



Preventing Intradialytic Hypotension: Colloids vs Crystalloids

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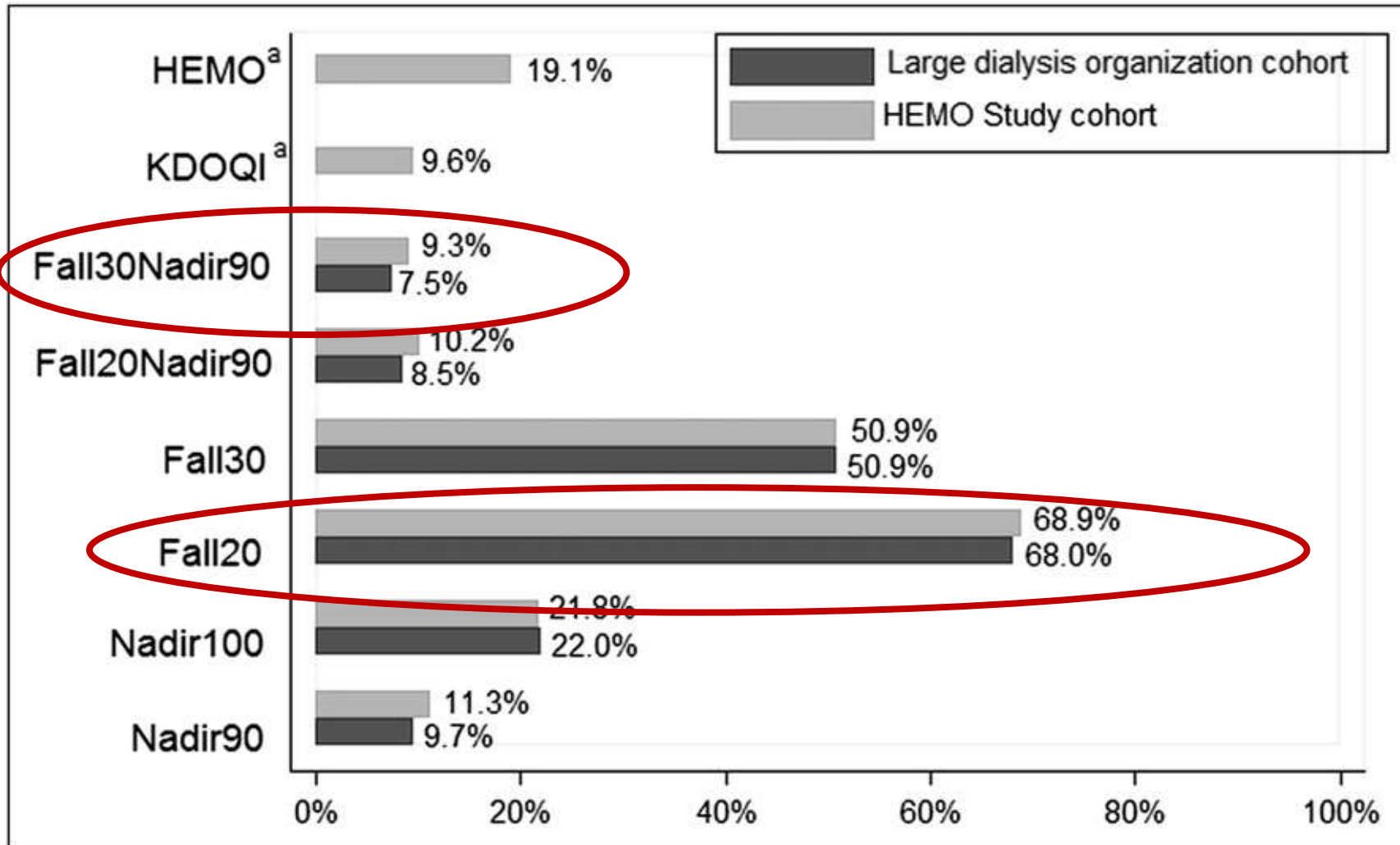
Intradialytic Hypotension (IDH) is Common

- Is the most common complication of hemodialysis
 - ESRD patients: 20 to 30% of treatments
 - AKI patients: 30 – 50% of treatments

We Have Several Definitions of Intradialytic Hypotension (IDH)

Term	Definition
Nadir 90	Min IHD SBP < 90 mmHg
Nadir 100	Min IHD SBP < 100 mmHg
Fall 20	Pre-HD SBP - min IHD \geq 20
Fall 30	Pre-HD SBP - min IHD \geq 30
Fall 20 Nadir 90	Pre-HD SBP - min IHD \geq 20 and min IHD SBP < 90
Fall 30 Nadir 90	Pre-HD SBP - min IHD \geq 30 and min IHD SBP < 90
KDOQI	Pre-HD SBP - min IHD \geq 20 and symptoms of cramping, headache, light-headedness, vomiting, or chest pain during HD
HEMO	Fall in SBP resulting in intervention of UF reduction, blood flow reduction, or saline administration

Frequency of Hypotension Varies According to Definition



In the HEMO study cohort:

- 19% of dialysis sessions required some intervention
- 10% had a SBP > 20 with symptoms of hypotension

Based on BP alone:

- Hypotension occurred from 7.5% by Fall30Nadir 90 to 68% based on Fall20

Consequences of Intradialytic hypotension (IDH)

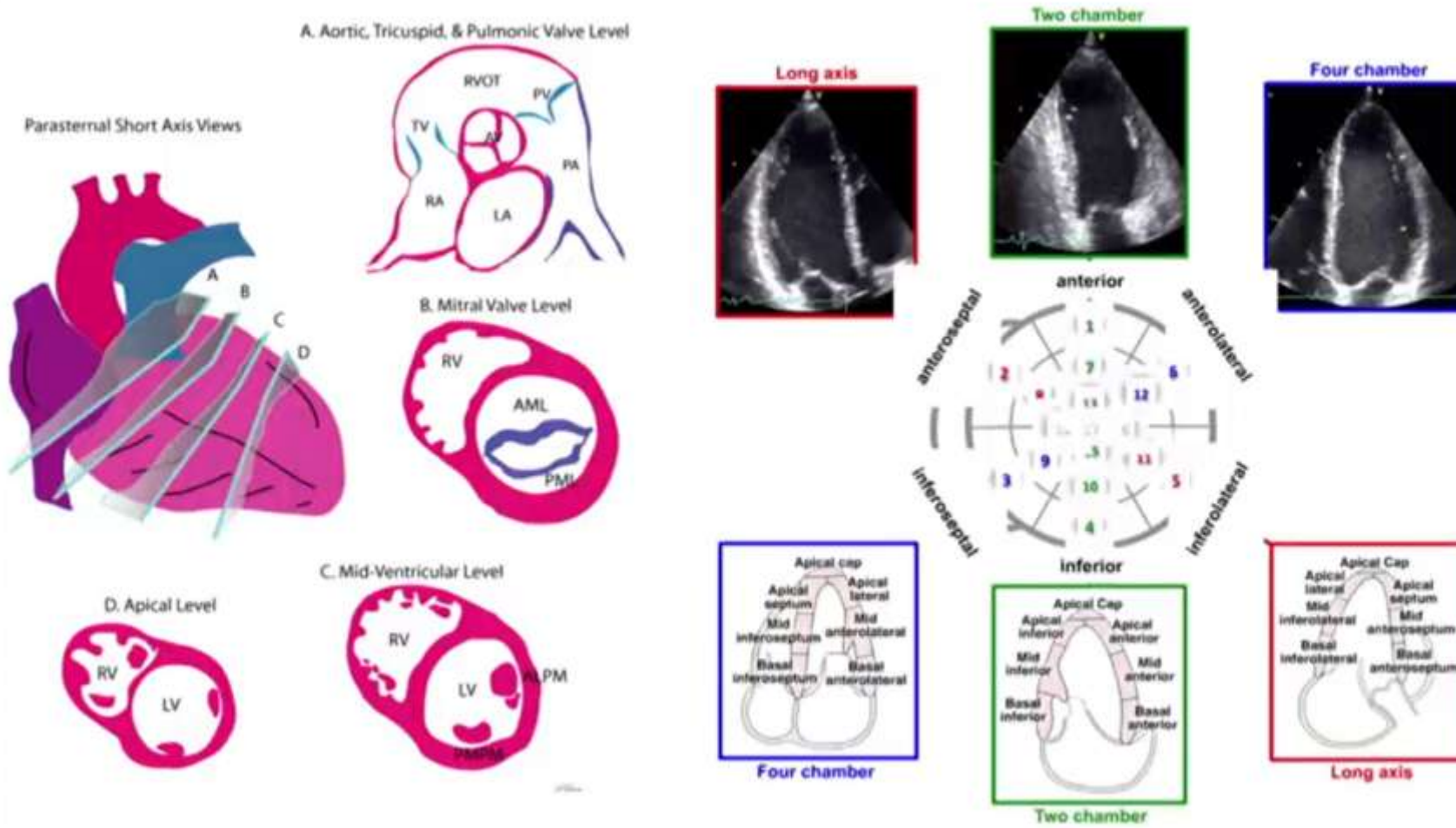
- Early discontinuation of dialysis
- Prevent achievement of fluid balance
- Delay or prevent kidney recovery
 - Repetitive ischemic insults
 - Maintain high venous pressure and decreased perfusion
- Decrease blood flow to vital organs
 - Acute complications:
 - Risk of cardiovascular events
 - Access complications
 - Chronic complications:
 - myocardial stunning leading to progression of Heart Failure

