Managing Fluid Overload in Peritoneal Dialysis

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The University of Queensland Australia
Australian Government National Health and Medical Research Council
NHMRC

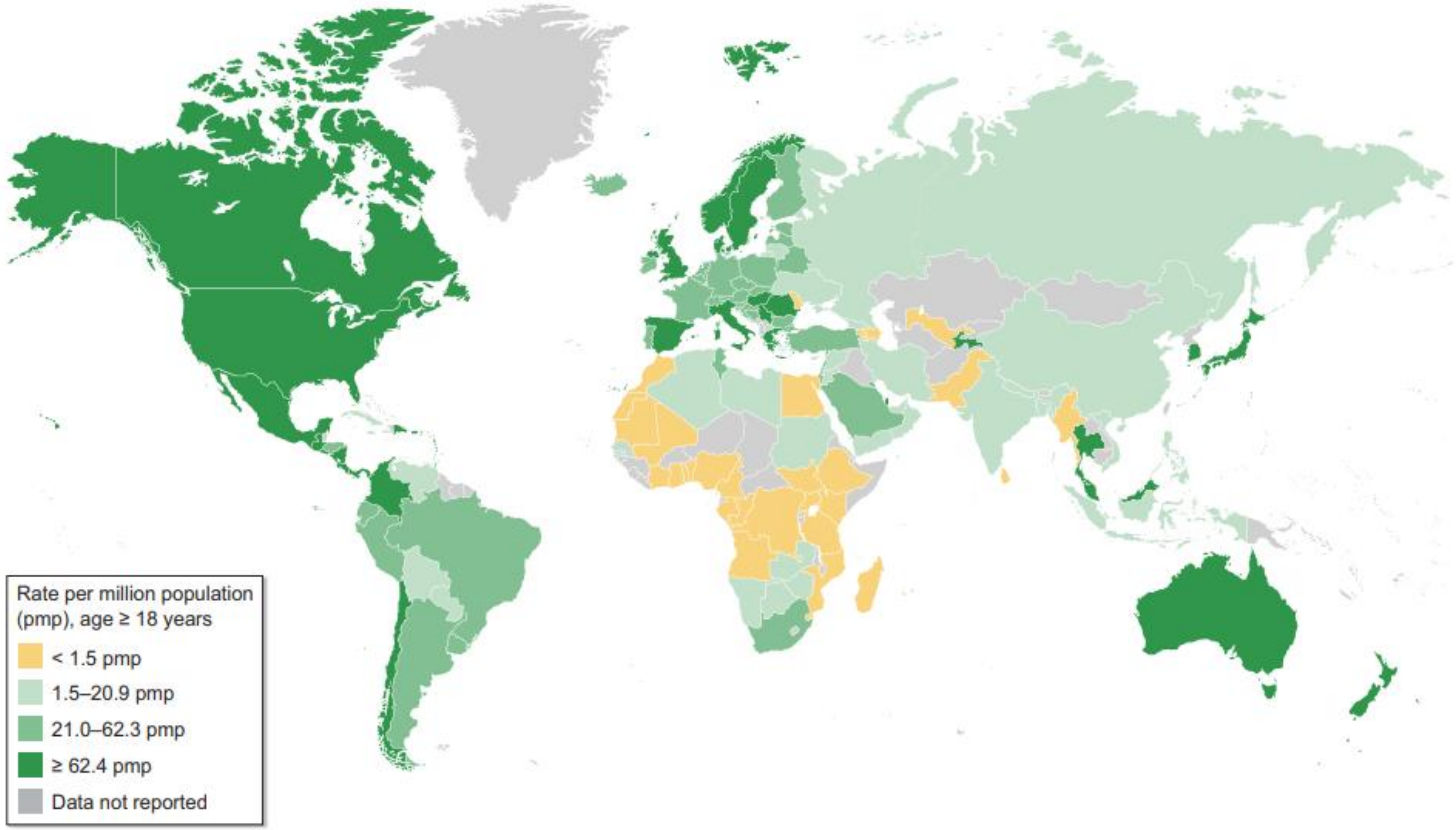
Disclaimers

- I am a nephrologist
- Participate and lead investigator-initiated trials at the Australasian Kidney Trials Network, at the University of Queensland, Australia
- Received research grants and speaker's honoraria from Vantive (Baxter) Healthcare and Fresenius Medical Care
- Current recipient of NHMRC Emerging Leadership Level 2 Investigator Grant
- Home dialysis enthusiast - especially PERITONEAL DIALYSIS

Learning Objectives

- Understand pathophysiology of fluid overload in PD
- Identify clinical consequences and risk factors
- Review assessment tools and management strategies

PD: Global Landscape

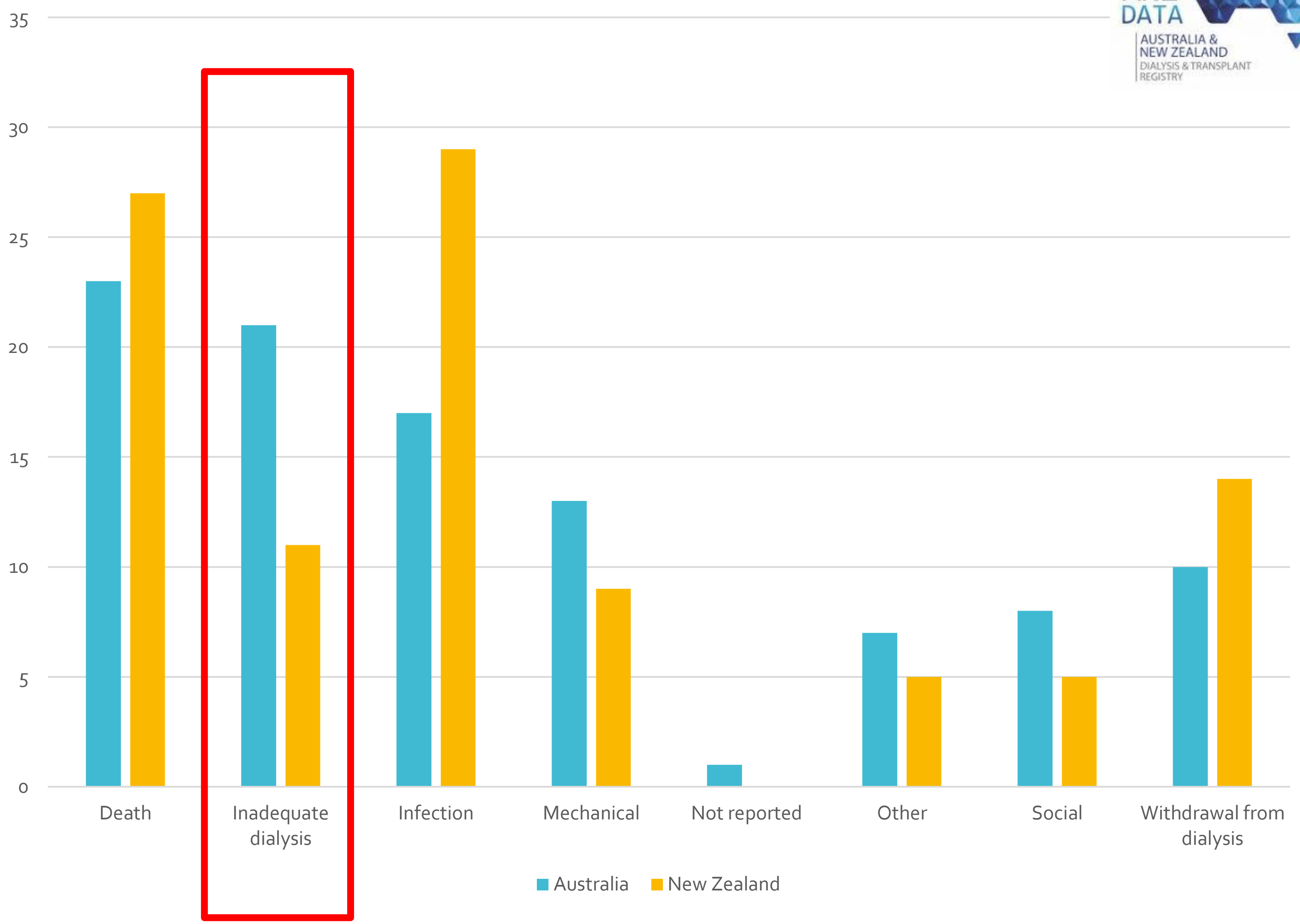


Median incidence of PD 22.4 pmp (prev 20.8 pmp)
Median prevalence of PD 21 pmp

HD prevalence 322.7 pmp

Cho Y et al, NDT 2024; 39(suppl2): ii18-ii25

Reasons for PD cessation



ANZDATA 2024

“Fluid overload is <u>common.</u>”

And may be more common than what we think..

How reliable is clinical assessment of fluid overload?

107 patients on HD – mid-week - asymptomatic

TABLE 1 Demographic, clinical, and laboratory parameters of patients according to the tertile of BIS-derived predialysis FO

Parameter	Overall	Low tertile (FO: <0.9 L)	Medium tertile (FO: 0.9–2.2 L)	High tertile (FO: >2.2 L)	*p* value

TABLE 3 Univariate and multivariate linear regression analysis of risk factors associated with BIS-derived predialysis overhydration

	Univariate analysis		Multivariate analysis	
Risk factor	**Standardized β**	***p* value**	**Standardized β**	***p* value**
Continuous variables				
Age (years)	−0.138	0.15	0.022	0.81
BMI (kg/m^2)	−0.243	0.01	−0.158	0.08
Interdialytic weight gain (kg)	0.108	0.27		
Hemoglobin (g/dl)	−0.146	0.14	−0.002	0.98
Serum albumin (g/dl)	−0.230	<0.05	−0.149	0.11
Urea reduction ratio (%)	−0.022	0.83		
Home SBP (mmHg)	0.306	0.001	0.287	<0.01
Categorical variables				
Gender (male vs. female)	0.003	0.97		
Dialysis vintage (per month)	0.358	<0.001	0.306	<0.001
History of diabetes (yes vs. no)	−0.079	0.42		
History of CAD (yes vs. no)	−0.030	0.76		
History of CHF (yes vs. no)	0.115	0.20		
Crackles in pulmonary auscultation (yes vs. no)	0.081	0.42		
Pedal edema (yes. vs. no)	0.094	0.34		
Antihypertensive drug use (yes vs. no)	0.051	0.60		
Average number of antihypertensives	0.250	<0.01	0.099	0.29

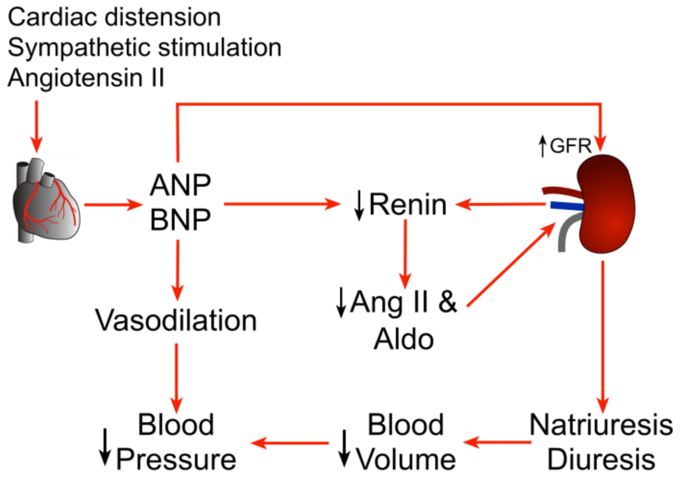
Abbreviations: BMI, body mass index; CAD, coronary artery disease; CHF, congestive heart failure; SBP, systolic blood pressure.

