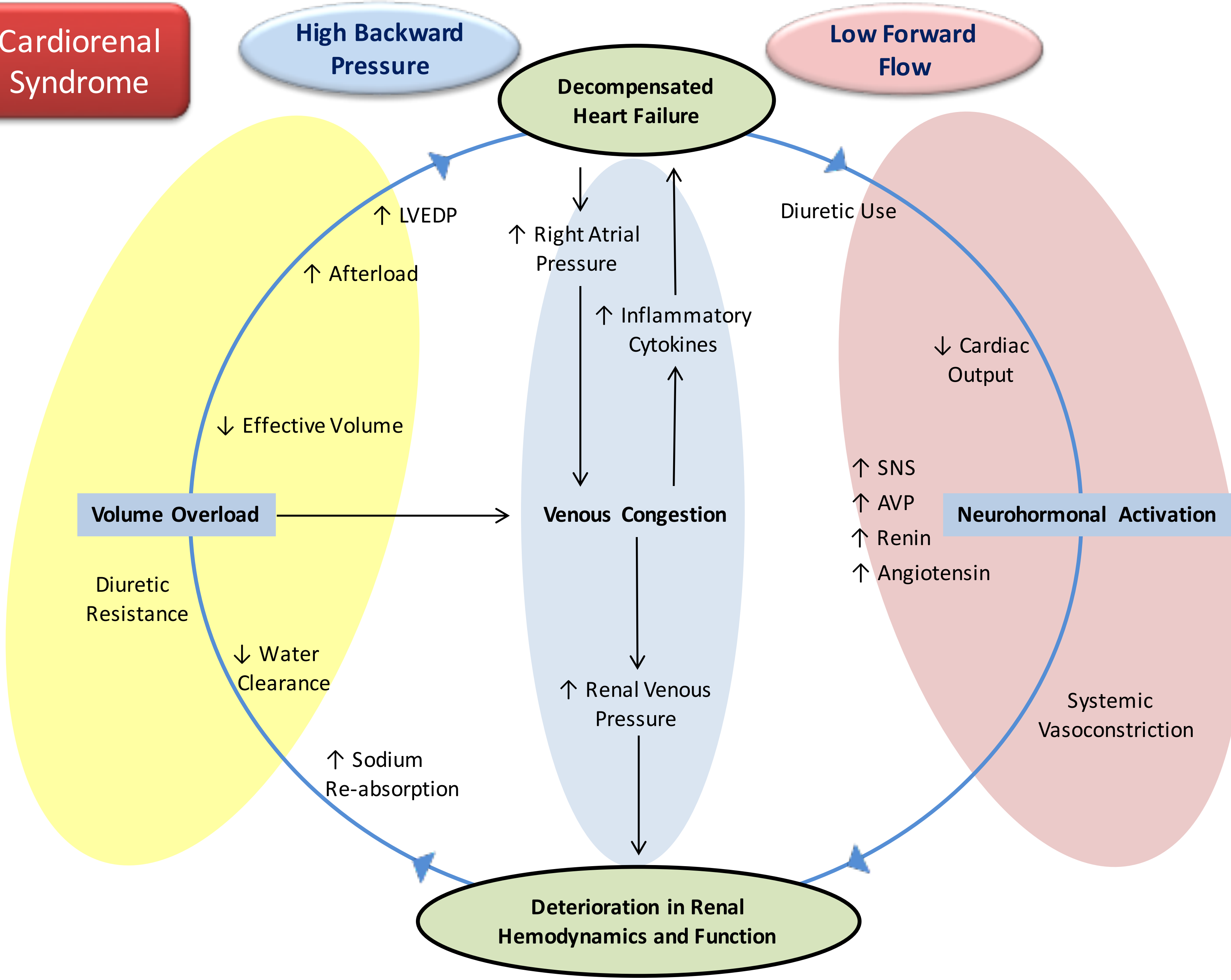
Heart Failure: a Perfect Model for Studying the Role of Ultrafiltration in Fluid Overload

up to 35 patients with Acute Heart Failure

Ultrafiltration

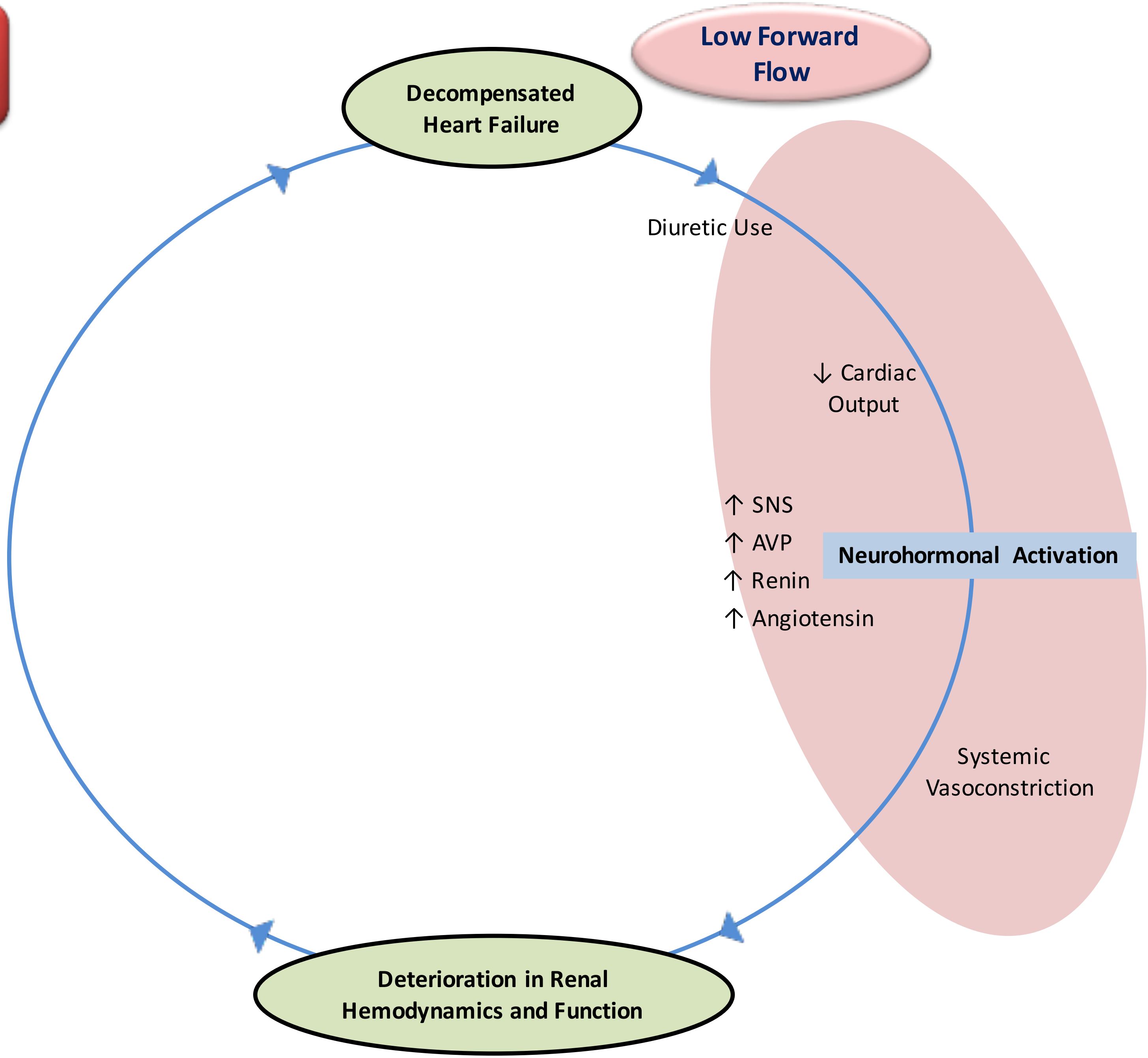
Several RCT's on the role of UF in Acute Heart Failure