Decrease Blood Flow -> Myocardial Stunning

- Myocardial stunning - even in patient with relative hypotension
 - transient myocardial ischemia may lead to LV dysfunction that can persist after the return of normal perfusion
- Repetitive episodes of ischemia can be cumulative and lead to prolonged LV dysfunction.
- One of the mechanisms for heart failure

Bedside Cardiac Echocardiography

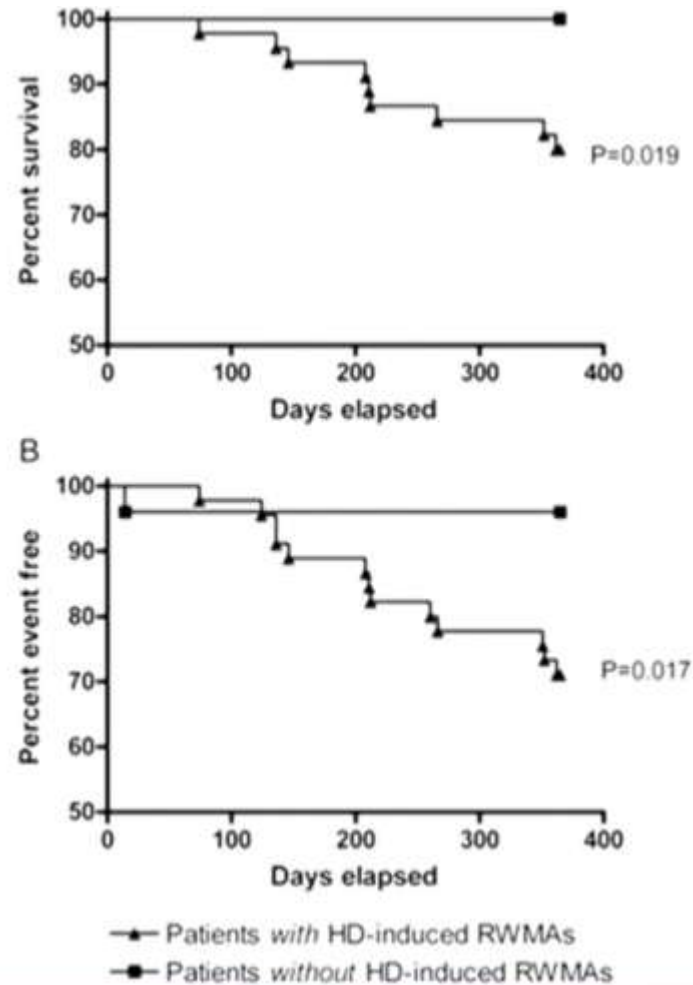
Assessment of Regional Wall Motion Abnormalities (RWMA)



Regional Wall Motion Abnormalities (RWMA) in Chronic Hemodialysis

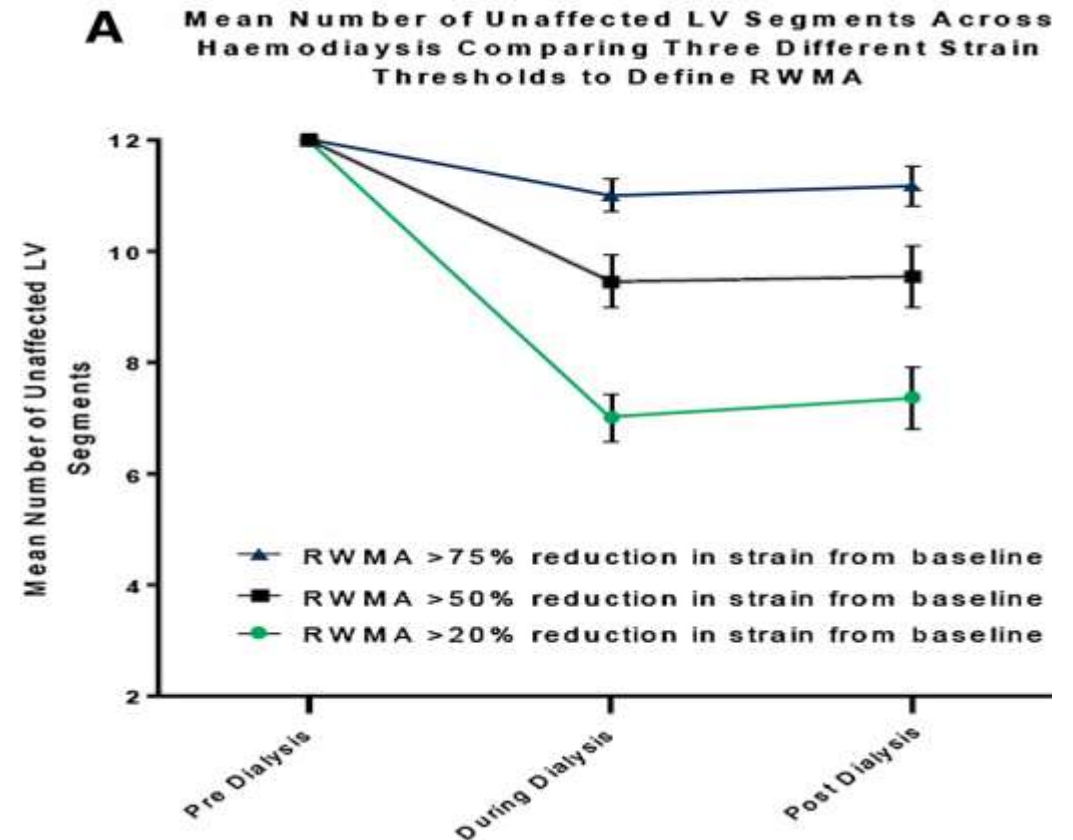
The presence of HD-induced RWMA has been associated with increased relative mortality at 12 months¹

Death resulted overwhelmingly from cardiovascular causes.



Myocardial stunning occurs during intermittent hemodialysis for AKI

- 11 patients requiring RRT for AKI
- (SOFA) score on day of study was 6(IQR2)
- ✓ All patients developed two or more new RWMA during dialysis
- ✓ median number of affected LV segments of 5(IQR 4–6).