Abbreviations: BP, blood pressure; CAD, coronary artery disease; CHF, congestive heart failure; DBP, diastolic blood pressure; OH, overhydration; SBP, systolic blood pressure.

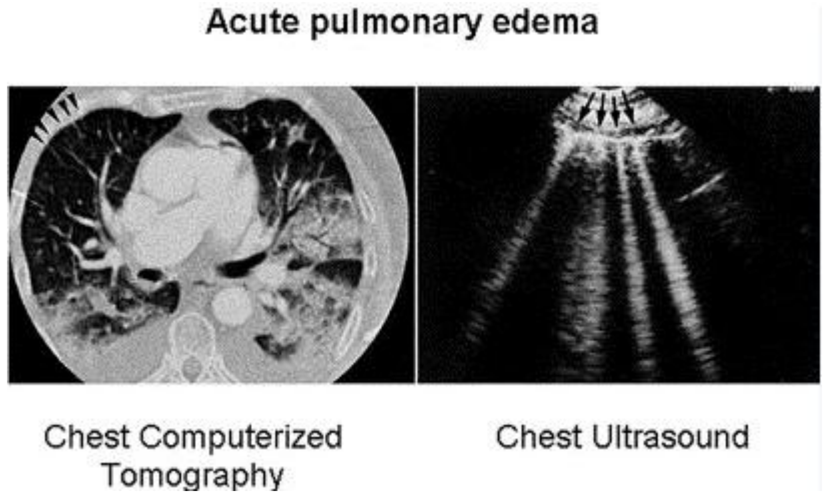
Tsikliras NC et al, Haemo Int; 2021; 25: 391-8

Other methods to assess fluid status

- **Serum Biomarkers**
  - B type natriuretic peptide (BNP)
    - Mainly reflects filling pressure of the left atrium – i.e. cardiac congestion (reflective of cardiac dysfunction and volume overload)



- **Lung Ultrasound**
  - Can be used to assess the extravascular content of the lungs
  - Reflects pulmonary wedge pressure – i.e., LV preload and circulating volume in relation to cardiac function rather than just fluid status



https://cvphysiology.com/blood-pressure/bp017

Picano E et al, JASEcho, 2006; 19(3): 356-63

Bioimpedance Measurement

- Uses a flow of electrical current through the body tissues to assess body composition based on measured impedance (a compound of resistance and reactance)

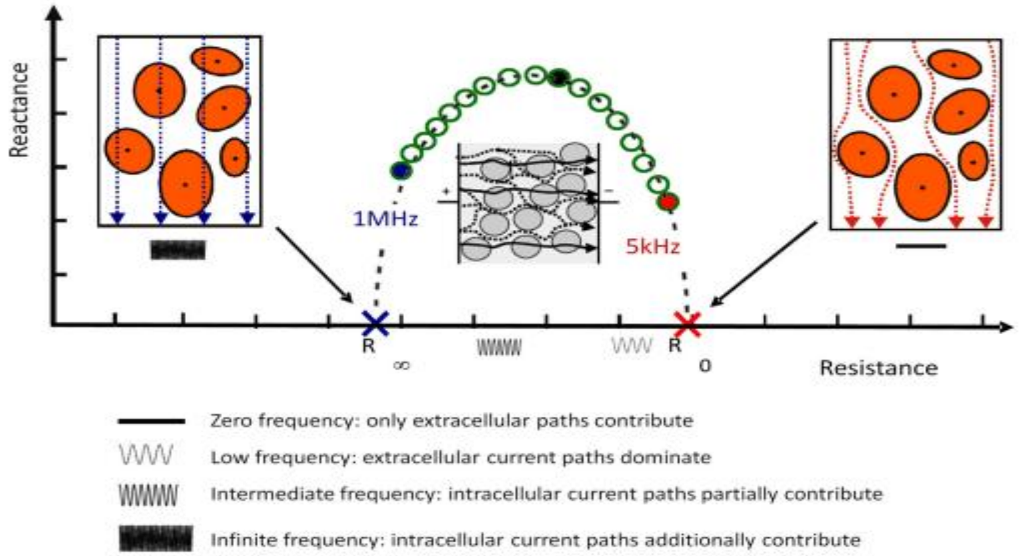


Figure 3. Principles of bioimpedance and bioimpedance spectroscopy.

- Model presume that the body is composed of 3 linked cylinders – arm, leg and the trunk (assumes constant fat-free mass – which is inaccurate in higher BMI)
- Resistance is related to water content whereas reactance is related to integrity of the cell membrane

Kim YL & van Biesen W, Semin Nephrol 2017; 37(1): 43-53

Fluid Status in Peritoneal Dialysis Patients: The European Body Composition Monitoring (EuroBCM) Study Cohort

Wim Van Biesen[1]*, John D. Williams[2], Adrian C. Covic[3], Stanley Fan[4], Kathleen Claes[5], Monika Lichodziejewska-Niemierko[6], Christian Verger[7], Jurg Steiger[8], Volker Schoder[9], Peter Wabel[9], Adelheid Gauly[9], Rainer Himmele[9], on behalf of the EuroBCM study group

- Cross sectional, observational, multi-centre study in 28 centres in 6 European countries
- To analyse hydration status in prev
  bio-impedance spectroscopy:
  - Absolute Δ Tissue Hydration (A
    the tissue detected by the BCM
    water present in the tissue unde
    conditions.
- Of 639 patients included:
  - **53.4%** met 'over-hydration' criteria (AΔTH>90th percentile of normal population)
  - Severe fluid overload, defined as a relative change in tissue hydration above 15% was present in 25.2% of the study population (meaning ~ **1 in 4** PD patients have severe fluid overload!)

? Problem of Prevalence –

~40% of patients with <500mL/day urine output

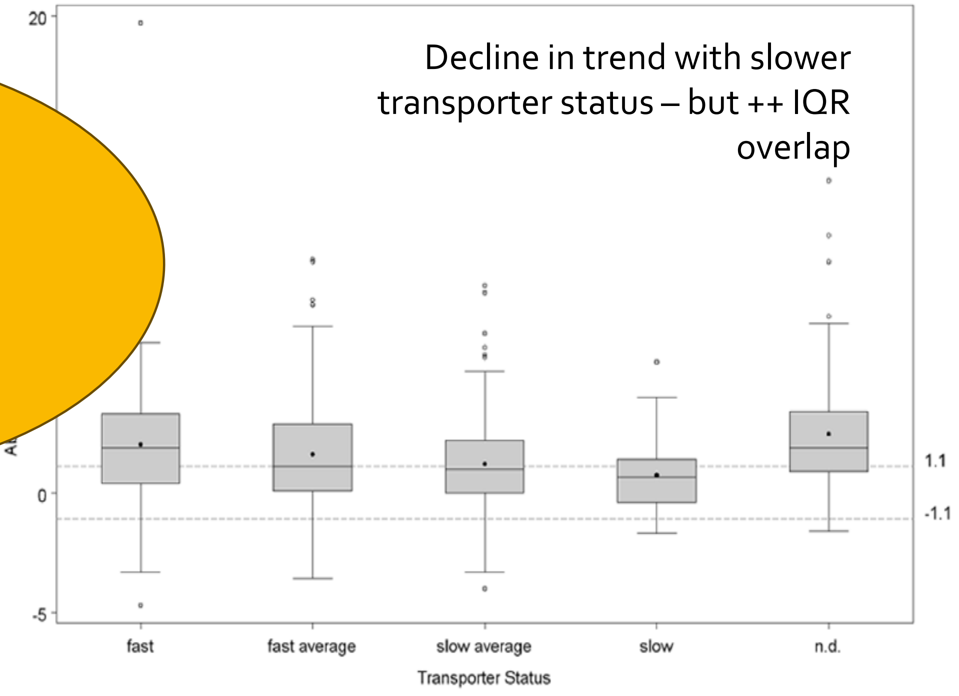


Figure 2. Box and whisker plots (median, 25th and 75th quartile, outliers) of Absolute ΔTissue Hydration (in liters) in the different transport categories. n.d.: no peritoneal transport characteristics available in the 4 months before the BCM measurement.
doi:10.1371/journal.pone.0017148.g002

Van Bissen W et al, PLoS ONE 2011; 6(2): e17148

Baseline hydration status in incident peritoneal dialysis patients: the initiative of patient outcomes in dialysis (IPOD-PD study)†

- Longitudinal, international, prospective observational study of incident PD patients
- 1092 incident patients (58.1% male) from 135 centres in 35 countries (Asia, Europe, Latin America)
- 56.4% were 'overhydrated' using BCM

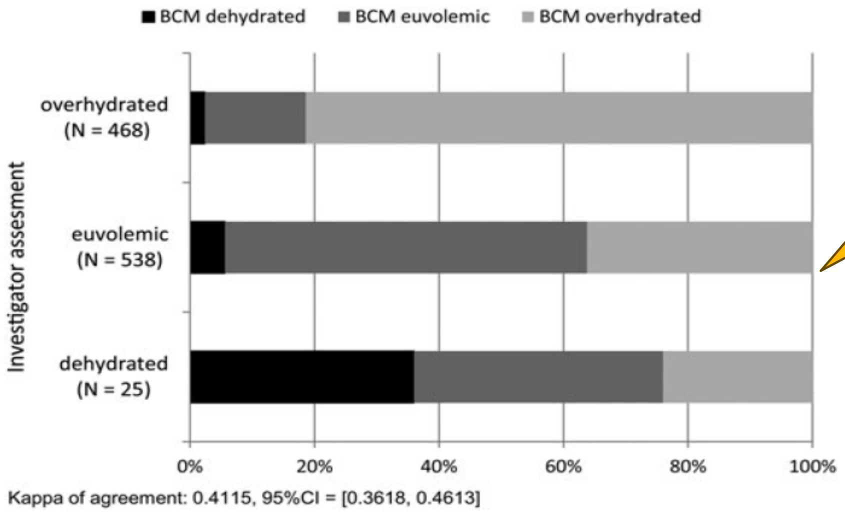


FIGURE 4: Assessment of hydration status with BCM versus clinical assessment by investigator using the physician specific assessment.