Cardiorenal Syndrome



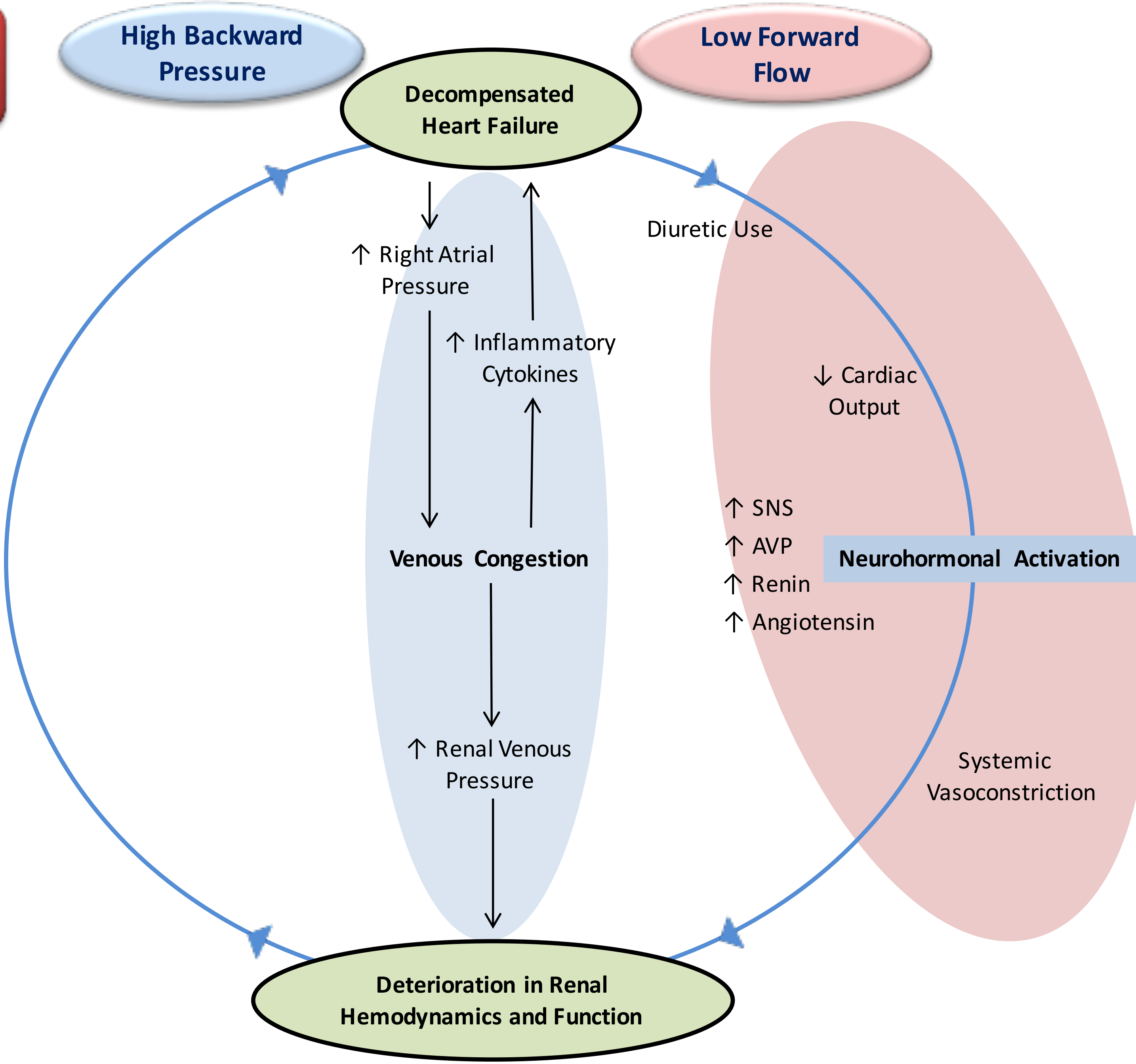
[Kazory A. Clin J Am Soc Nephrol 2013; 8: 1816-28]