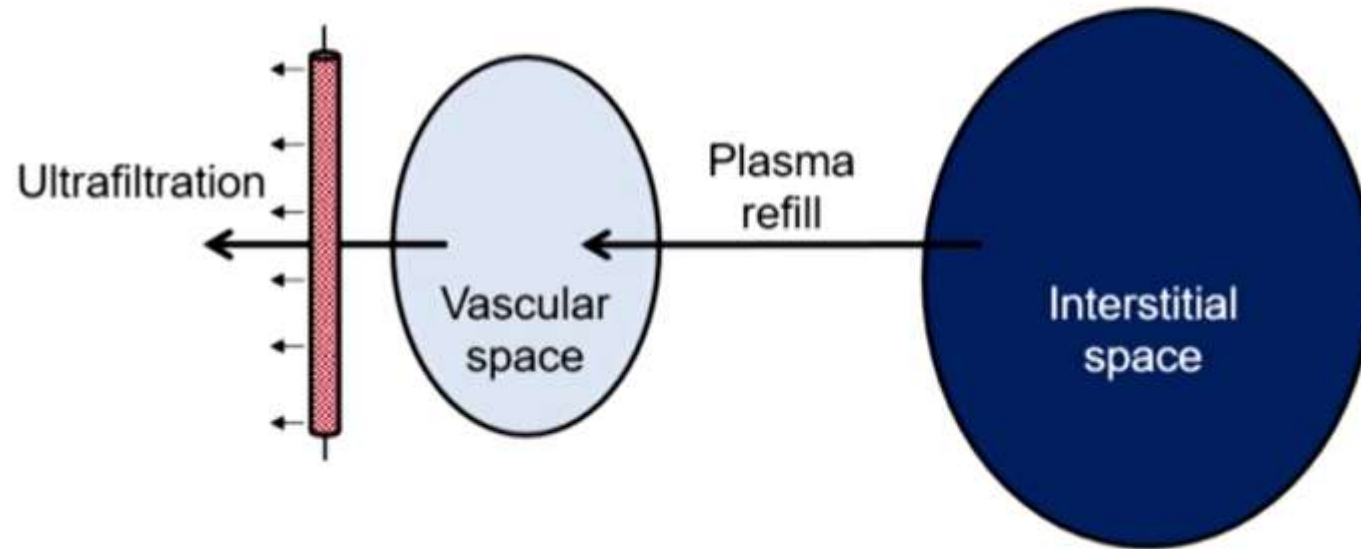


Methods to Prevent Hypotension During Dialysis

- ✓ Limit fluid and salt intake
- ✓ Discourage eating immediately before or during dialysis.
- ✓ Maximize diuretic use for patients who had residual renal function.
- ✓ Minimize use of BP-lowering medications prior to dialysis session.
- ✓ Hold antihypertensive medications prior to dialysis.
- ✓ **Lower dialysate temperature to 36 °C**
- ✓ Ultrafiltration and Na sodium profile

Balance between Ultrafiltration and Plasma Refill Rate

UF rate > plasma refill rate → hypotension



UF = Refill Rate

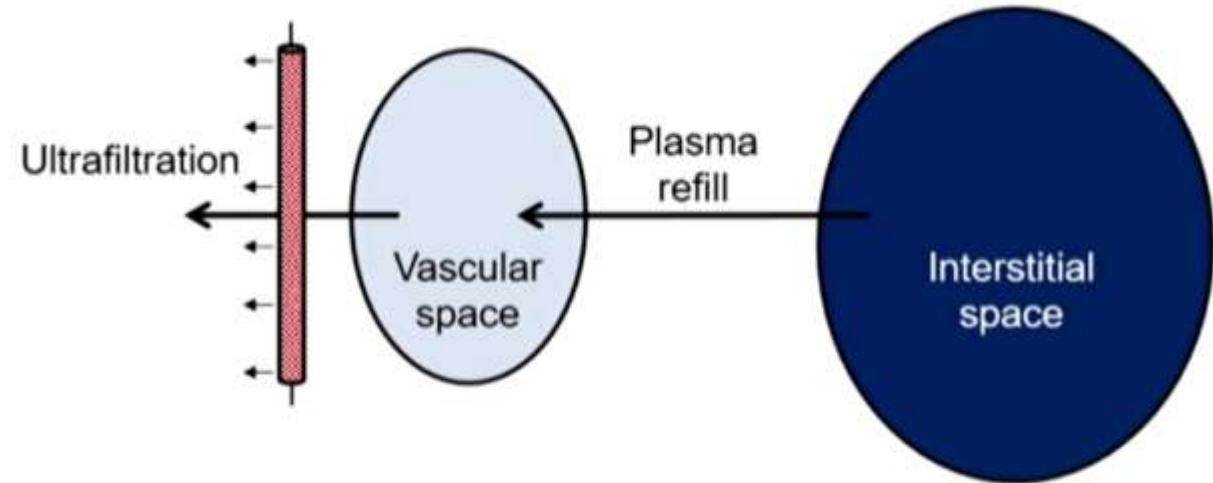
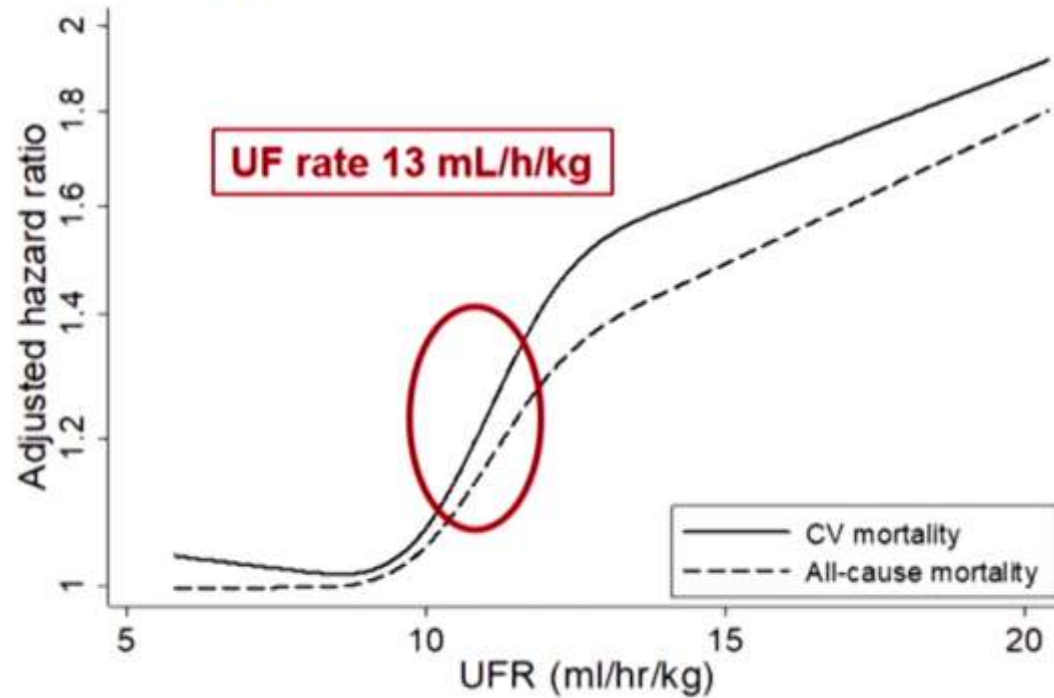
UF > Refill Rate



Decrease intravascular volume

Higher UF Rate Associated with Death

Higher UF rate → death



Strategies for Achieving Fluid Balance with RRT

Target ultrafiltration rate to match
plasma refilling rate

Improve fluid mobilization from
sequestered compartments

Albumin for the Treatment of Intradialytic Hypotension

- Albumin increase **oncotic pressure** - greater expansion of the plasma volume
 - ✓ Improve fluid mobilization
 - ✓ Has been used for the treatment or prevention of IDH
- **Antioxidative effects**
- **Anti-inflammatory effects**: blocks interactions between neutrophils – endothelium and NFκB-activation
 - ✓ stabilization of glycocalyx

AIMS

- ✓ In hospitalized patients with low albumin levels

AIM 1: Determine if the utilization of IV albumin can improve the safety of fluid removal during dialysis.