When in doubt – fluid overload is more likely than not!

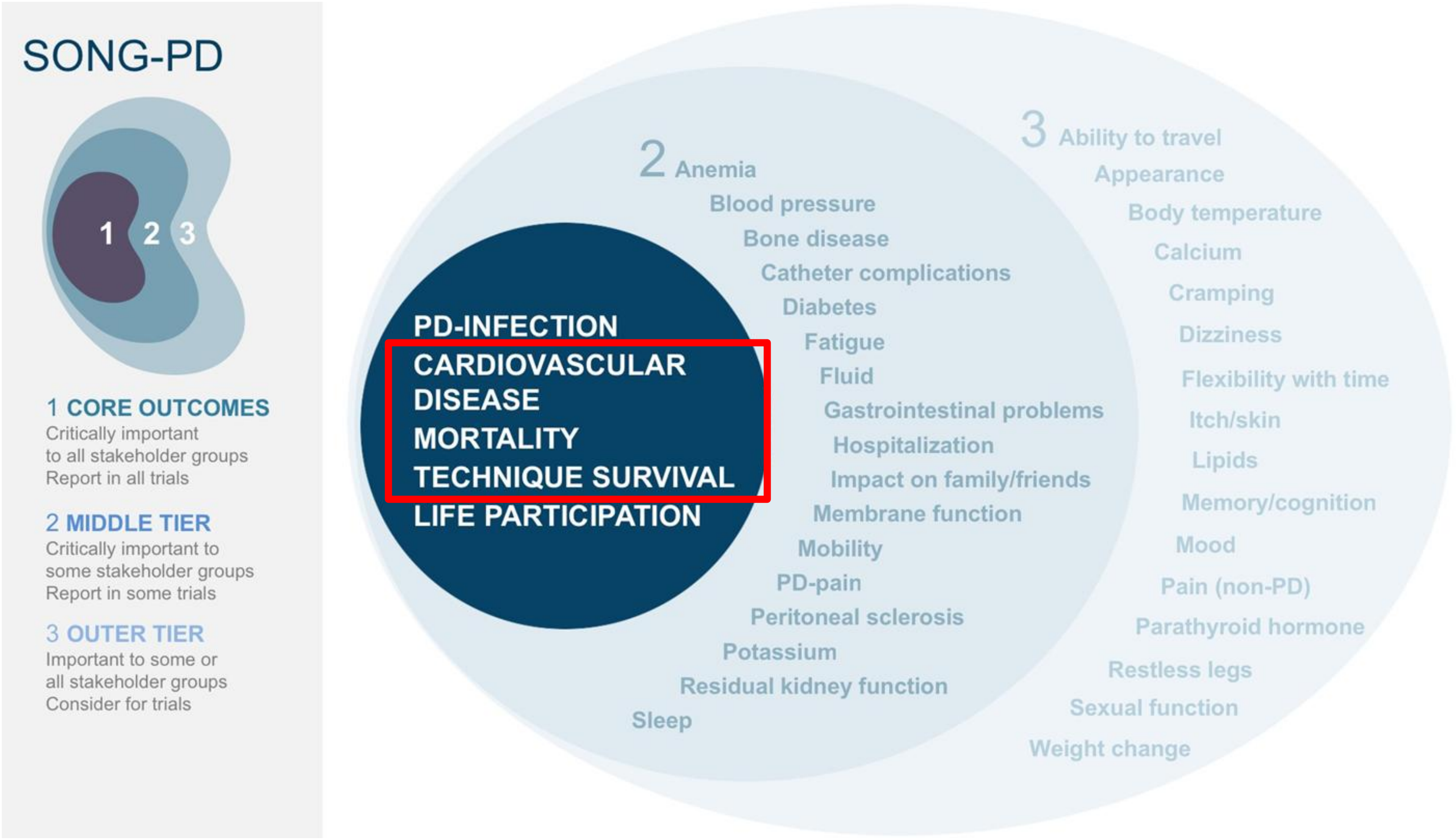
Target Weight in PD = normotensive, euvolaemic and symptom free

Table 1. Baseline patient characteristics of the entire analysis cohort and according to hydration status

	Total, N = 1031	Dehydrated, N = 50 (4.8%)	Normohydrated, N = 399 (38.7%)	Overhydrated, N = 582 (56.5%)
Age [years]	58.0 ± 15.3	55.1 ± 15.1	56.0 ± 16.1	60.0 ± 14.6
Gender (men) [%]	58.1	42.0	44.6	[illegible]
Height [cm]	[illegible]	164.8 ± 9.4	163.9 ± 9.5	167.8 ± 10.3
Weight [		79.8 ± 18.4	69.7 ± 15.5	73.0 ± 16.2
Eth				
		66.0	74.2	69.1
		8.0	3.3	3.1
		12.0	12.8	17.9
		6.0	4.3	3.6
		8.0	5.5	6.4
		[illegible]	17.5	36.9
		[illegible]	22.1	16.5
		[illegible]	17.3	16.2
		[illegible]	12.3	7.0
		16.0	11.5	10.0
		12.0	7.5	6.4
		2.0	7.3	8.6
		4.0	4.5	7.7
		2.0	2.3	4.3
NYHA 4	1.3	2.0	0.8	1.5
Not specified NYHA	[illegible]	[illegible]	[illegible]	[illegible]
Blood pressure [mmHg]				
Male (sys)	142.3 ± 21.5	136.3 ± 23.0	138.1 ± 20.4	144.6 ± 21.6
Male (dias)	80.7 ± 13.0	81.8 ± 10.6	79.5 ± 11.9	81.1 ± 13.5
Female (sys)	135.6 ± 21.8	136.0 ± 18.5	131.4 ± 20.2	140.6 ± 23.0
Female (dias)	79.1 ± 12.5	80.3 ± 13.1	78.7 ± 12.2	79.5 ± 12.8
Residual renal function				
Residual urinary output [mL]	1551 ± 753	1834 ± 900	1601 ± 752	1492 ± 734
eGFR [mL/min/1.73 m^2]	10.8 ± 13.3 (N = 450)	8.7 ± 4.7 (N = 24)	11.7 ± 15.2 (N = 171)	10.4 ± 12.4 (N = 255)
Creatinine clearance [mL/min]	10.4 ± 6.0 (N = 657)	12.0 ± 7.1 (N = 35)	11.8 ± 6.9 (N = 253)	9.4 ± 4.9 (N = 369)
Urea clearance [mL/min]	5.4 ± 3.7 (N = 453)	6.1 ± 4.9 (N = 24)	5.7 ± 3.5 (N = 173)	5.2 ± 3.7 (N = 256)
Extracellular water [L]	17.3 ± 4.0	16.4 ± 4.2	15.3 ± 3.1	18.8 ± 3.9
Intracellular water [L]	18.6 ± 4.7	22.6 ± 7.1	18.0 ± 4.4	18.7 ± 4.5
ECV/ICV	0.9 ± 0.2	0.7 ± 0.1	0.9 ± 0.1	1.0 ± 0.2
FO [L]	1.9 ± 2.4	−1.8 ± 0.6	0.2 ± 0.6	3.3 ± 2.08

Ronco C et al, NDT 2015; 30: 849-58

"Fluid overload is common and associated with <u>adverse patient outcomes</u>"



Manera K et al, AJKD 2020; 75(3): 404-12

ORIGINAL ARTICLE

The impact of volume overload on technique failure in incident peritoneal dialysis patients

François Vrtovsnik[1], Christian Verger[2], Wim Van Biesen[3], Stanley Fan[4], Sug-Kyun Shin[5], Carmen Rodríguez[6], Isabel Garcia Méndez[7], Frank M. van der Sande[8], Tatiana De los Ríos[9], Katharina Ihle[9], Adelheid Gauly[9], Claudio Ronco[10] and James Heaf[11], for the IPOD-PD Study Group

- From IPOD-PD Study, 719 patients meeting inclusion criteria were included (e.g., f/up >6 months, valid measurement of BCM data at month 6).
- BCM was measured at baseline and every 3 monthly.
- Outcome: time to technique failure (defined as composite of death + t/f to HD)
- Transplantation was considered a competing event

Table 1. Patient characteristics at baseline (technique failure analysis population, n = 719)

Characteristics	Technique failure analysis population (n = 719)
Age, years	58.4 ± 14.9
Sex (male), %	57.2
Height, cm	166.9 ± 10.1
Weight, kg	73.3 ± 16.3
Blood pressure (systolic), mmHg	137.9 ± 22.7
Blood pressure (diastolic), mmHg	80.2 ± 12.6
Transport status (first assessment within 6 months), %	
High (fast)	8.8
High average	28.5
Low average	20.2
Low (slow)	16.7
Missing	25.9
Primary renal disease, %	
Diabetes	21.1
Glomerulonephritis	21.1
Hypertension	12.8
Hereditary/congenital disease	12.2
Other	18.9
Unknown	13.8
Comorbidities, %	
Hypertension	89.0
Diabetes (Types 1 + 2)	37.4
Liver disease	4.8
Cardiovascular disease (NYHA Stages I, II, III, IV, unknown)	24.1 (7.9, 6.7, 3.1, 1.0, 5.4)