Cardiorenal Syndrome

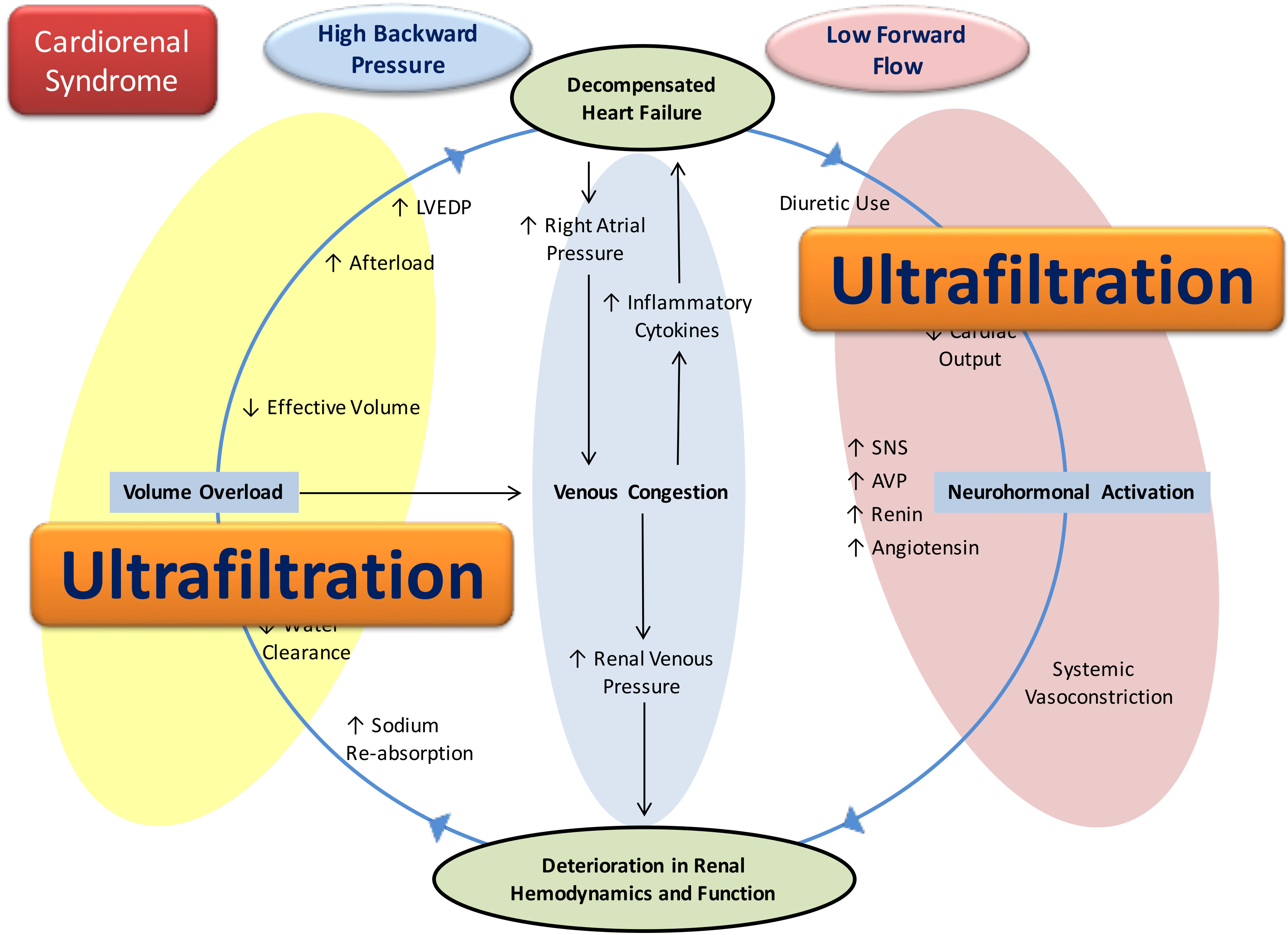


[Kazory A. Clin J Am Soc Nephrol 2013; 8: 1816-28]

Cardiorenal Syndrome

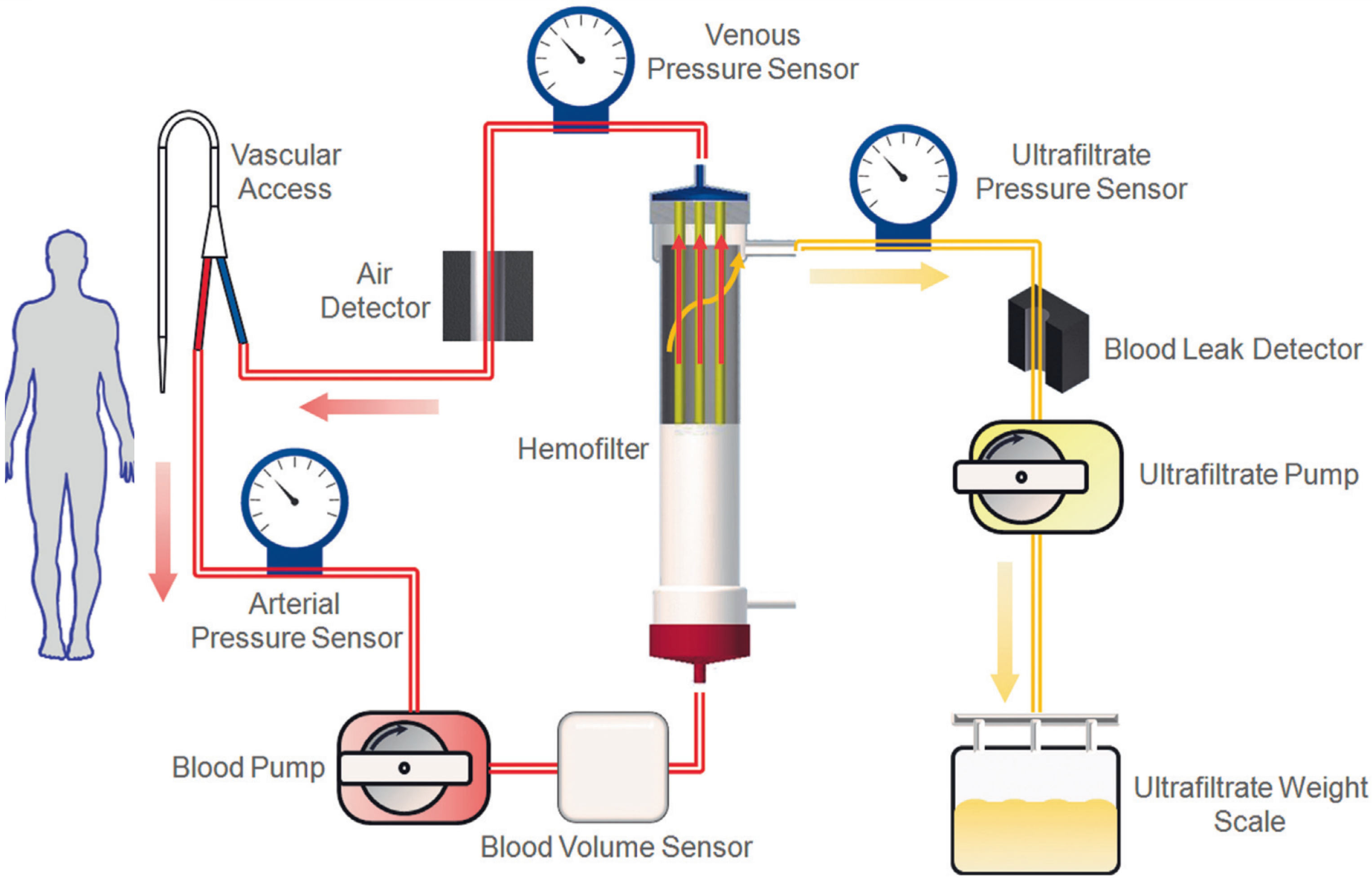


[Kazory A. Clin J Am Soc Nephrol 2013; 8: 1816-28]



[Kazory A. Clin J Am Soc Nephrol 2013; 8: 1816-28]

Ultrafiltration Therapy



[Costanzo MR. JACC Heart Fail 2017; 19:2428]

Contemporary Trials of Ultrafiltration

	RAPID-CHF	UNLOAD	ULTRADISCO	Hanna et al.	CARRESS-HF	CUORE	AVOID-HF
Year of Publication	2005	2007	2011	2012	2012	2014	2016
Country	US	US	Italy	US	US - Canada	Italy	US
Number of Centers	6	28	1	1	22	2	30
Number of Patients	40 (20 UF, 20 PT)	200 (100 UF, 100 PT)	30 (15 UF, 15 PT)	36 (17 UF, 19 PT)	188 (94 UF, 94 PT)	56 (27 UF, 29 PT)	224 (110 UF, 114 PT)
Age (years)	67.5 UF, 69.5 PT	62 UF, 63 PT	72 UF, 66 PT	60 UF, 59 PT	69 UF, 66 PT	75 UF, 73 PT	67 UF, 67 PT
Male Gender (%)	70 UF, 70 PT	70 UF, 68 PT	87 UF, 87 PT	84 UF, 76 PT	78 UF, 72 PT	81 UF, 83 PT	69 UF, 73 PT
Weight (kg)	NR	101 UF, 96 PT	74 UF, 83 PT	93 UF, 98 PT	94 UF, 106 PT	83 UF, 89 PT	110 UF, 111 PT
LVEF (%)	69 UF, 78 PT†	71 UF, 70 PT †	34 UF, 30 PT	19 UF, 18 PT	30 UF, 35 PT	32 UF, 32 PT	36 UF, 37 PT