AIM 2: Determine if the utilization of IV albumin can improve volume of fluid removal.

Study Design

Prospective, interventional study

Hospitalized adult patients (>18 ys)

- AKI and ESRD
- require fluid removal with dialysis
- **serum albumin level < 3G/dl at initiation of dialysis**

Excluded

- renal transplant
- not expected to be on dialysis for more than 24 hrs
- known drug allergy to albumin or experience any adverse reactions to albumin (i.e., anaphylactic response)
- Use mannitol

Cross-over design, standard care dialysis

- Randomized to start first therapy with:
 - **100 ml of 25% albumin - 25g albumin supplied by Grifols**
 - **100 ml of 0.9% saline**
- Given intravenously at start of intermittent dialysis

Measurements and Outcomes

Fluid removal

- Prescribed vs Delivered
- Ultrafiltration Rate - ml/kg/hr

Intradialytic Complications

- Hypotension
- Symptoms
- Heart rate changes
- Cardiac ECHO

Tissue Perfusion

- Microcirculatory changes

- Dialysis BP, HR, RR data
- Blood volume monitoring
- Bioimpedance
- Sublingual Microcirculation
- Cardiac ECHO

Demographics

N=65 patients	N (%) or mean (SD)
Gender - Male	46 (71.9%)
Age (years)	58 (+/- 12)
AKI or AKI on CKD	47(72%)
ESRD	18(27%)
Weight (kg)	77 (+/- 19)
HTN	18(27%)
DM	5(7%)
COPD	5(7%)
Chronic Heart Failure	1(0.2%)
MI	5(7%)
Liver Cirrhosis	3(0.5%)

Efficacy Parameters

Effect on Fluid Removal

	Overall	Normal Saline	Albumin	p-value
Prescribed Removal Rate ml/kg/h	-7.24 (-9.13 -5.19)	-7.24 (-9.00 - 5.18)	-7.13 (-9.28 - 5.24)	0.1
Delivered Removal Rate ml/kg/h	-8.26 (-11.32 -5.65)	-8.25 (-11.18 -5.80)	-8.27 (-12.22 - 5.53)	0.011*

* GEE - Generalized estimating equations – account for the correlation between the observations of the same subject

Efficacy Solute Removal per Session

	Overall	Normal Saline	Albumin	p-value
Urea Reduction Rate				
	69.41 (8.45)	69.23 (8.36)	69.60 (8.58)	0.671
Kt/V				
	1.69 (6.09)	2.05 (8.45)	1.29 (0.38)	0.337

Safety Parameters

Intradialytic hypotension definition and frequency

Term	Definition	Overall
Nadir90	Min IHD SBP < 90 mmHg	53 (21.3%)
Nadir100	Min IHD SBP < 100 mmHg	111 (44.6%)
Fall20	Pre-HD SBP - min IHD \geq 20	103 (41.9%)
Fall30	Pre-HD SBP - min IHD \geq 30	69 (28.0%)
Fall20Nadir90	Pre-HD SBP - min IHD \geq 20 and min IHD SBP < 90	18 (7.3%)
Fall30Nadir90	Pre-HD SBP - min IHD \geq 30 and min IHD SBP < 90	12 (4.9%)
KDOQI	Pre-HD SBP - min IHD \geq 20 and symptoms of cramping, headache, lightheadedness, vomiting, or chest pain during HD	28 (11.4%)
HEMO	Fall in SBP resulting in intervention of UF reduction, blood flow reduction, or saline administration	42 (16.9%)

Intradialytic hypotension in NS vs. Albumin Groups

Term	Definition	Overall	NS	Albumin	p
Nadir90	Min IHD SBP < 90 mmHg	53 (21.3%)	31 (24.8%)	22 (17.7%)	0.093
Nadir100	Min IHD SBP < 100 mmHg	111 (44.6%)	56 (44.8%)	55 (44.4%)	0.926
Fall20	Pre-HD SBP - min IHD ≥ 20	103 (41.9%)	59 (48.0%)	44 (35.8%)	0.026
Fall30	Pre-HD SBP - min IHD ≥ 30	69 (28.0%)	40 (32.5%)	29 (23.6%)	0.041
Fall20Nadir90	Pre-HD SBP - min IHD ≥ 20 and min IHD SBP < 90	18 (7.3%)	14 (11.4%)	4 (3.3%)	0.016
Fall30Nadir90	Pre-HD SBP - min IHD ≥ 30 and min IHD SBP < 90	12 (4.9%)	9 (7.3%)	3 (2.4%)	0.099
KDOQI	Pre-HD SBP - min IHD ≥ 20 and symptoms of cramping, headache, lightheadedness, vomiting, or chest pain during HD	28 (11.4%)	19 (15.4%)	9 (7.3%)	0.002
HEMO	Fall in SBP resulting in intervention of UF reduction, blood flow reduction, or saline administration	42 (16.9%)	26 (20.8%)	16 (12.9%)	0.072

Intradialytic hypotension definition and frequency

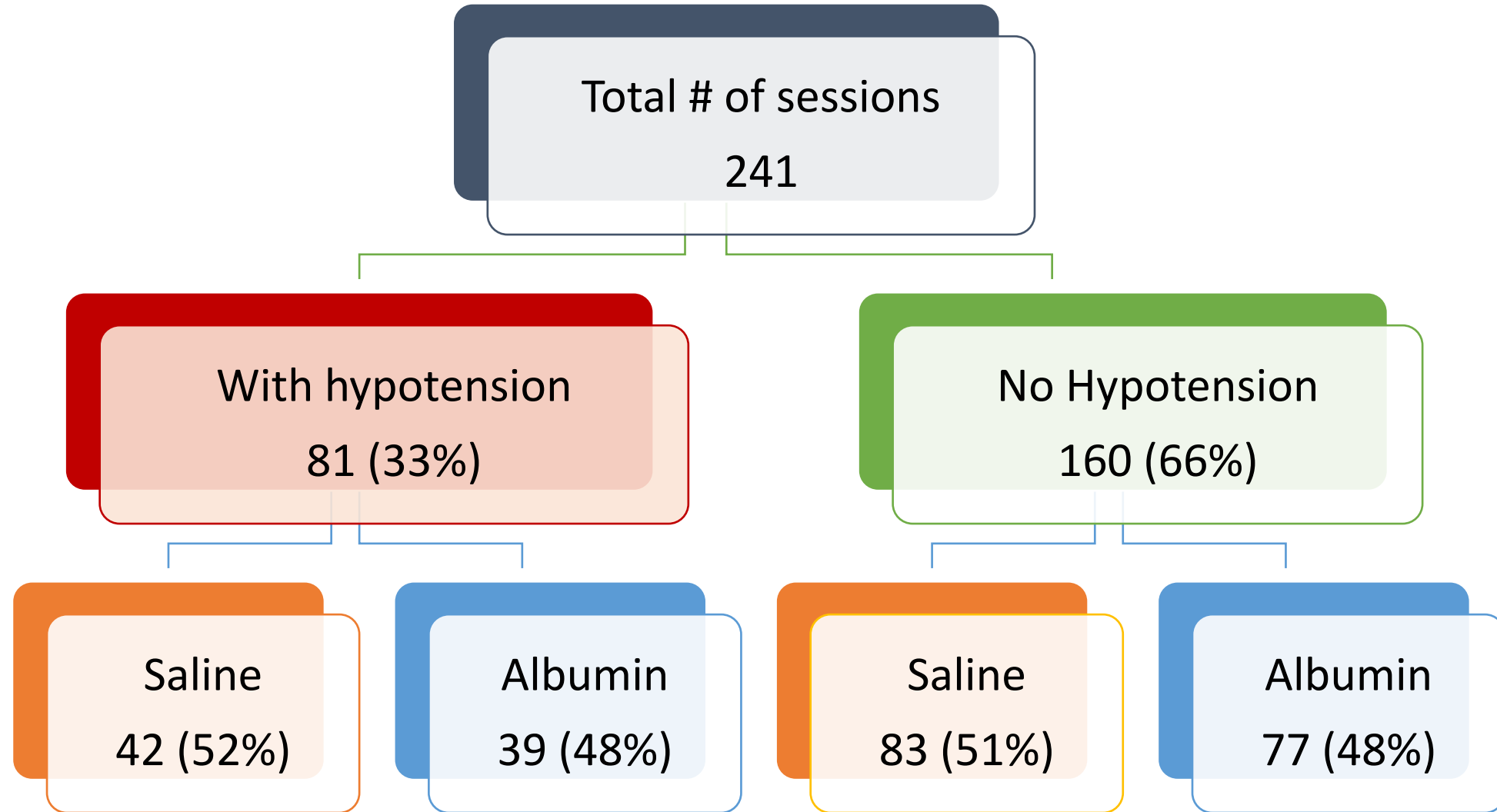
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Fall30	Pre-HD SBP - min IHD ≥ 30	69 (28.0%)	40 (32.5%)	30 (23.9%)	0.044