Vrtovsnik F et al, CKJ 2021; 14(2): 570-7

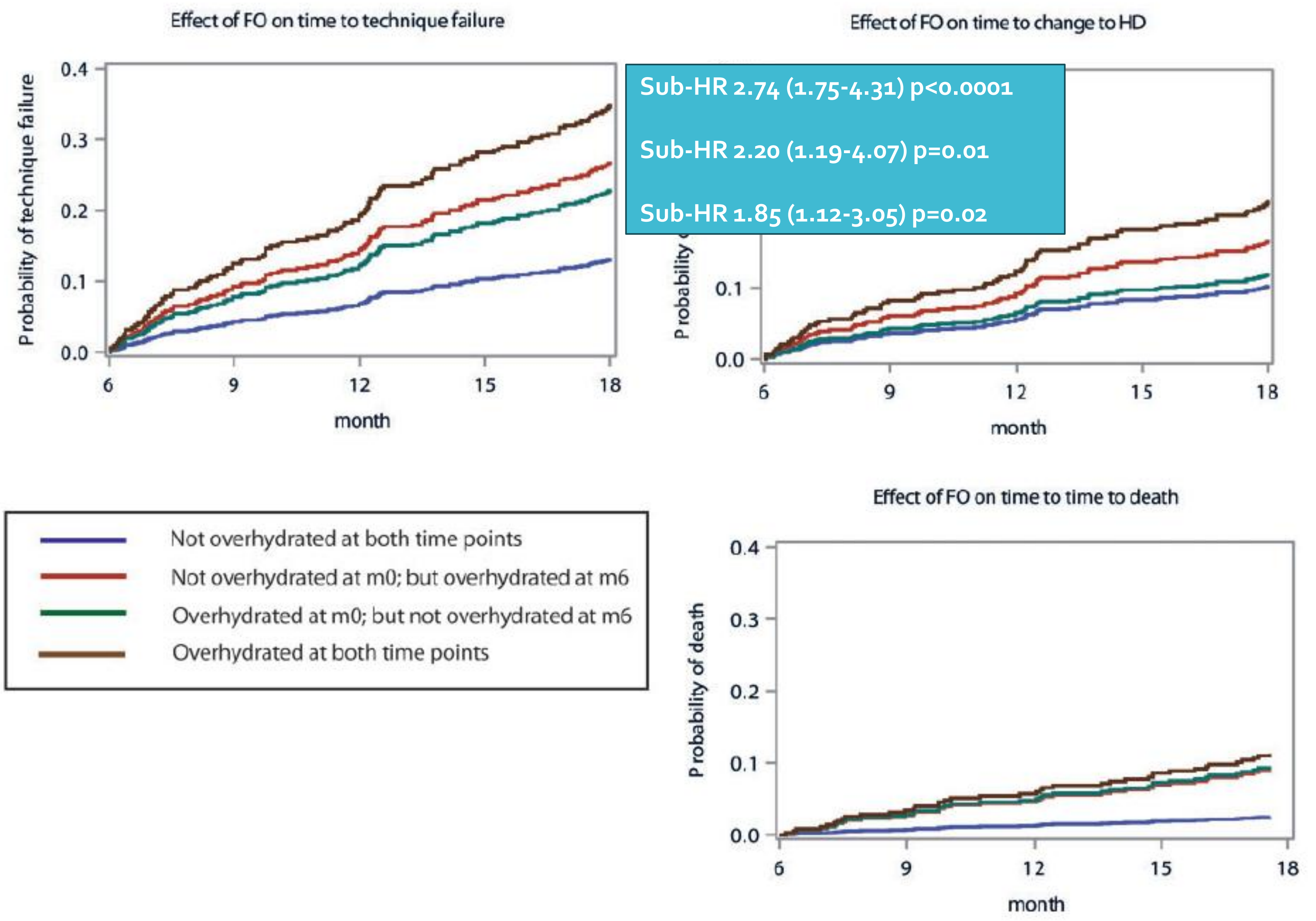


FIGURE 2: Cumulative incidence curves displaying the effect of fluid overload on composite endpoint and the two single components transfer to HD and death. m0, Month 0; m6, Month 6; FO, fluid overload.

Vrtovsnik F et al, CKJ 2021; 14(2): 570-7

Asymptomatic fluid overload predicts survival and cardiovascular event in incident Chinese peritoneal dialysis patients

Jack Kit-Chung Ng, Bonnie Ching-Ha Kwan, Kai-Ming Chow, Wing-Fai Pang, Phyllis Mei-Shan Cheng, Chi-Bon Leung, Philip Kam-To Li, Cheuk-Chun Szeto*

- Single-centre study of 311 incident PD patients, median follow-up of 27.3 months.
- Volume status measured by BIS:
  - Volume of Overhydration (OH)
  - OH/extracellular water (ECW)ration
  - ECW/total body water (TBW) ratio
  - ECW to intracellular water (ICW) ratio (E:I ratio)
- Outcomes:
  - Patient survival
  - Technique survival
  - cardiovascular event-free survival

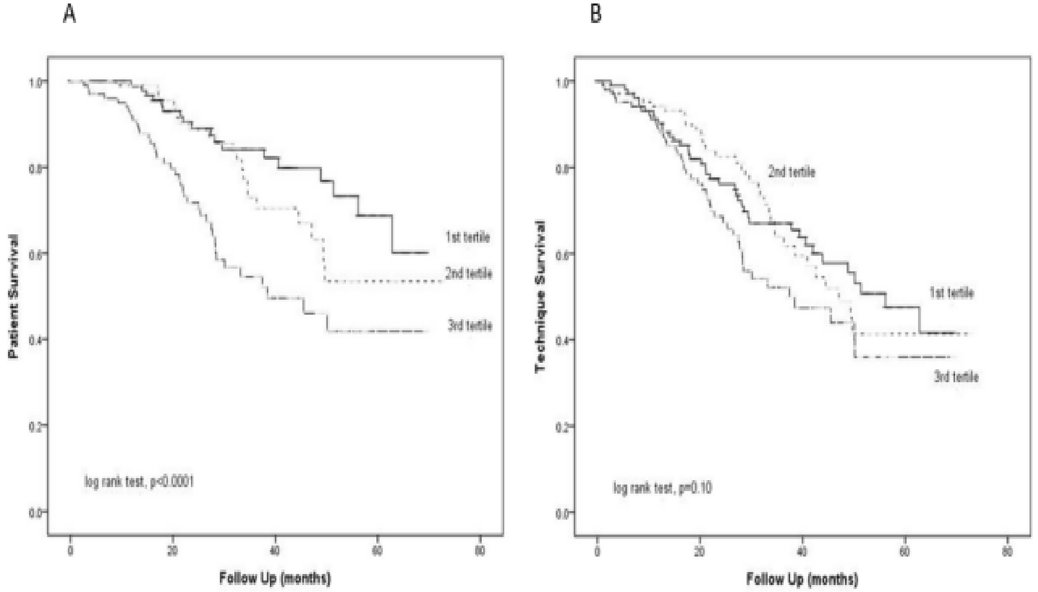


Fig 1. Kaplan-Meier plot of (A) patient survival; and (B) technique survival. Patients were divided into tertiles according to their baseline E:I ratio (1^{st} tertile: ≤0.91; 2^{nd} tertile >0.91–1.07; 3^{rd} tertile >1.07). Data were compared by the log rank test.

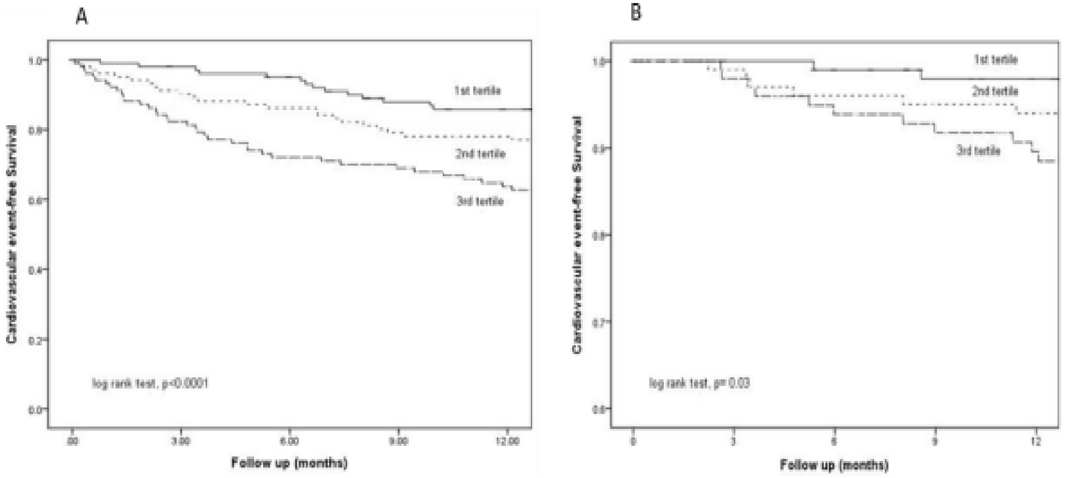


Fig 2. Kaplan-Meier plot of cardiovascular event-free survival with hospital admission for congestive he failure (A) included; and (B) excluded. Patients were divided into tertiles according to their baseline E:I rat tertile: <0.91; 2^{nd} tertile >0.91–1.07; 3^{rd} tertile >1.07). Data were compared by the log rank test.

https://doi.org/10.1371/journal.pone.0202203.t002


KEEP
CALM
AND
DON'T
PANIC


PROBLEM
SOLUTION

Understand the CAUSE/s to inform strategies of ACTION

- Inadequate peritoneal ultrafiltration
- Reduced residual kidney function
- Increased dietary salt and fluid intake

Fluid Restriction

- Generally, “restrictive” (e.g., 1.5L/day)

- NHS Oxford Kidney Unit patient information brochure for PD states:
  - Your fluid allowance = 750mL + previous days 24-hour urine output

How much fluid you can have differs from person to person. This depends on kidney function, urine output, and dialysis. Your fluid allowance may also change over time. Discuss with your kidney doctor, nurse, or dietitian if you are unsure of your allowance.

My fluid allowance is _______ mL per day.

Let's talk about fluid – 'obvious' and 'hidden'

Example 1		Example 2	
Breakfast	**Fluid mL**	**Breakfast**	**Fluid mL**
2 slices of wholegrain bread with 2 poached eggs / tomato / mushroom / jam / honey 1-2 tablespoons dried fruit 1 cup tea / coffee / water	250	½-1 cup high fibre cereal with 1/2 cup low fat milk 1 medium sized orange ½ cup tea / coffee / water	125 80 125
Breakfast total = 250mL		*Breakfast total = 330mL*	
Lunch		**Lunch**	
2 slices wholegrain bread or 1 x wrap or 4 rice cakes with scrape of avocado / marg / butter with cheese, 1 cup mixed salad +/- lean meat / egg / tuna / salmon / chicken ½ cup tinned fruit 1 cup tea / coffee / water / juice	125 250	1 cup salt reduced soup +/- bread 1 tub of low fat / diet yoghurt (150g) ½ cup tea / coffee / water / juice	250 120 125
Lunch total = 375mL		*Lunch total = 495mL*	
Dinner		**Dinner**	
100-120g of lean meat / chicken (no skin) / fish baked potato plenty of other mixed cooked vegetables / salad low fat/diet yoghurt (150g) 1 cup tea / coffee / water	120 250	100-120g of lean meat / chicken (no skin) / fish with 1 cup rice / pasta (cooked) plenty of other mixed cooked vegetables / salad ½ cup custard ½ cup tea / coffee / water	100 100 125
Dinner fluid total = 370mL		*Dinner fluid total = 325mL*	
Snack Ideas		**Snack Ideas**	
1 cup of low fat milk 1 thin slice of fruit bread / raw unsalted nuts (2 tablespoons) OR 2-3 grainy crackers with cottage cheese and tomato	250	1 piece of fruit 1 thin slice of fruit bread / raw, unsalted nuts (2 tablespoons) OR 2-3 grainy crackers with cottage cheese and tomato	80
Snack total = 250mL		*Snack total = 80mL*	
Plus 1 additional cup of fluid (water / juice / soda water / tea / coffee)	250	Plus 1 additional cup of fluid (water / juice / soda water / tea / coffee)	250
TOTAL Example 1	**1495mL**	**TOTAL Example 2**	**1480mL**