Jain A. et al. Heart Fail Rev 2016; 21:611

	RAPID-CHF	UNLOAD	ULTRADISCO	Hanna et al.	CARRESS-HF	CUORE	AVOID-HF
Baseline SCr (mg/dL)	1.6 UF, 1.8 PT	1.5 UF, 1.5 PT (Scr > 3 mg/dL excluded)	2.2 UF, 1.9 PT (Scr > 3.0 mg/dL excluded)	55 UF, 51 PT ϕ (eGFR < 15 excluded)	1.9 UF, 2.09 PT (Scr > 3.5 mg/dL excluded)	1.7 UF, 1.9 PT (Scr > 3 mg/dL excluded)	1.5 UF, 1.6 PT (Scr ≥ 3 mg/dL excluded)
Diabetes (%)	35 UF, 53 PT	50 UF, 49 PT	40 UF, 60 PT	37 UF, 30 PT	61 UF, 63 PT	59 UF, 45 PT	62 UF, 64 PT
CAD (%)	45 UF, 40 PT ¶	56 UF, 48 PT	60 UF, 60 PT	21 UF, 30 PT *	70 UF, 51 PT *	59 UF, 55 PT *	64 UF, 61 PT
HTN (%)	60 UF, 65 PT	74 UF, 74 PT	20 UF, 60 PT	42 UF, 53 PT	NR	48 UF, 66 PT	88 UF, 83 PT
Primary Endpoint	Weight loss	Weight loss and dyspnea §	Change in clinical, biohumoral, and hemodynamic parameters	Time for PCWP to be kept at ≤ 18 mmHg	Change in Scr and weight	Incidence of HF rehospitalization	Time to first HF event
Follow Up (months)	1	3	[36 hours]	3	2	12	3

Jain A. et al. Heart Fail Rev 2016; 21:611

Endpoints of Interest

Efficacy – Decongestion

- Weight Change
- Fluid Removal

Safety – Renal Function

- Change in Serum Creatinine

Clinical Outcomes

- HF Re-hospitalization
- Mortality

Adverse Events

- Infection
- Bleeding

Jain A. et al. Heart Fail Rev 2016; 21:611

Endpoints of Interest

Efficacy – Decongestion

- Weight Change
- Fluid Removal

Safety – Renal Function

- Change in Serum Creatinine

Clinical Outcomes

- HF Re-hospitalization
- Mortality

Adverse Events

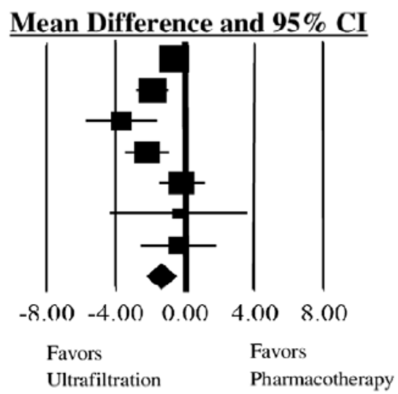
- Infection
- Bleeding

Jain A. et al. Heart Fail Rev 2016; 21:611

Weight Loss

771 patients

Study	Ultrafiltration Mean	Ultrafiltration SD	Ultrafiltration Total	Pharmacotherapy Mean	Pharmacotherapy SD	Pharmacotherapy Total	WMD [95% CI]	p-Value	Weight
RAPID-CHF	2.5	1.2	20	1.86	1.2	20	0.64 [-0.10, 1.38]	0.09	21.89
UNLOAD	5.0	3.1	100	3.1	3.5	100	1.9 [0.98, 2.82]	0.00	20.19
Hanna et al.	4.7	3.5	19	1.0	2.5	17	3.7 [1.69, 5.71]	0.00	10.82
ULTRADISCO	9.1	1.7	15	6.9	1.8	15	2.2 [0.95, 3.45]	0.00	16.85
CARRESS-HF	5.7	3.9	94	5.5	5.1	94	0.2 [-1.10, 1.50]	0.76	16.43
CUORE	7.5	5.6	27	7.9	9.0	29	-0.4 [-4.36, 3.56]	0.84	4.02
AVOID-HF	10.7	7.2	110	10.3	9.2	111	0.4 [-1.78, 2.58]	0.72	9.8
Random			385			386	1.35 [0.49, 2.21]	0.00	



Heterogeneity: Q = 16.20; d.f. = 6 (p = 0.013); $Tau^2 = 0.74$; $I^2 = 62.97\%$
Egger's Test: p (2-tailed) = 0.80
Overall Z = 3.07

UF

DR

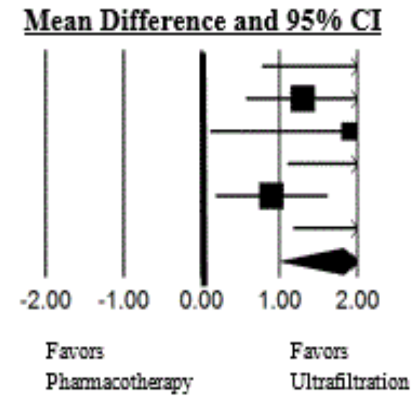
UF > DR

Jain A. et al. Heart Fail Rev 2016; 21:611

Fluid Removal

771 patients

Study	Ultrafiltration Mean	SD	Total	Pharmacotherapy Mean	SD	Total	WMD [95% CI]	p-Value	Weight
RAPID-CHF	8.42	3.65	20	5.38	3.65	20	3.04 [0.78, 5.30]	0.01	9.49
UNLOAD	4.60	2.61	100	3.30	2.61	100	1.3 [0.58,2.02]	0.00	29.27
ULTRADISCO	9.70	2.90	15	7.80	2.00	15	1.9 [0.12,3.68]	0.04	13.28
Hanna et al.	5.22	3.41	19	2.17	2.38	17	3.05 [1.11,4.99]	0.00	11.83
CARRESS-HF	4.70	2.60	94	3.80	2.40	94	0.9 [0.18,1.62]	0.01	29.43
AVOID-HF	12.91	10.70	110	8.91	10.70	111	4.0 [1.18,6.82]	0.01	6.69
Random							1.81 [1.01,2.62]	0.00	



Heterogeneity: Q = 10.30; df = 5 (p = 0.07); $Tau^2 = 0.44$; $I^2 = 51.44\%$
Egger's Test: p (2-tailed) = 0.01
Overall Z = 4.43