based on **Fall20Nadir90**

In albumin sessions patients were **74%** less likely to experience hypotension during the dialysis

KDOQI	Pre-HD SBP - min IHD ≥ 20 and symptoms of cramping, headache, lightheadedness, vomiting, or chest pain during HD	28 (11.4%)	19 (15.4%)	9 (7.3%)	0.002
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Hypotension Detected by Nurse



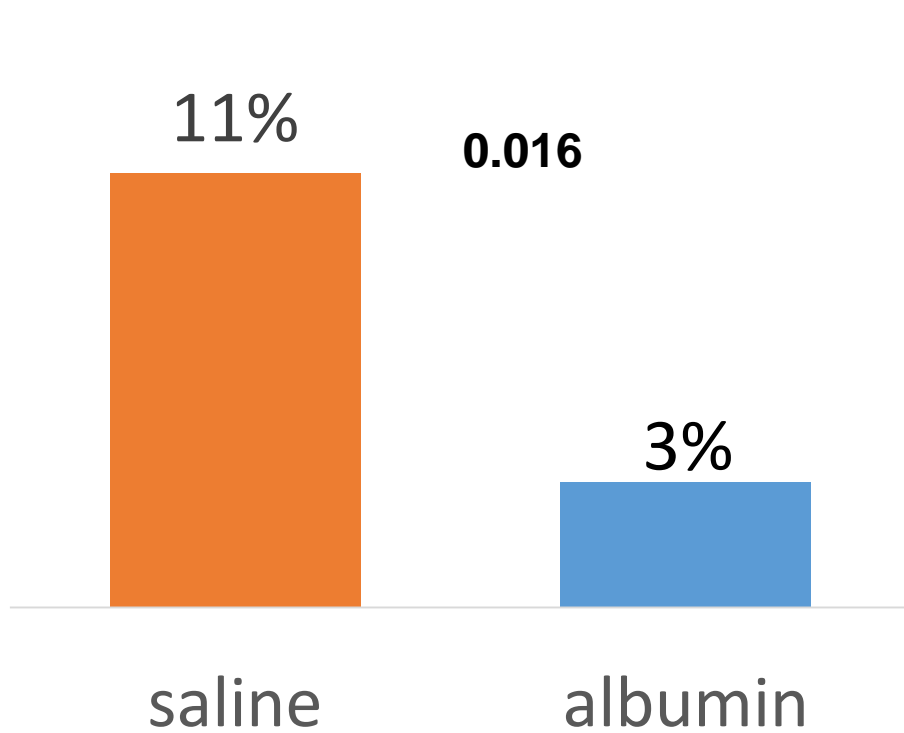
Hypotension

Levels of BP before dialysis

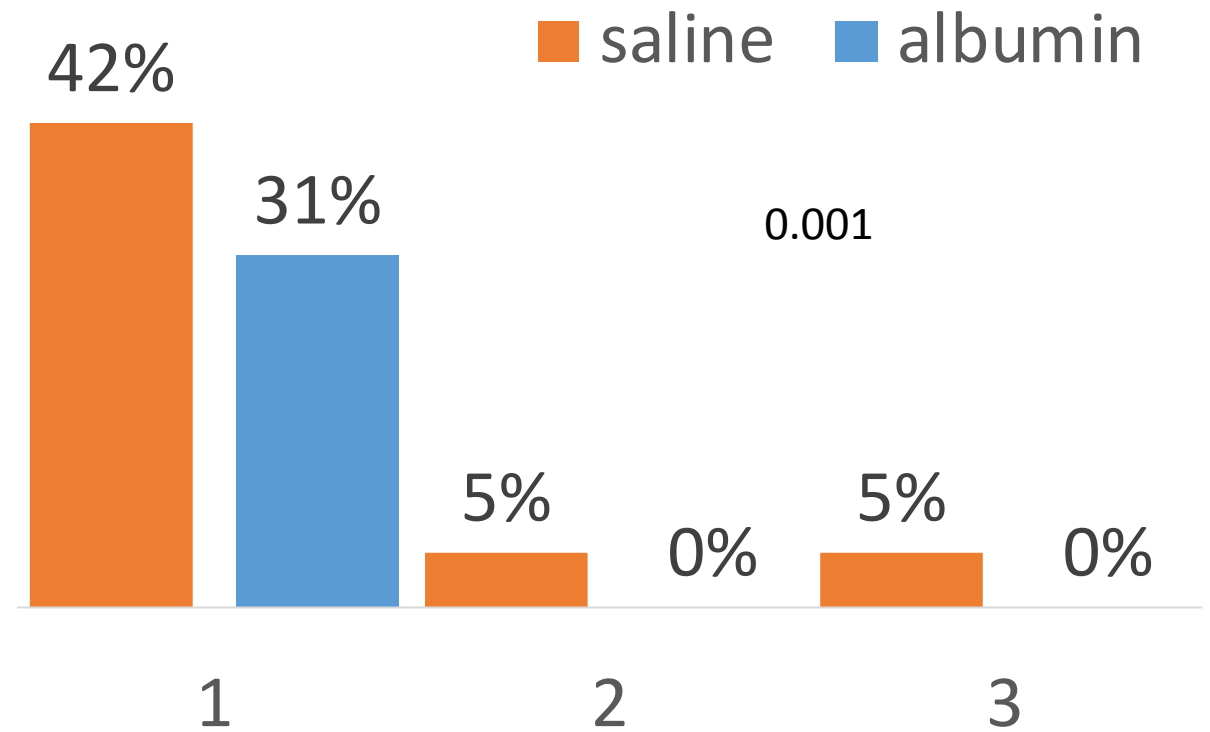
	Overall	Normal Saline	Albumin	p-value
Initial SBP	107 (21)	109 (23)	105 (18)	
Lowest SBP	87 (14)	83 (12)	90 (15)	0.035*
Time to First Episode (min)	57 (65)	61 (66)	53 (65)	0.341