Control your THIRST

SALT RESTRICTION

- <2g (87mmol/L) / day recommended in PD
- Strategies:
  - Fresh, minimally processed foods
  - Remove salt on table
  - Cook with little/no added salt
  - Use herbs/spices to flavour
  - Limit the use of commercial sauces, dressings and instant products
  - Choose foods with lower sodium content (e.g., <120mg/100g of sodium = best)

GLYCAEMIC CONTROL

- Diet
- PD Prescription – lower glucose strength
- Glucose-lower treatments
  - OHG – DPP4 inhibitors (e.g., linagliptin)
  - Insulin – tailored to individual needs (consider PD prescription); multiple daily injection preferred (mix of long- and short-actings) – if unable premixed 70/30 or 70/25

Food Groups	OK to Eat *Choose these foods every day. One serving has less than 100 mg sodium.*	Eat Sometimes *Choose these foods once in a while. One serving has less than 300 mg sodium.*	Avoid These Foods *Choose these foods rarely. One serving has more than 300 mg of sodium.*
Fruits	• All fruits and fruit juices		
Vegetables	• All fresh, frozen, and canned vegetables with no salt or sauces added	• Most canned vegetables with salt • Low-sodium tomato and V-8 juice	• Regular tomato or V-8 juice • Ready-to-eat tomato sauces • Pickled foods like sauerkraut, olives, and pickles
Meats and Other Protein Foods	• Fresh meats, poultry, and fish (no salt added) • Clams and mussels, steamed • Unsalted peanut butter and nuts • Tuna fish, canned without added salt • Dried beans or peas, cooked without salt • Tofu • Eggs	• Peanut butter • Shellfish, not treated with salt • Canned beans • Frozen meals with less than 300 mg sodium	• Tuna fish, canned with added salt • Fried foods • Salted, smoked, cured, or canned meats • Lunch deli meats • Spam • Corned beef • Hot dogs and sausage • Jerky • Ham and bacon • Frozen meals with more than 600 mg sodium
Dairy	• Unsalted butter • Unsalted cottage cheese • Milk and yogurt	• Buttermilk • Lower sodium cheeses like mozzarella, Swiss, cheddar, ricotta	• High-sodium cheeses like feta, bleu, and goat cheese • Cottage cheese
Cereals, Grains, and Starches	• Plain hot cereal • Shredded wheat or puffed rice cereal • Unsalted corn tortillas, granola, quick breads • Low-sodium breads • Rice, pasta, whole grains, cooked without salt • Unsalted potatoes and squash	• Salted crackers and pretzels • Most cold cereals • Most breads and muffins • Pancakes and waffles	• Stuffing mixes • Cornbread • Rice or noodles prepared with flavor packets
Spices, Seasonings, and Condiments	• Fresh or dried herbs • Powders, not salts (for example, use onion and garlic *powder* instead of onion and garlic *salt*) • Tabasco (no more than 1 tablespoon) • Vinegar, lemon and lime juice • Fresh garlic • Sesame seeds • Allspice • Mrs. Dash and Lawry's salt-free seasonings • Flavored extracts like vanilla and almond	• Some hot sauces (check label for sodium content) • Mayonnaise • Mustard • Low-sodium ketchup	• Most canned soups • Bouillion cubes and prepared broths • Sauces: teriyaki, soy, fish, Worcestershire • Sea salt, regular salt • Baking soda (regular) • Garlic, onion, and other flavored or seasoned salts • Relishes • Monosodium glutamate (MSG) • Meat tenderizers • Ketchup and barbecue sauce • All seasoning packets • Salad dressing • Cheese sauce mixes, such as Alfredo sauce • Olives • Some hot sauces

2 Gram Sodium Diet, University of Washington Medical Centre

Work your KIDNEYS

- Diuretics should be utilised (and 1st therapeutic choice in those with preserved RKF)
- Options include:
  - Loop diuretics – frusemide (up to 500mg/day)
  - Others – HCT, metolazone

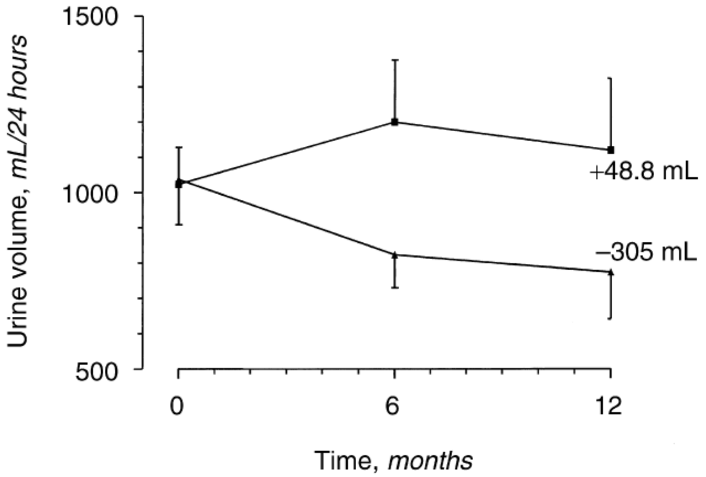


Fig. 1. Evolution of urine volume (UV) over one year of peritoneal dialysis (PD). UV at randomization was comparable between groups. In the diuretic group (■), it remained constant over one year of CAPD, whereas in the control group (▲), UV declined. Data presented are mean ± SEM at each time point.

- 61 incident patients on CAPD randomised 1:1 to 250mg daily frusemide vs. placebo

Table 2. Change in urine volume, urinary sodium, urea and creatinine clearance

	Control	Diuretic	*P* value
Δ Urine volume *mL/month*	−23.3 ± 11.2	+6.47 ± 9.52	0.047
Δ 24-hour urinary sodium *mmol/24 h*	−2.57 ± 1.51	+0.72 ± 0.85	0.041
Δ Creatinine clearance *mL/min/month*	−0.071 ± 0.04	−0.12 ± 0.05	0.45
Δ Urinary Kt/v *per month*	−0.019 ± 0.01	−0.020 ± 0.01	0.92

Medcalf JF et al, KI 2001; 59: 1128-33

Efficacy of triple diuretic treatment in continuous ambulatory peritoneal dialysis patients: A randomized controlled trial

Raweewan Witoon, Somchai Yongsiri, Prapan Buranaburidej, Pacharin Nanna

Table 2. Overhydration measured by BIS in the single diuretic group and the triple diuretic group at baseline, 3rd month, and 6th month of study

	Single diuretic	Triple diuretics	*P* value
OH (L)			
Baseline	2.27 ± 2.35	2.94 ± 2.08	0.34
3rd month	2.03 ± 1.80	1.03 ± 0.68	0.01
6th month	2.78 ± 2.42	1.39 ± 1.64	0.06
ΔOH (L)			
3rd month vs. baseline (OH 3rd month–OH baseline)	1.84 ± 2.27	0.44 ± 1.62	0.03
6th month vs. baseline (OH 6th month–OH baseline)	1.49 ± 2.82	–0.48 ± 2.61	0.02

Data are presented as mean ± standard deviation.
BIS, bioimpedance spectroscopy; OH, overhydration.

Table 1. Baseline demographic features of both groups

Baseline characteristic	All patients (n = 51)	Single diuretic (n = 27)	Triple diuretics (n = 24)	*P* value
Sex, female/male	30/21	18/9	12/12	0.265
Age (yr)	59.29 ± 9.81	59.25 ± 10.37	58.5 ± 6.79	0.768
Comorbidity				
Diabetes	34 (66.7)	17 (63.0)	17 (70.8)	0.767
Hypertension	36 (70.6)	17 (63.0)	19 (79.2)	0.235
Dyslipidemia	4 (7.8)	2 (7.4)	2 (8.3)	0.999
Dialysis vintage (mo)	12.19 ± 13.95	11.74 ± 14.42	17.17 ± 17.18	0.231
Residual urine volume (mL)	855.00 ± 508.92	870.74 ± 474.38	837.50 ± 620.53	0.832
< 100 mL	2 (3.9)	0 (0)	2 (8.3)	0.402
100–500 mL	19 (37.3)	10 (37.0)	9 (37.50)	
501–1,000 mL	9 (17.7)	6 (22.2)	3 (12.50)	
> 1,000 mL	21 (41.2)	11 (40.7)	10 (41.7)	
Peritoneal membrane type				
Low	1 (2.0)	0 (0)	1 (4.2)	0.061
Low average	19 (37.3)	6 (22.2)	13 (54.2)	
High average	16 (31.4)	11 (40.7)	5 (20.8)	
High	3 (5.9)	1 (3.7)	2 (8.3)	
No data	12 (23.5)	9 (33.3)	3 (12.5)	
Dialysis adequacy				
Kt/V urine	0.64 ± 0.98	0.68 ± 1.22	0.60 ± 0.69	0.772
Kt/V PD	1.85 ± 0.40	1.91 ± 0.41	1.80 ± 0.38	0.325
Kt/V total	2.48 ± 0.99	2.59 ± 1.22	2.38 ± 0.72	0.453
Renal CCr (L/wk/1.73 m^2)	24.50 ± 31.42	20.33 ± 34.32	28.49 ± 28.58	0.359
PD CCr (L/wk/1.73 m^2)	43.57 ± 20.01	39.50 ± 27.10	47.46 ± 8.19	0.156
Daily net glucose exposure	139.54 ± 39.21	138.54 ± 25.21	144.21 ± 43.27	0.590
Antihypertensive drugs				
Angiotensin converting enzyme inhibitors	5 (9.8)	2 (7.4)	3 (12.5)	0.656
Angiotensin receptor blockers	30 (58.8)	15 (55.6)	15 (62.5)	0.777
Calcium channel blockers	14 (27.5)	10 (37.0)	4 (16.7)	0.127
Beta blockers	31 (60.8)	19 (70.4)	12 (50.0)	0.161
Others	16 (31.4)	10 (37.0)	6 (25.0)	0.385
Diuretic drugs				
Loop diuretics	51 (100)	27 (100)	24 (100)	0.999
Thiazide	0 (0)	0 (0)	0 (0)	0.999
Spironolactone	1 (2.0)	1 (3.7)	0 (0)	0.999