DR

UF

UF > DR

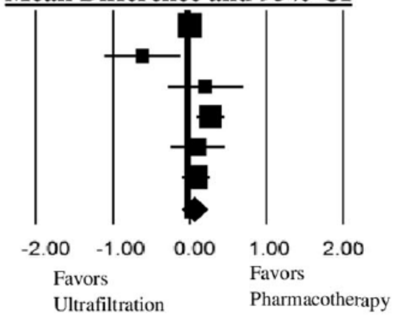
Jain A. et al. Heart Fail Rev 2016; 21:611

Rise in Serum Creatinine (RSC)

771 patients

	Ultrafiltration			Pharmacotherapy					
Study	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**WMD [95% CI]**	**p-Value**	**Weight**
UNLOAD	0.1	0.4	69	0.1	0.4	75	0.00 [-0.13, 0.13]	1.00	25.63
ULTRADISCO	-0.55	0.75	15	0.07	0.63	15	-0.62 [-1.12, -0.12]	0.01	8.05
Hana et al.	0.2	0.7	19	0	0.8	17	0.20 [-0.29, 0.69]	0.42	8.19
CARRESS-HF	0.23	0.7	94	-0.04	0.53	94	0.27 [0.09, 0.45]	0.00	22.53
CUORE	0.1	0.63	27	0	0.7	29	0.10 [-0.25, 0.45]	0.58	12.78
AVOID-HF	0.13	0.88	110	0.05	0.3	111	0.08 [-0.09, 0.25]	0.36	22.83
Random			334			341	0.06 [-0.11, 0.22]	0.48	

Mean Difference and 95% CI



Heterogeneity: Q = 13.73; d.f. = 5 ($p = 0.017$); $Tau^2 = 0.023$; I2 = 63.57%
Egger's Test: p (2-tailed) = 0.65
Overall Z = 0.70

UF

DR

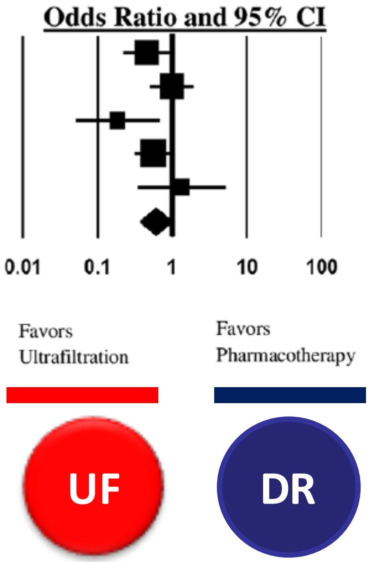
UF = DR

Jain A. et al. Heart Fail Rev 2016; 21:611

HF Rehospitalization

771 patients

	Ultrafiltration		Pharmacotherapy				
Study	Rehospitalization	Total	Rehospitalization	Total	M-H OR [95% CI]	p-Value	Weight
UNLOAD	16	89	28	87	0.46 [0.23,0.93]	0.03	23.88
CARRESS-HF	23	90	24	93	0.99[0.51,1.92]	0.97	25.26
CUORE	4	27	14	29	0.19[0.05,0.68]	0.01	11.09
AVOID-HF	36	105	52	108	0.56[0.32,0.98]	0.04	29.44
Hanna et al.	8	19	6	17	1.33[0.35,5.14]	0.68	10.32
Random	87	330	124	334	0.60[0.37,0.98]	0.04	



Heterogeneity: Q = 7.26; d.f. = 4 (p = 0.12); $Tau^2 = 0.13$; $I^2 = 44.90\%$
Egger's Test: p (2-tailed) = 0.82
Overall Z = -2.05

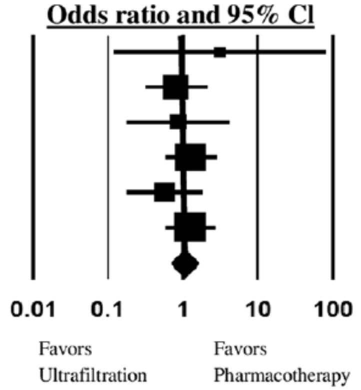
UF > DR

Jain A. et al. Heart Fail Rev 2016; 21:611

Mortality

771 patients

	Ultrafiltration		Pharmacotherapy				
Study	Events	Total	Events	Total	M-H OR [95% CI]	p-Value	Weight
RAPID-CHF	1	20	0	20	3.15 [0.12, 82.16]	0.49	1.64
UNLOAD	9	94	11	95	0.81 [0.32, 2.05]	0.65	20.16
Hanna et al.	4	19	4	17	0.87 [0.18, 4.18]	0.86	7.07
CARRESS-HF	16	94	13	94	1.28 [0.58, 2.83]	0.55	27.65
CUORE	7	27	11	29	0.57 [0.18, 1.79]	0.34	13.41
AVOID-HF	17	110	14	111	1.27 [0.59, 2.71]	0.54	30.07
Random	54	364	53	366	1.03 [0.68, 1.57]	0.89	



Heterogeneity: Q = 2.34; d.f. = 5 (p = 0.80); $Tau^2 = 0.00$; $I^2 = 0.00\%$
Egger's Test: p (2-tailed) = 0.99
Overall Z = 0.14

UF

DR

UF = DR

Jain A. et al. Heart Fail Rev 2016; 21:611

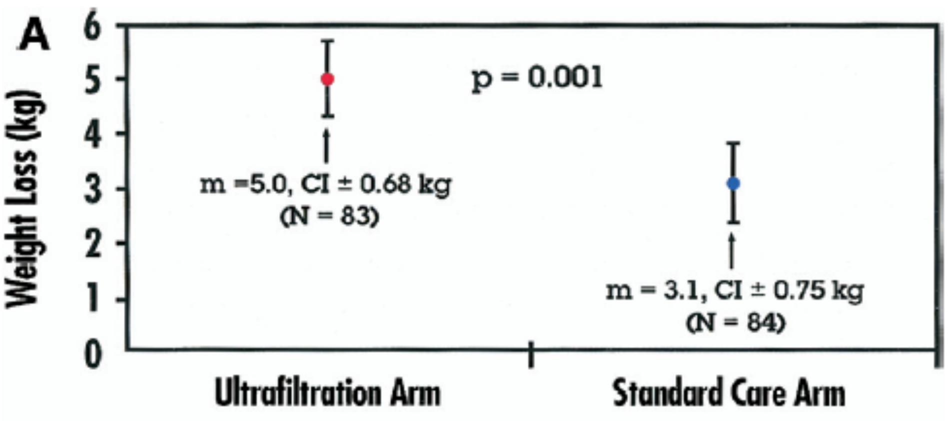
Ultrafiltration vs. Medical Therapy

“Practice of UF Therapy”: What did Landmark Clinical Trials Do?