Hypotension

Hypotensive Episodes based on Fall20Nadir90

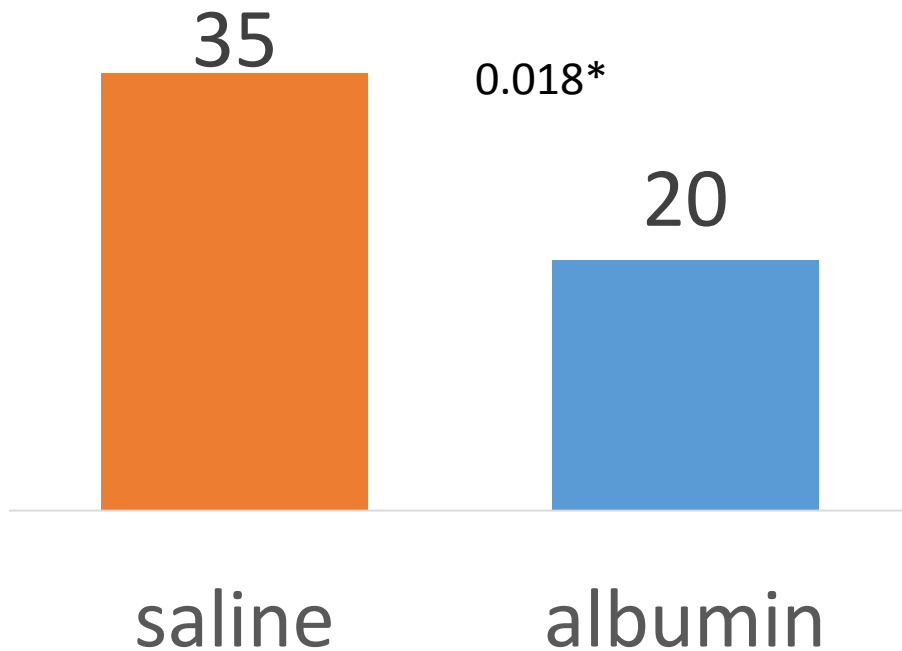


Episodes of Hypotension with Ultrafiltration discontinuation

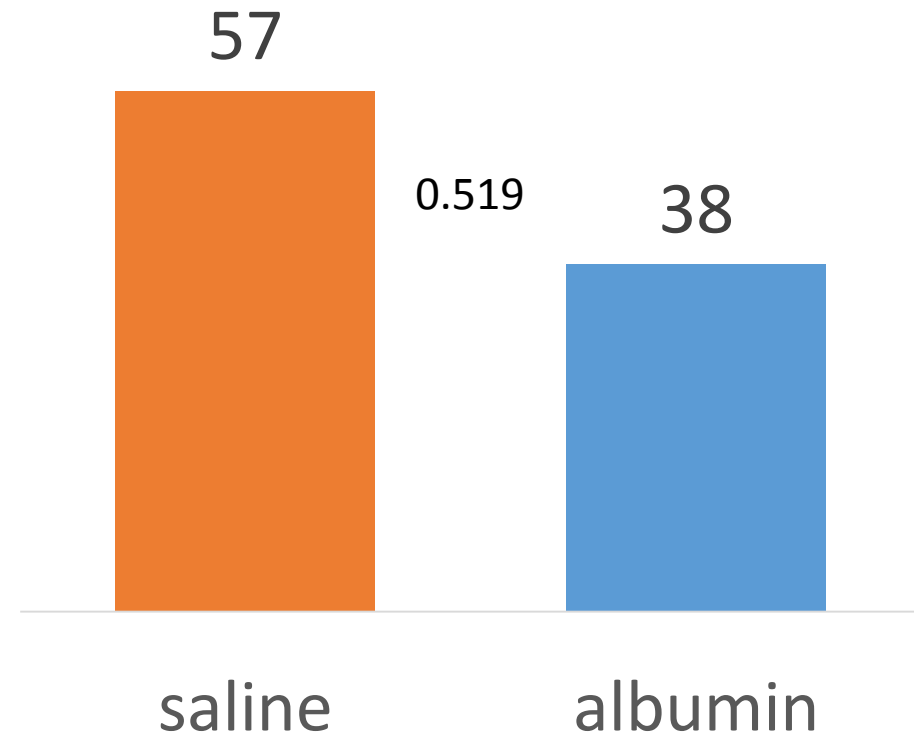


In Sessions with Hypotension

Total time with UF discontinued during session (min)



Total volume NS infused during session (ml)



Summary of Results

- ✓ In hypoalbumenemic patients, 25% albumin infusion at start of RRT improves fluid removal rates
- ✓ Hypotension episodes can be reduced with infusion of albumin
- ✓ Mechanistic effects of albumin need to be better defined and evaluated further

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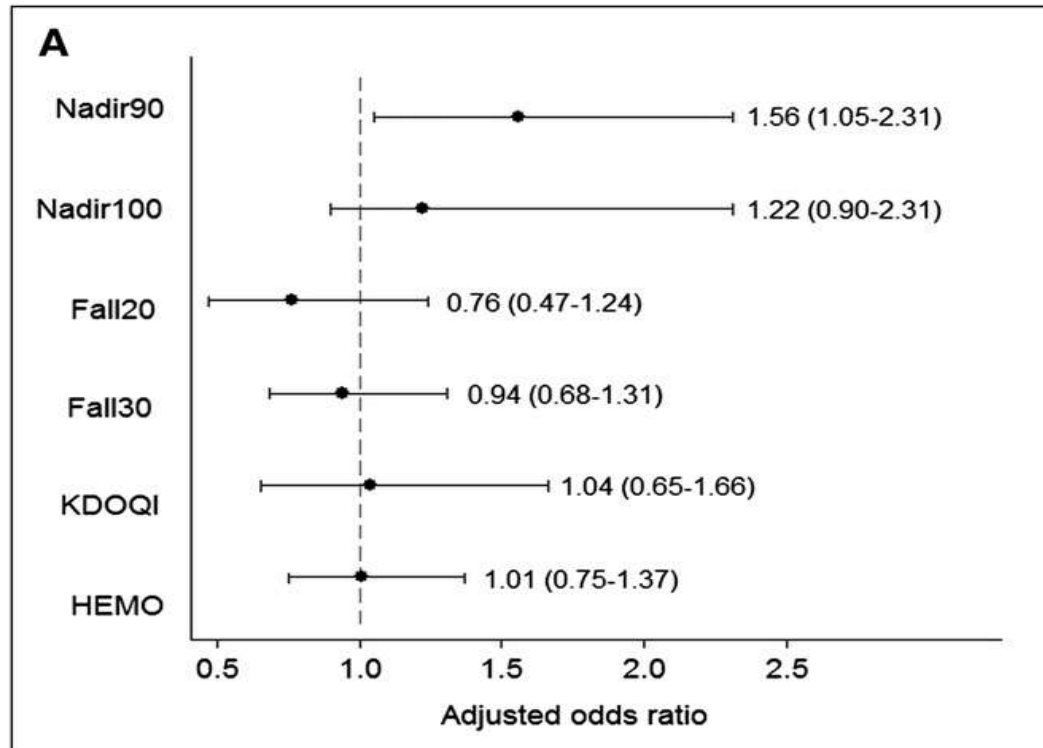
Thank you