No difference in adverse events

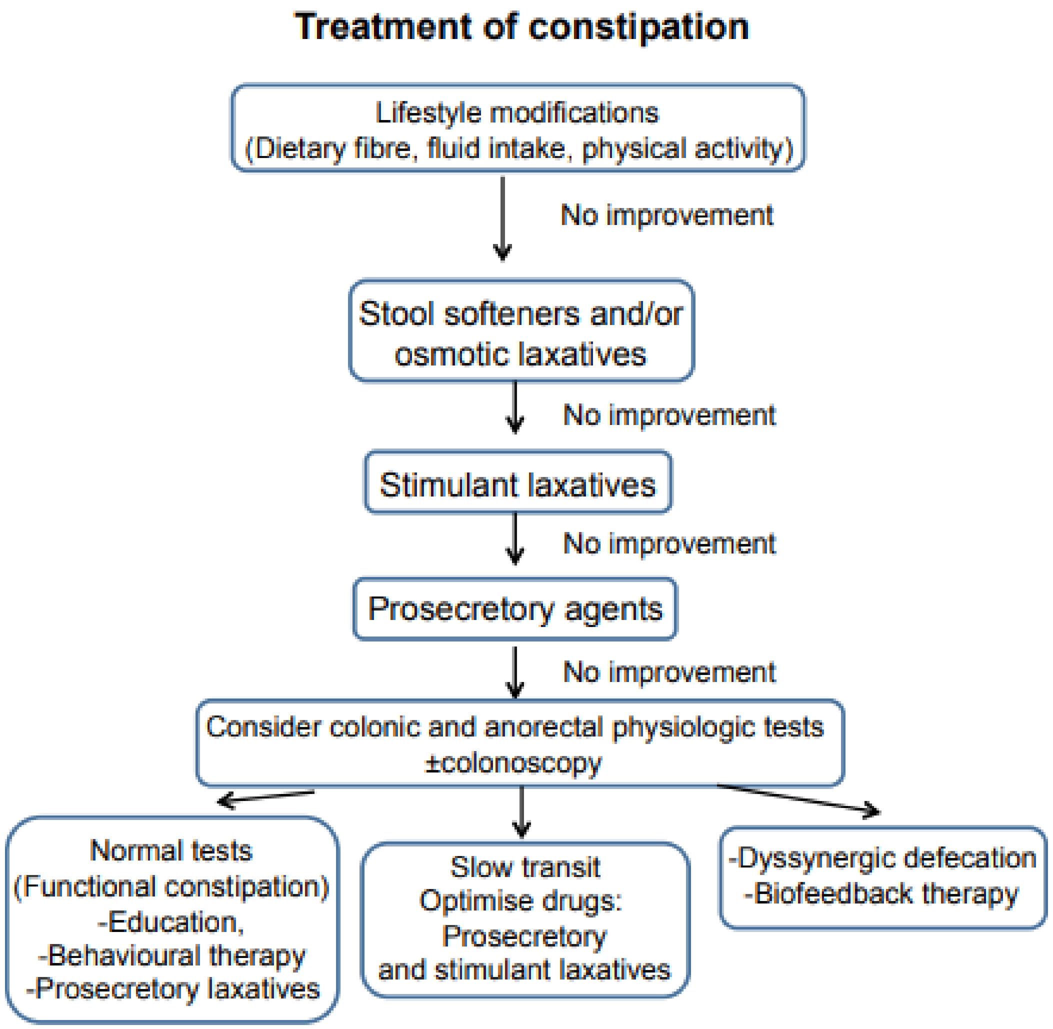
Witoon R et al, Kidney Res Clin Pract 2019; 38: 108-15

Make sure PD is working (optimally)

- **Rule out constipation**
- **Ensure proper adherence to prescription**
- Rule out catheter flow dysfunction
- Rule out hernias/leaks
- **Optimise PD prescription with cautious increase in concentration of dextrose-based solutions as needed**

Avoid Constipation

Laxative class	Site of action	Mechanisms of action	Medication	Adverse events
Bulk-producing agents	Small and large bowel	Retain water in stool improving consistency and peristalsis	Psylium Methylcellulose Dietary fiber Calcium polycarbophil	Flatulence, bloating, abdominal distension
Emollient stool softeners	Colon	Soften stool by promoting luminal water binding/ detergent-like action	Docusate sodium and calcium	Diarrhea, Intestinal cramping
Stimulants	Colon	Stimulate colonic contractions/decrease intestinal water absorption	Senna Aloe Bisacodyl Sodium picosulfate Magnesium hydroxide	Abdominal discomfort and cramps, nausea, vomiting, diarrhea, rectal irritation DO NOT use if concern for obstruction
Osmotic laxatives	Colon	Osmotic water binding	Polyethylene glycol Lactulose Milk of magnesia Magnesium citrate/sulfate	Bloating, cramps, flatulence, electrolyte disturbance



Kosmadakis G et al, PDI 2019; 39(5): 399-404

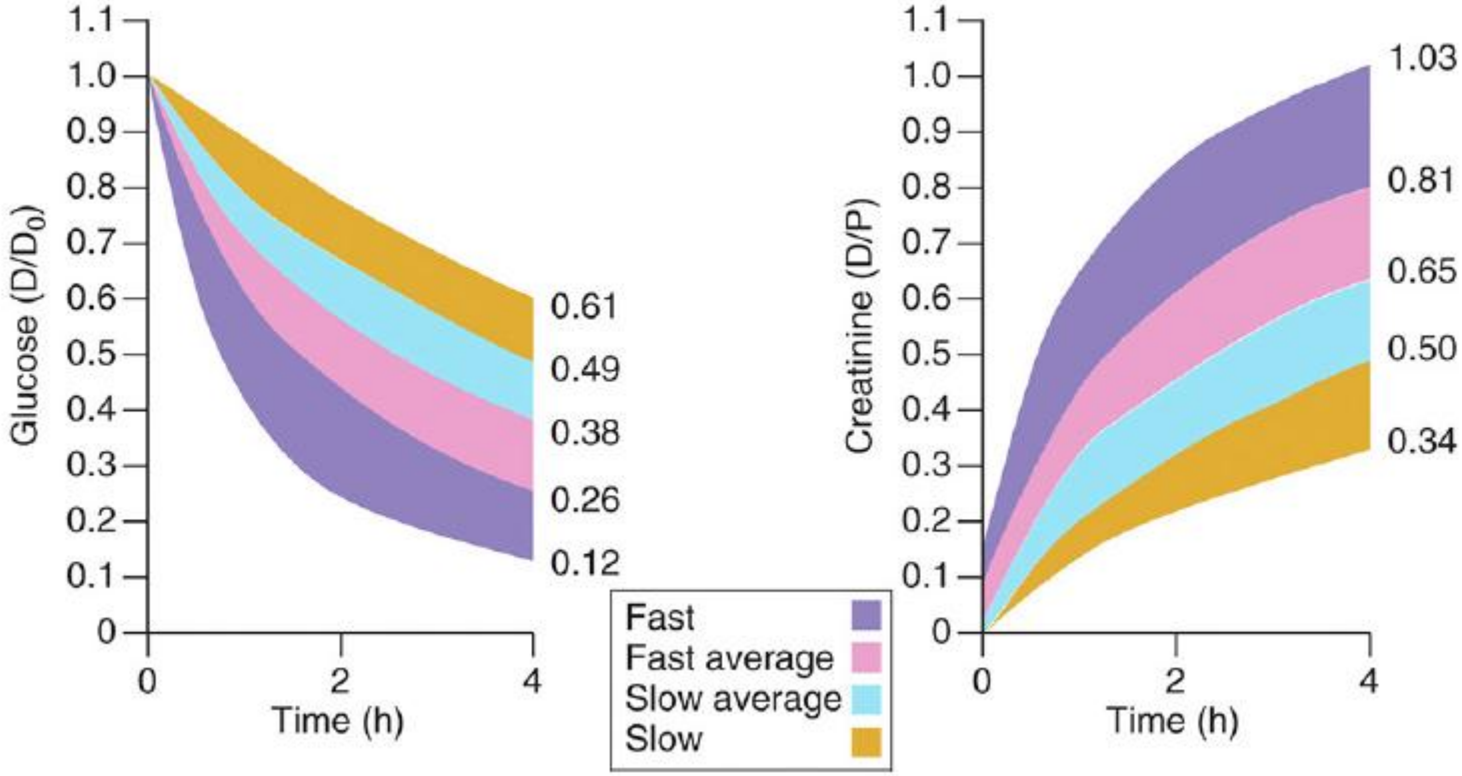
Check Adherence to PD and implement timely intervention

Table 3:

Number of adverse events and the IRR for events in group APD versus events in group RM-APD,

Type of event	Crude APD/RM-APD	IRR (95% CI)	P > |z|
PD infection events	100/86 (P = .12)	1.28 (0.69–2.37)	.42
Mechanical events	**33/62 (P = .001)**	**0.42 (0.18–0.98)**	**.04**
Intra-abdominal pressure events	6/13 (P = .07)	0.48 (0.16–1.40)	.18
Fluid balance events	**123/35 (P = .001)**	**3.44 (1.95–6.07)**	**.001**
Cardiovascular events	**79/44 (P = .02)**	**1.81 (1.03–3.09)**	**.03**
Metabolic events	**108/44 (P = .001)**	**2.78 (1.51–5.38)**	**.005**
Other events	53/77 (P = .005)	1.01 (0.45–2.29)	.97
Mechanical hospitalization events	**18/45 (P = .004)**	**0.41 (0.22–0.66)**	**.001**
FOL and IDE hospitalizations	**19/7 (P = .01)**	**3.24 (1.24–7.53)**	**.03**
All-cause deaths	**55/33 (P = .01)**	**1.82 (1.18–2.81)**	**.006**
Cardiovascular deaths	**24/13 (P = .05)**	**2.03 (1.03–3.97)**	**.04**