UNLOAD	CARRESS-HF
ADHF – 200 patients	CRS – 186 patients
Randomized within 24 hours of admission	RSC 90 days before to 10 days after admission
Baseline Creatinine 1.5 mg/dl	Baseline Creatinine 2.0 mg/dl
Primary Endpoint: changes in weight	Primary Endpoint: changes in weight and serum creatinine
Flexible UF (up to 500 ml/hr)	Fixed UFR (200 ml/hr)

UNLOAD

CARRESS-HF



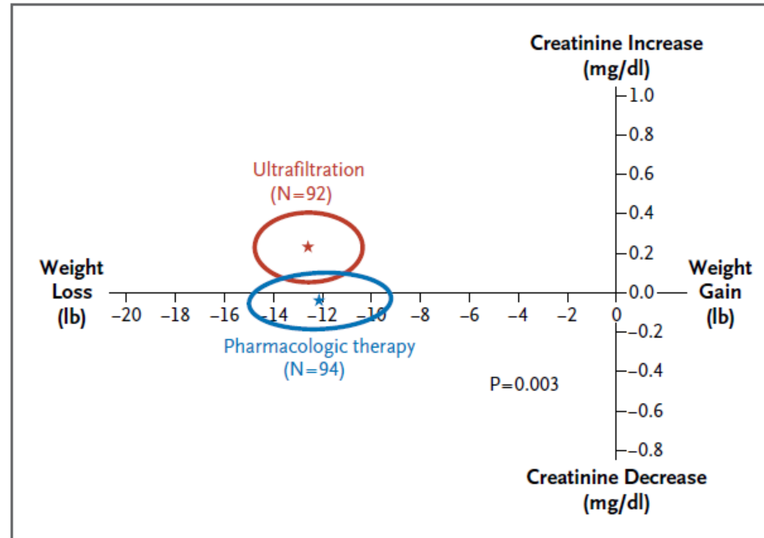


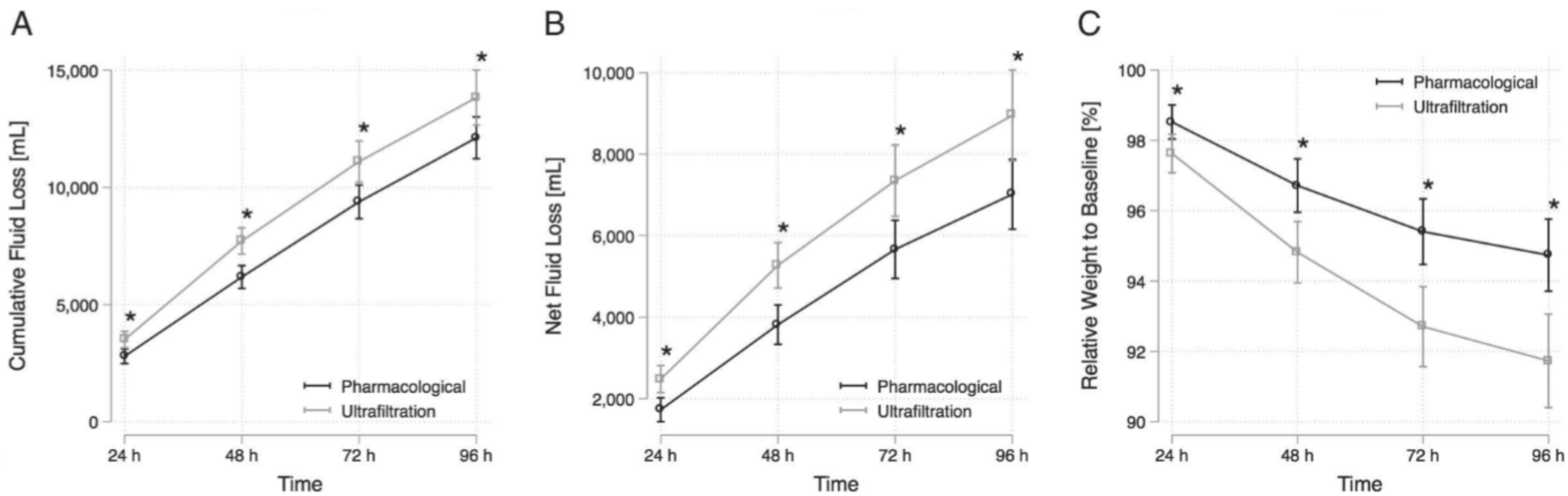
Figure 1. Changes in Serum Creatinine and Weight at 96 Hours (Bivariate Response).

Decongestion: UF > DR
RSC (WRF): UF = DR

Decongestion: UF = DR
RSC (WRF): UF > DR

CARRESS-HF

per-protocol analysis



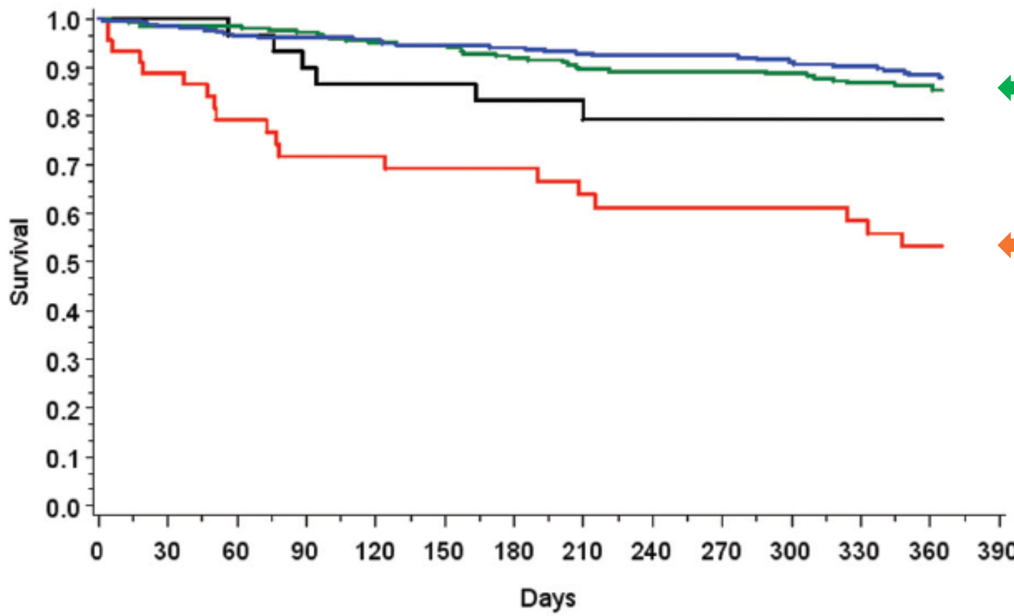
In contrast to the original trial (intention-to-treat), UF was associated with significantly more fluid loss and weight reduction

Decongestion: UF > DR

[Grodin JL, Europ J Heart Fail 2018doi:10.1002/ejhf.1158]

Interplay of RSC (WRF)-De(Congestion)