Adjusted associations between IDH definitions and mortality

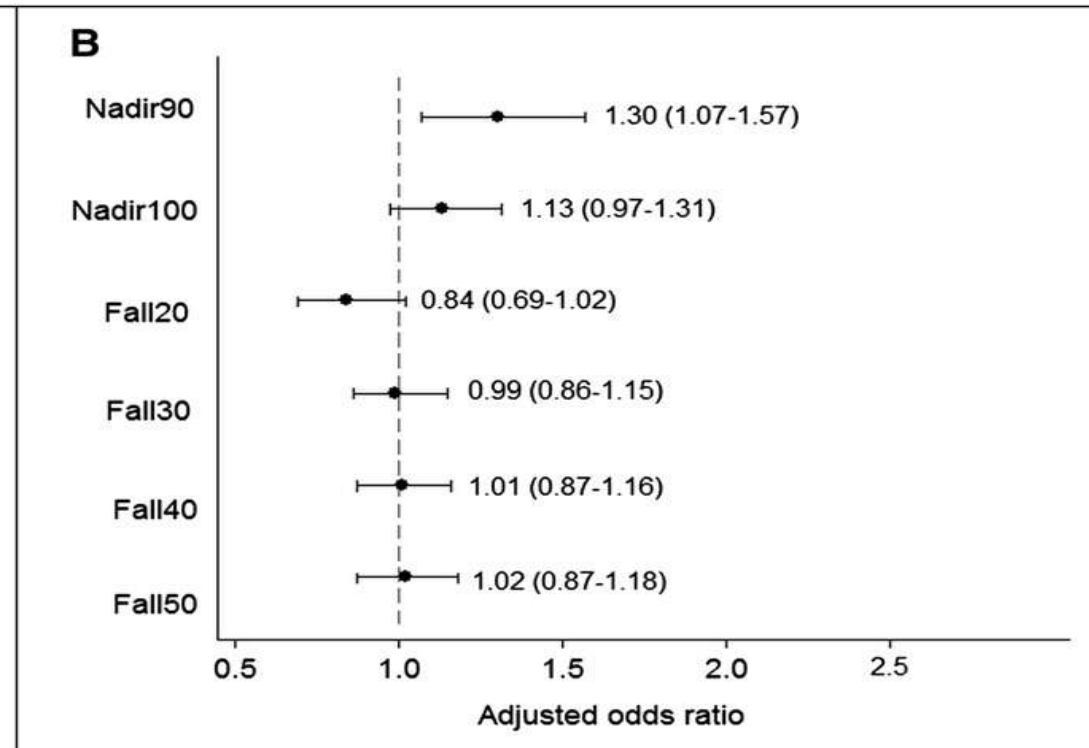
HEMO cohort

N=1409 patients



Large Dialysis Organization cohort

N= 10,392 patients



During 1 month - 30% of IHD during exposure period treatments
Mortality evaluated over 1 year

A Randomized, Controlled Trial of Albumin *versus* Saline for the Treatment of Intradialytic Hypotension

Double blind randomized three-period crossover study

Setting: Hospital, single center

- Country: Canada
- Adult patients who underwent hemodialysis treatments for a minimum of 3 months.

All participants needed to have at least 3 symptomatic episodes of IDH within the 60 days preceding enrolment.

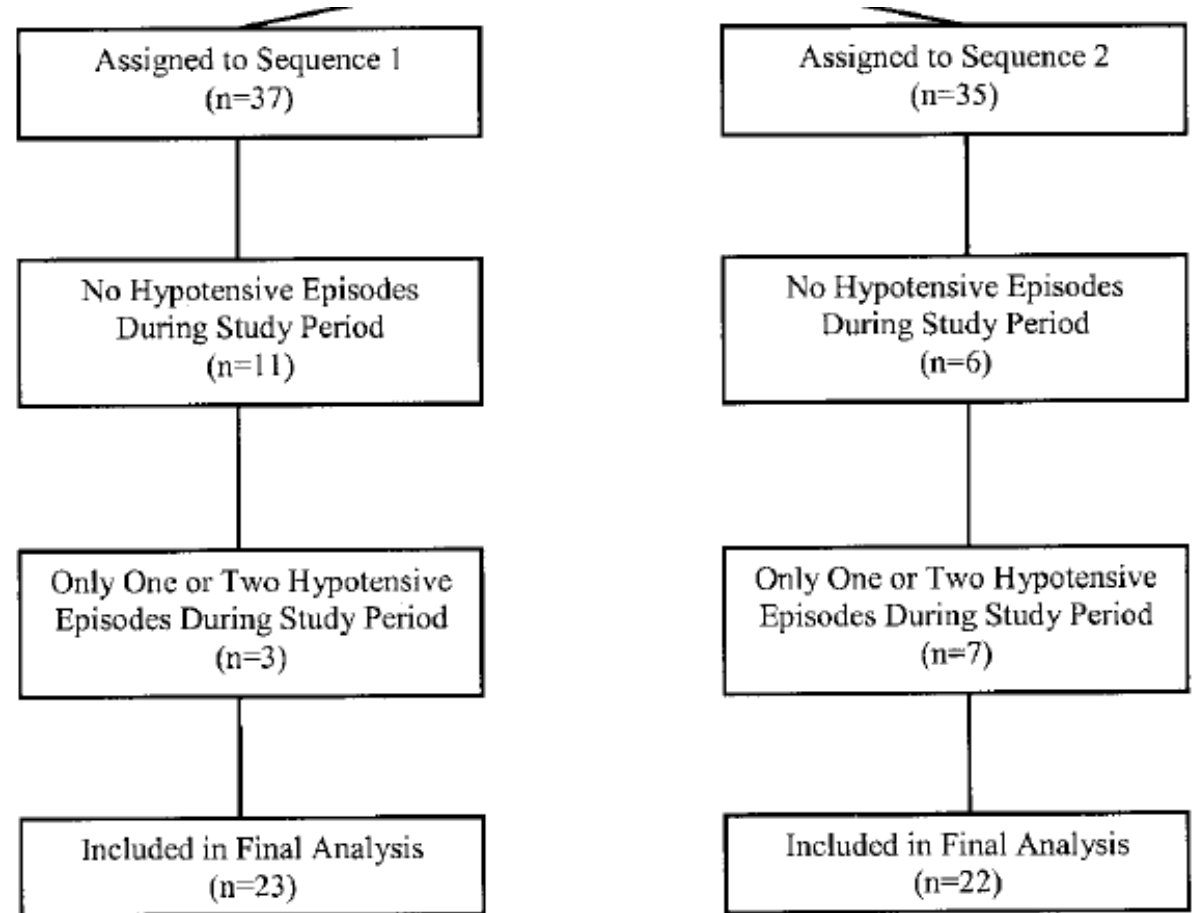
55 Patients Switching Solution to Treat Hypotension Episodes

Sequence 1

- 5% albumin to treat the first dialysis episode of hypotension, the 2nd and 3rd dialysis sessions with hypotension were treated with normal saline.

Sequence 2

- Normal saline to treat the first dialysis episode of hypotension, the 2nd and 3rd dialysis sessions with hypotension were treated with 5% albumin.