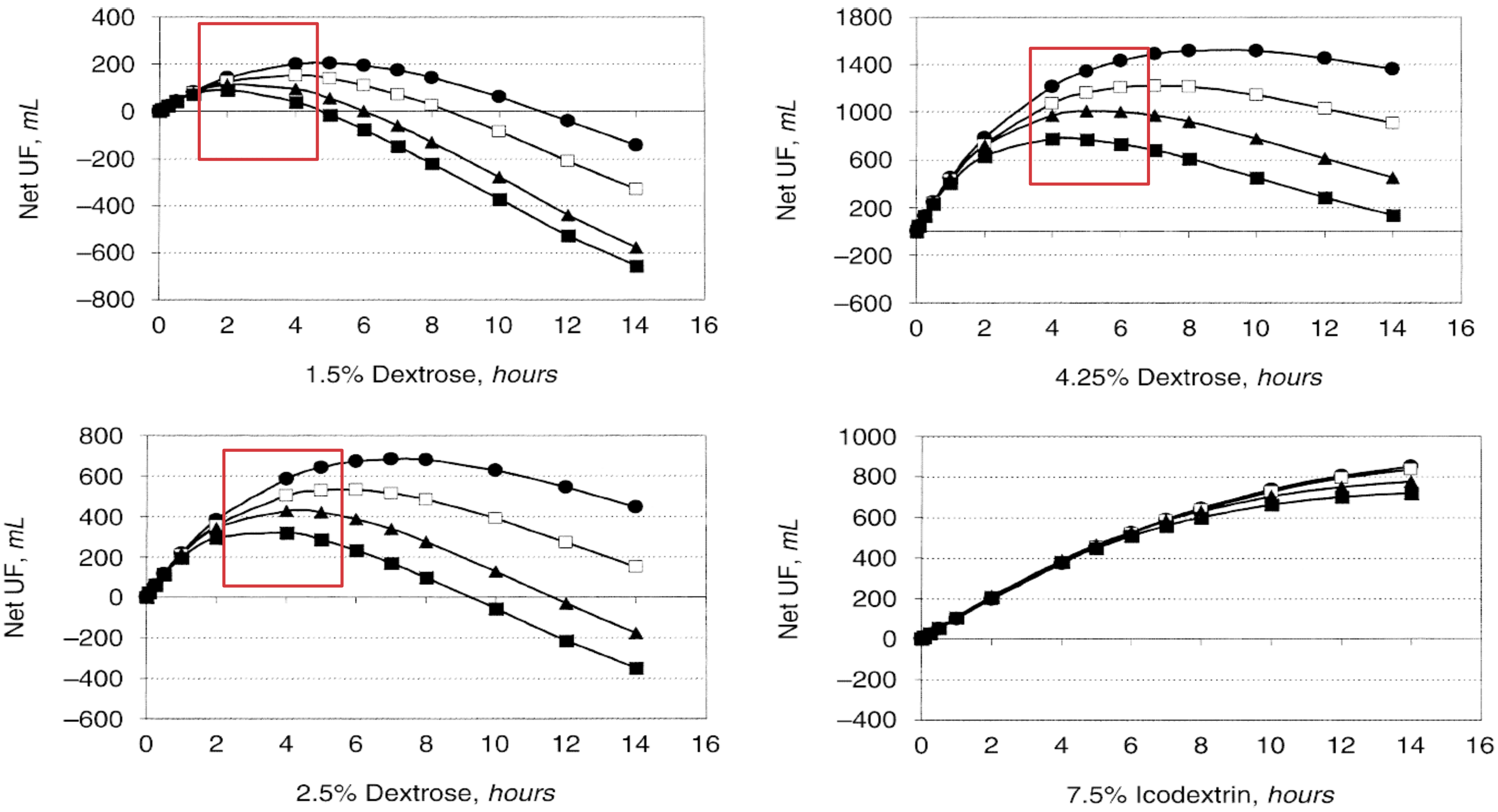
Optimise PD Prescription



Auguste BL & Bargman JM. AJKD 2022; 81(1): 100-9

Fast vs. Slow

Fast (high) Transporter	Slow (low) Transporter
• Reach urea/creatinine equilibrium quickly • **Reduction in dialysate volume after ~2 hrs** (glucose absorption) • Reduction in creatinine clearance after 4 hrs (convective creatinine re-absorption) • Short dwells more effective • APD often useful • Icodextrin useful	• Solute $D/P_{urea/creatinine}$ increases progressively • UF continues **late** into dwell • Clearance continues to increase with longer dwell times • CAPD – (or APD (CCPD) but often less effective)



(●) low transport; (□) low average transport; (▲) high average transport; (■) high transport group.

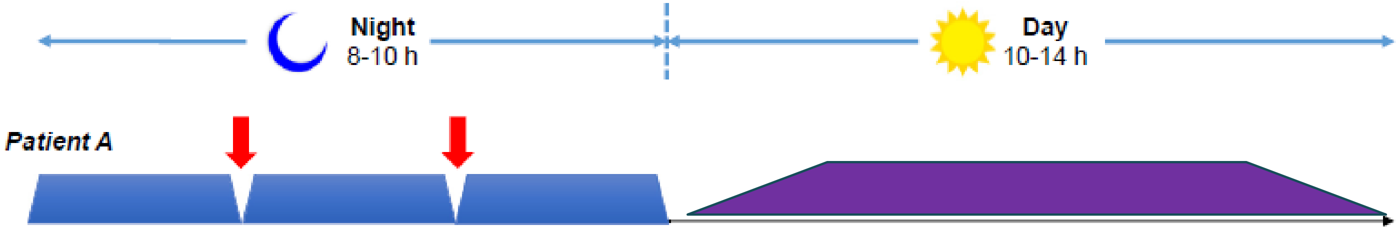
Mujais S & Vonesh E, KI 2002; 62 (81): S17-S22

Special Series/Guidelines

ISPD recommendations for the evaluation of peritoneal membrane dysfunction in adults: Classification, measurement, interpretation and rationale for intervention

Johann Morelle [1], Joanna Stachowska-Pietka [2], Carl Öberg [3], Liliana Gadola [4], Vincenzo La Milia [5], Zanzhe Yu [6], Mark Lambie [7], Rajnish Mehrotra [8], Javier de Arteaga [9], and Simon Davies [7]

Guideline 2b: *Clinical implications and mitigation of fast solute transfer:* A faster PSTR is associated with lower survival on PD. (**GRADE 1A**) This risk is in part due to the lower ultrafiltration (UF) and increased net fluid reabsorption that occurs when the PSTR is above the average value. The resulting lower net UF can be avoided by shortening glucose-based exchanges, using a polyglucose solution (icodextrin), and/or prescribing higher glucose concentrations. (**GRADE 1A**) Compared to glucose, use of icodextrin can translate into improved fluid status and fewer episodes of fluid overload. (**GRADE 1A**) Use of automated PD and icodextrin may mitigate the mortality risk associated with fast PSTR. (**practice point**)



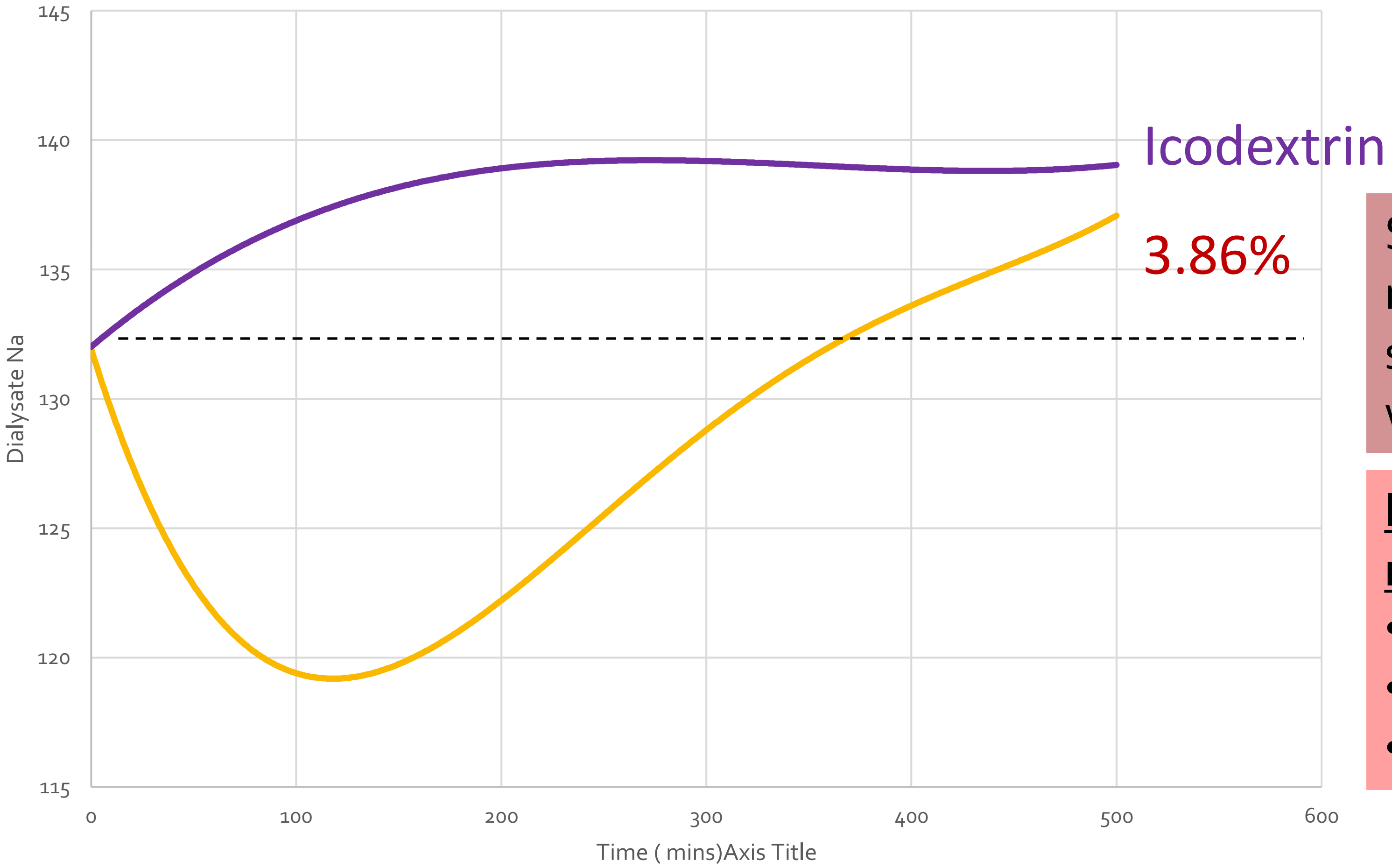
Predicted UF =

~ 300mL X 3 (2.5%, 3 hour dwell)
+ 600mL (7.5% 10 hour)
=
1.5L

Morelle J et al, PDI 2021; 41(4): 352-72
Auguste BL & Bargman JM. AJKD 2022; 81(1): 100-9

Consider sodium sieving..