599 patients



	0	30	60	90	120	150	180	210	240	270	300	330	360
WRF/Cong	45	40	32	29	28	26	26	24	23	23	23	22	20
No WRF/Cong	31	31	29	27	26	26	24	22	20	19	19	19	18
WRF/No Cong	253	247	243	235	218	216	204	195	189	188	185	178	170
No WRF/No Cong	265	259	249	244	237	229	227	223	217	214	208	202	197

WRF +/ CONG –

WRF+/CONG +

Endpoints: 1 year death or urgent transplantation

[Metra M. Circ Heart Fail 2012; 5: 54]

AVOID-HF

ADHF – 224 patients

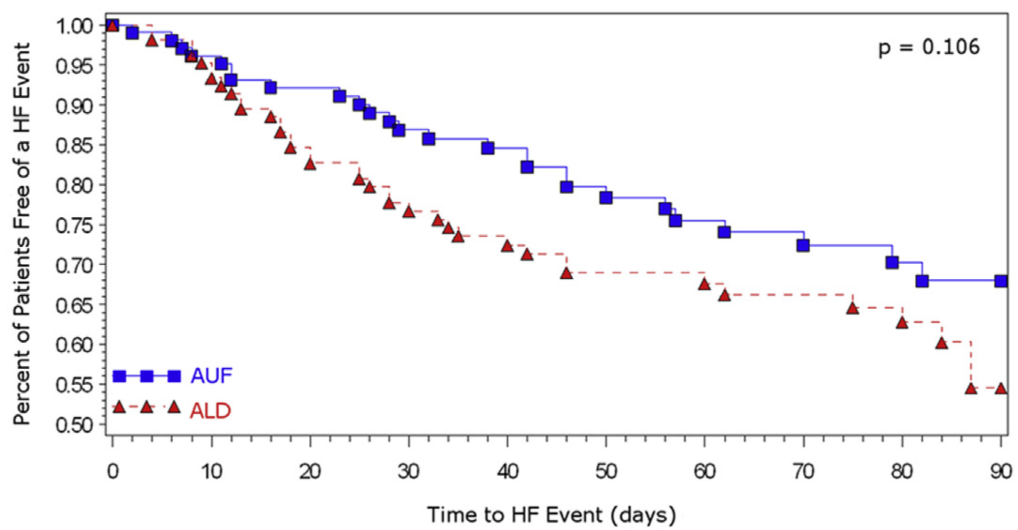
Randomized within 24 hours of admission

Baseline Creatinine 1.5 mg/dl

Time to first HF event within 90 days: Primary Endpoint

Adjustable UF

FIGURE 2 Primary Endpoint: Time to Heart Failure Event after Discharge



Fluid Removal: UF > DR
HF Event: UF < DR
RSC (WRF): UF = DR

[Costanzo MR, JACC Heart Fail 2016; 4: 95-105*]*

Table IV. Treatment guidelines for the aquapheresis arm

General comments:

1. Once an initial UF rate is chosen, avoid increasing the UF rate unless there are clear indications to do so.
2. Because patients' plasma refill rate usually declines as fluid is removed, it should be expected that UF rate will need to be decreased during the course of therapy.

A. Choose initial UF rate:

SBP <100 mm Hg: 150 cc/h
SBP 100-120 mm Hg: 200 cc/h

General comments:

1. Once an initial UF rate is chosen, avoid increasing the UF rate unless there are clear indications to do so.
2. Because patients' plasma refill rate usually declines as fluid is removed, it should be expected that UF rate will need to be decreased during the course of therapy.

A. Choose initial UF rate:

SBP <100 mm Hg: 150 cc/h
SBP 100-120 mm Hg: 200 cc/h
SBP >120 mm Hg: 250 cc/h

B. Decrease starting UF rate by 50 cc/h if any of the following are present:

a. RV > LV systolic dysfunction
b. sCr increase 0.3 mg/dL above recent baseline
c. Baseline sCr > 2.0 mg/dL
d. History of instability with diuresis or UF in the past

C. Reevaluate UF rate every 6 h:

1. Evaluate recent BP, HR, UO, net intake/output, sCr
2. Consider decreasing Aq. by 50 cc/h and checking STAT sCr (unless sent in past 2 h) if:

D. Consider completion of UF therapy if one of the following occurs:

1. Resolution of congestion (all of following):
   a. Jugular venous pressure <8 cm H_2O
   b. No orthopnea
   c. Trace or no peripheral edema
2. Best achievable dry weight has been reached
   a. Evidence of poor tolerance of fluid removal

AND

   b. UF rate <100 cc/h or net negative <1 L/24 h
3. Persistent elevation in sCr >1.0 mg/dL above baseline at start of UF treatment
4. Persistent hemodynamic instability

E. After completion of UF Therapy:

1. If satisfactory dry weight has been reached AND sCr is stable:
   a. Initiate oral loop diuretics with goal to keep net even (new dose of loop diuretics may be less than baseline dose in some patients)
   b. GDMT
2. If sCr, hemodynamics, or UO are NOT stable:
   a. Hold diuretics until sCr is stable for minimum of 12 h, then:
      i. If dry weight/adequate decongestion has been reached then initiate oral diuretics as above
      ii. If dry weight/adequate decongestion has NOT been reached then initiate IV diuretics
   b. If elevated sCr or hemodynamic instability persist, then consider bolus of IV fluids

Abbreviations: *SBP*, Systolic blood pressure; *RV*, right ventricle; *LV*, left ventricle; *BP*, blood pressure; *HR*, heart rate; *UO*, urine output; HFpEF, Heart Failure with preserved ejection fraction.

[Costanzo MR, JACC Heart Fail 2016; 4: 95-105]