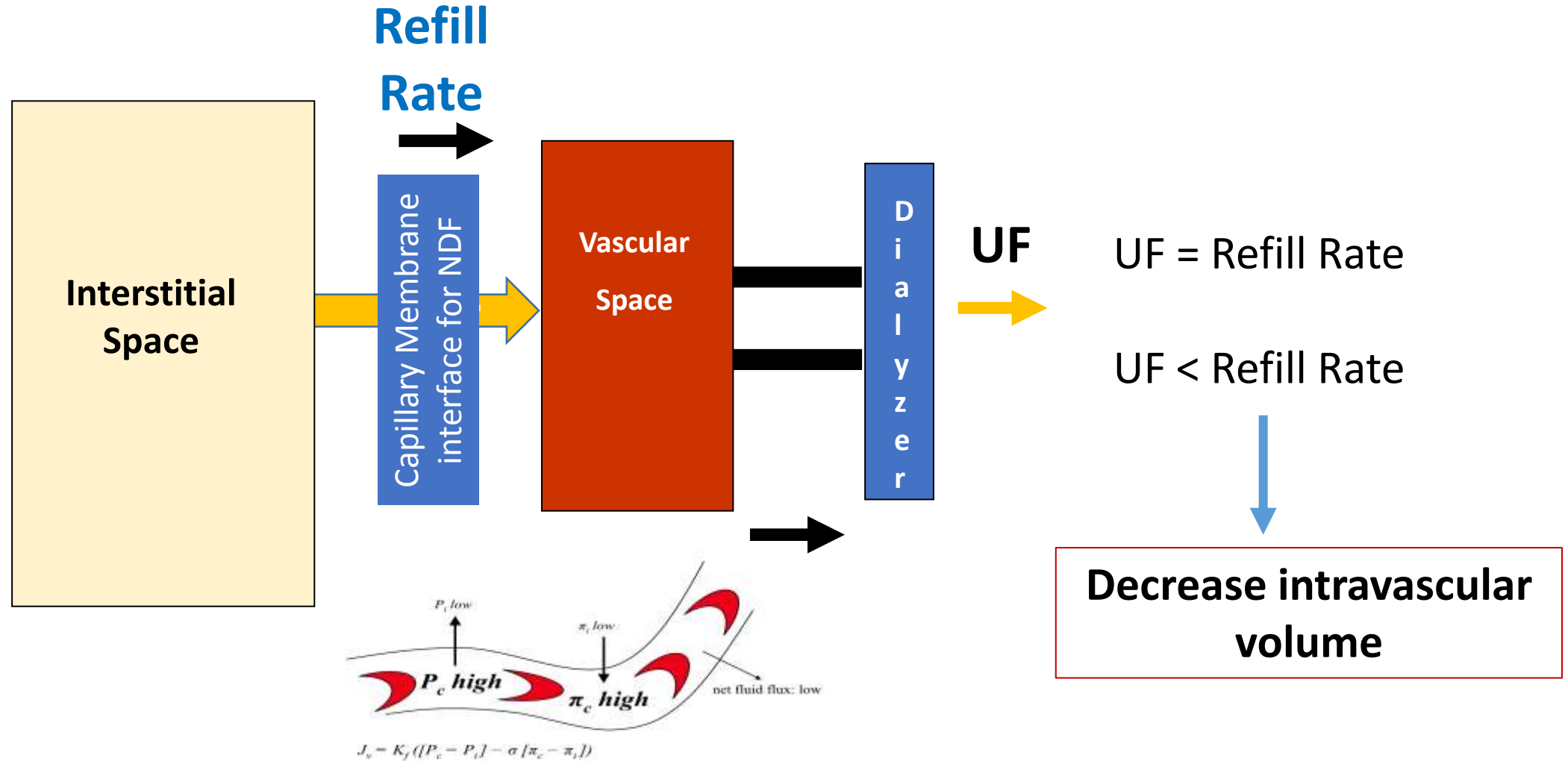


Outcomes

	Albumin (45)	Normal saline (45)	P value
Mortality	None	None	
Non-fatal serious adverse events	NR	NR	
Treatment failure (%)	22	24	1.0
Surrogate outcome measures			
Time to restore BP (min)	7.9 ± 6.6	9.9 ± 7.5	0.09
Nursing time to treat episode (min)	15.1 ± 7.2	15.9 ± 7.3	0.47
Recurrent hypotension (%)	36	36	1.0
Actual ultrafiltration	2.6 ± 1.4	2.6 ± 1.2	0.58
% target ultrafiltration achieved	0.84 ± 0.17	0.80 ± 0.16	0.14

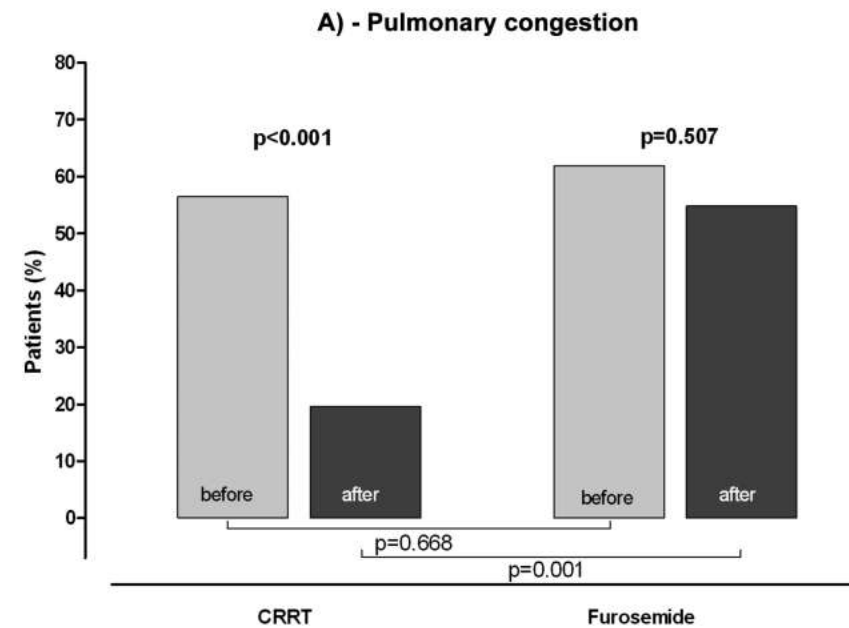
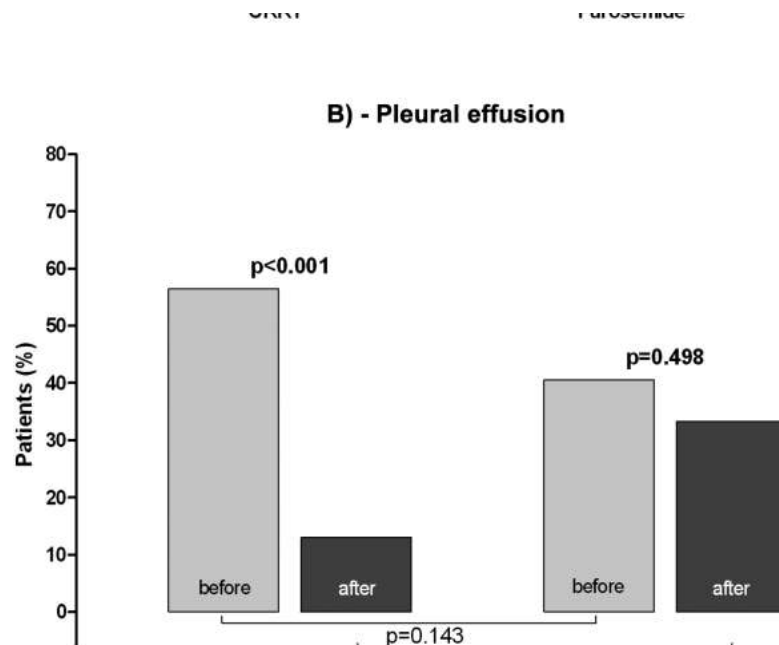
- ✓ Concluded that 5% albumin was **no more effective than normal saline** for the treatment of IDH in chronic hemodialysis patients.
- ✓ Normal saline should be used as the initial fluid for the treatment of IDH.

Balance between Ultrafiltration and Plasma Refill Rate



Congestive heart failure and decongestion ability of two different treatments: CRRT and diuretic therapy, experience of a cardiac step down unit

- 88 patients with HF (NYHA class III-IV)
- CRRT (n = 46) vs. intravenous diuretics (n = 42)
- choice of diuretics or CRRT was guided by renal impairment or diuretics' resistance.



In Sessions with Hypotension

	Overall	Normal Saline	Albumin	p-value
Total time with UF discontinued during session (min)				
	28 (50)	35 (52)	20 (47)	0.018*
Total volume NS infused during session (ml)				
	48 (88)	57 (94)	38 (81)	0.519

Number of Episodes with need for discontinuing UF during session

0	47 (58.0%)	20 (47.6%)	27 (69.2%)		< 0.001***
1	30 (37.0%)	18 (42.9%)	12 (30.8%)		
2	2 (2.5%)	2 (4.8%)	0 (0.0%)		
3	2 (2.5%)	2 (4.8%)	0 (0.0%)		

■ saline ■ albumin