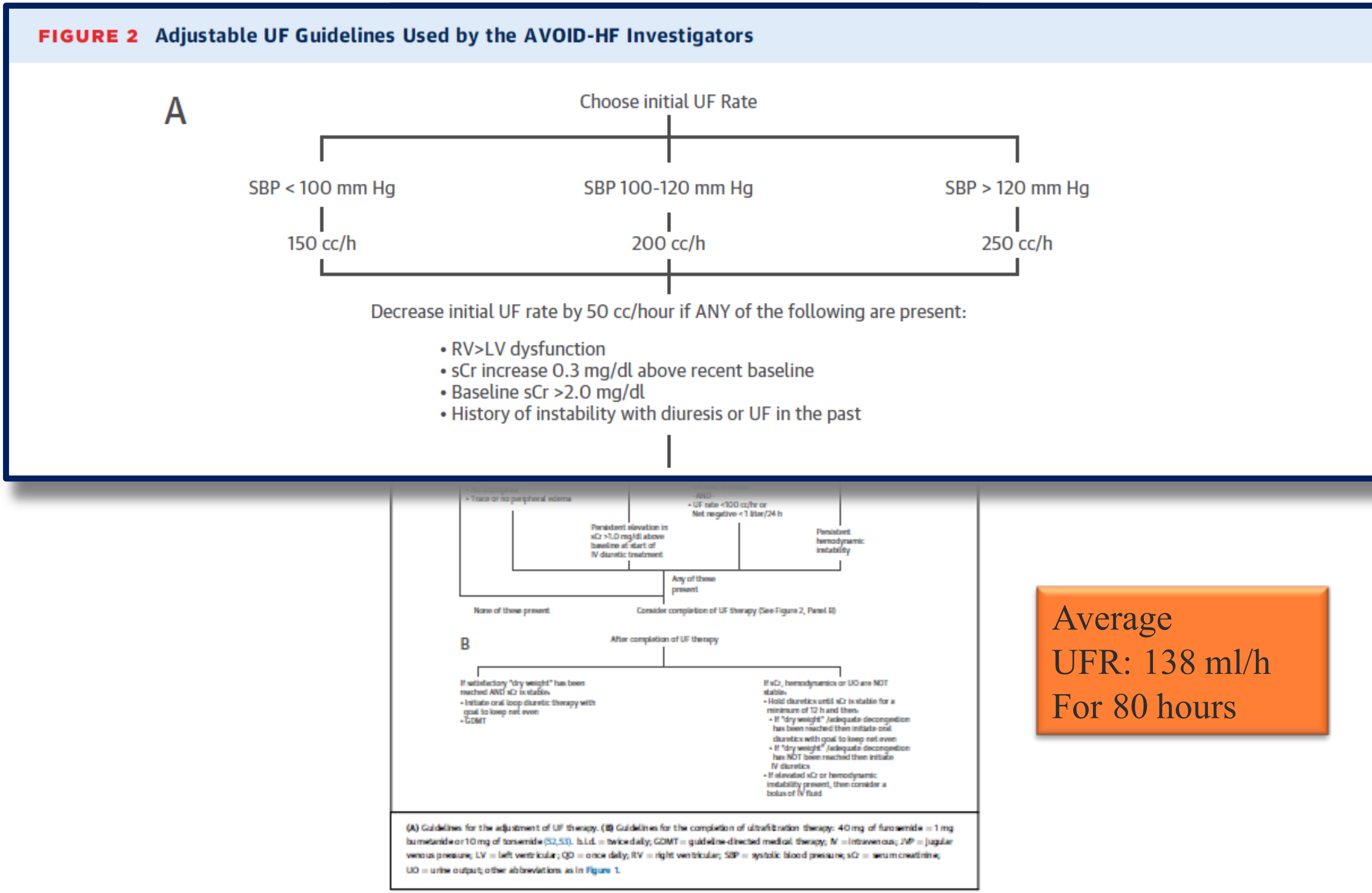


FIGURE 2 Adjustable UF Guidelines Used by the AVOID-HF Investigators

Average
UFR: 138 ml/h
For 80 hours

[Costanzo et al. J Am Coll Cardiol 2017; 69:2428]

Optimal Ultrafiltration Protocol for ADHF and Fluid Overload

1) Patients selection (recurrent admissions)
2) Early initiation of UF
3) Withhold Diuretics during UF therapy
4) Use low UFR
5) Customize UF therapy on initiation
6) Revisit UFR frequently during therapy
7) Objectively monitor decongestion

In the Pipeline: 2024

Ultrafiltration versus IV Diuretics in Worsening Heart Failure (REVERSE-HF)

Multicenter, Open Label, RCT USA

Aquadex Smartflow® System

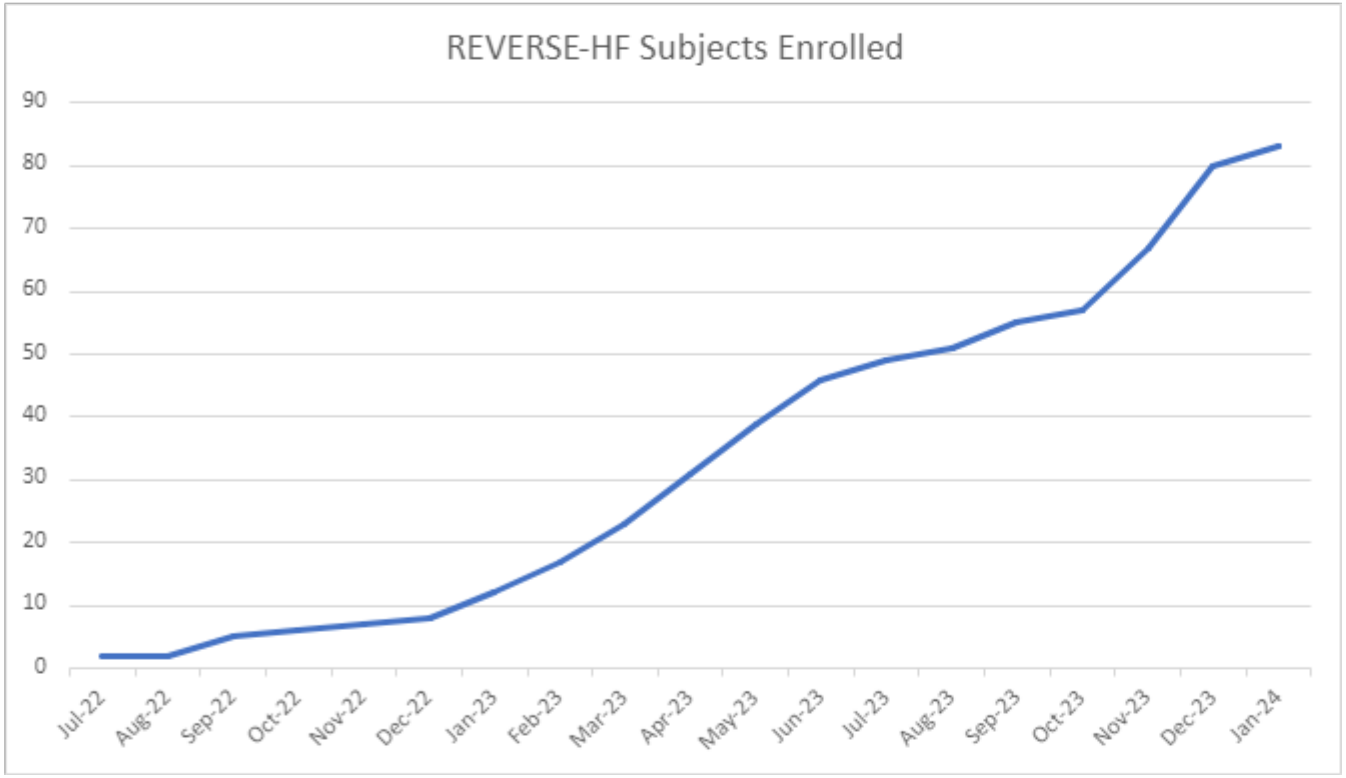
Adjustable UF vs. Adjustable Diuretics

ADHF – 372 patients

6 months follow up

Endpoints: Time to first HF event (90 d), Mortality (90 d), HF event (30 d)

In the Pipeline: 2024



Objective: 372 subjects to be enrolled, randomized, and treated

Jan 2024: 83 subjects enrolled

Thank You…

E-mail: Amir.Kazory@medicine.ufl.edu
X (Twitter): @AmirKazory