-**Crystalloid osmotic gradient** (glucose)
-**Colloid osmotic agent** (icodextrin)



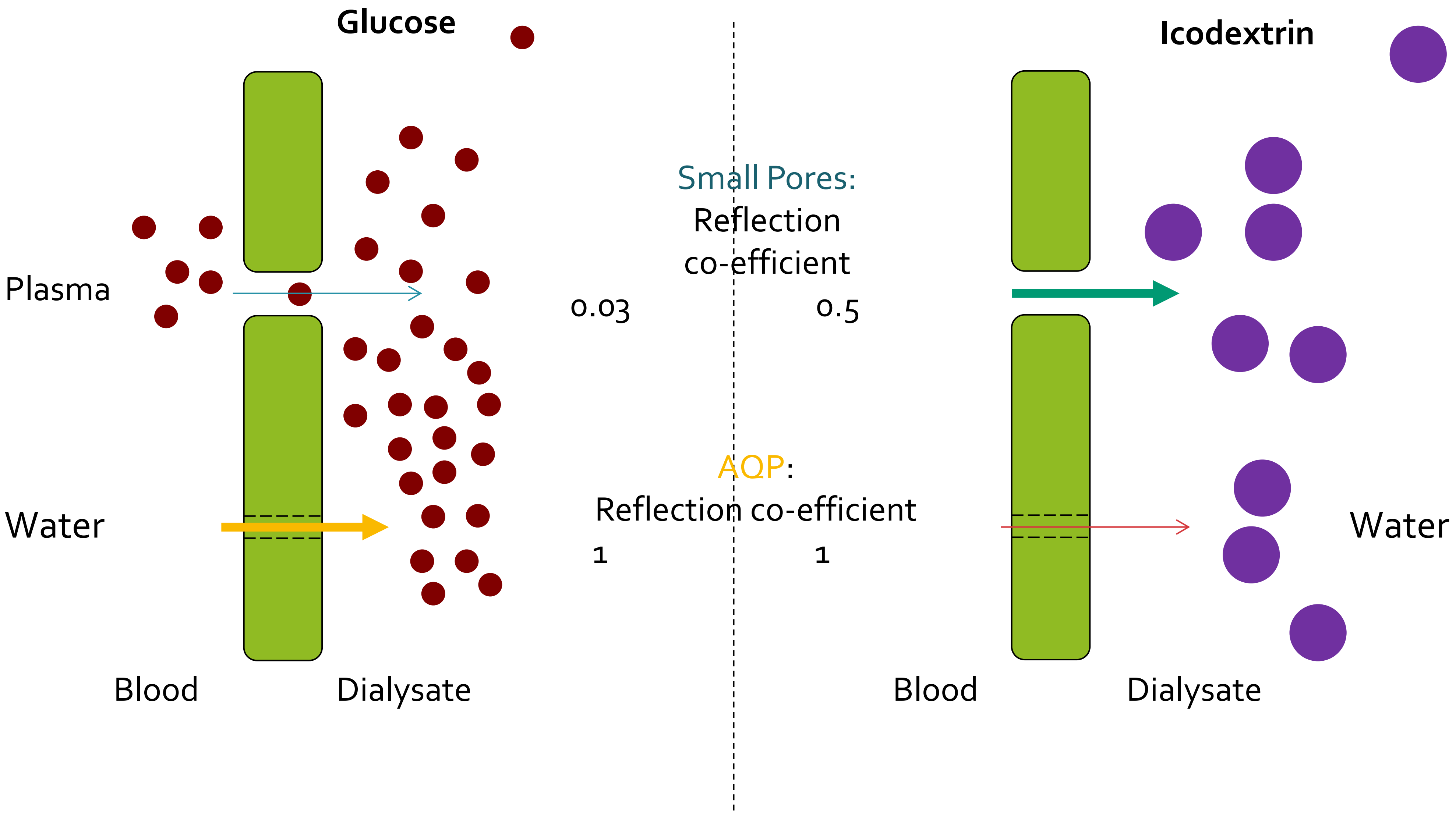
Short dwell may mean that in *less* sodium removed cf water.

Inadequate sodium removal

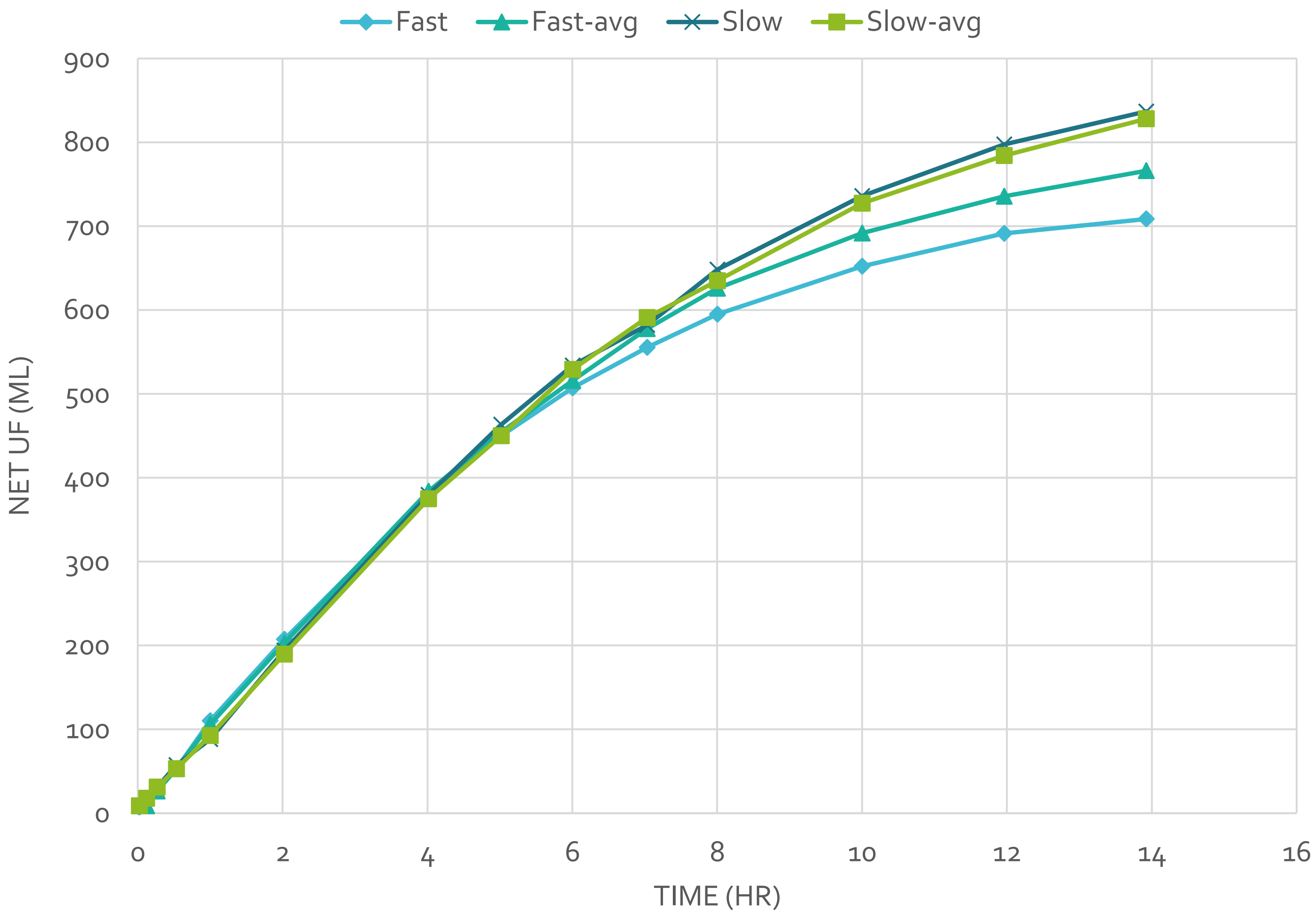
- Thirst
- Hypertension
- LVH.

Rippe, B. & Davies, S., 2011. Permeability of peritoneal and glomerular capillaries: what are the differences according to pore theory? *PDI* 31(3), pp.249–258.

OSMOTIC pressure drives **ONCOTIC** pressure drives

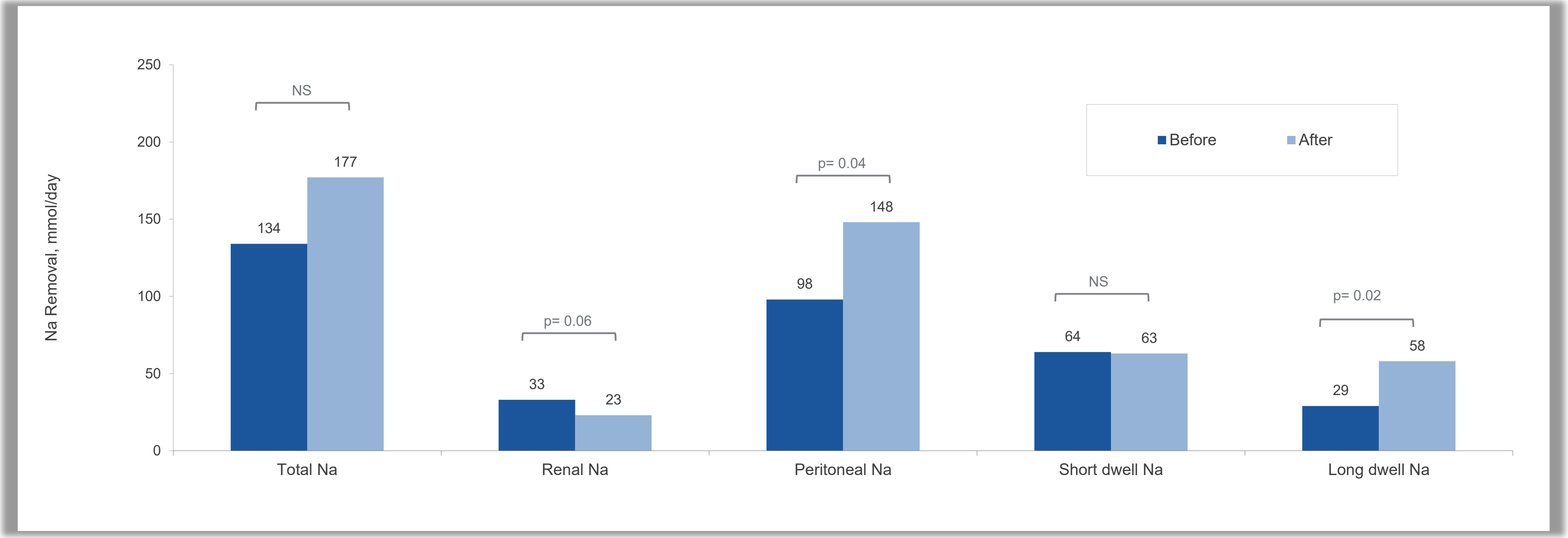


Sustained UF with icodextrin



Mujais S, et al. Kidney Int Suppl. 2002;(81):S17-S22.

Icodextrin can remove higher levels of sodium during the long dwell when compared to glucose

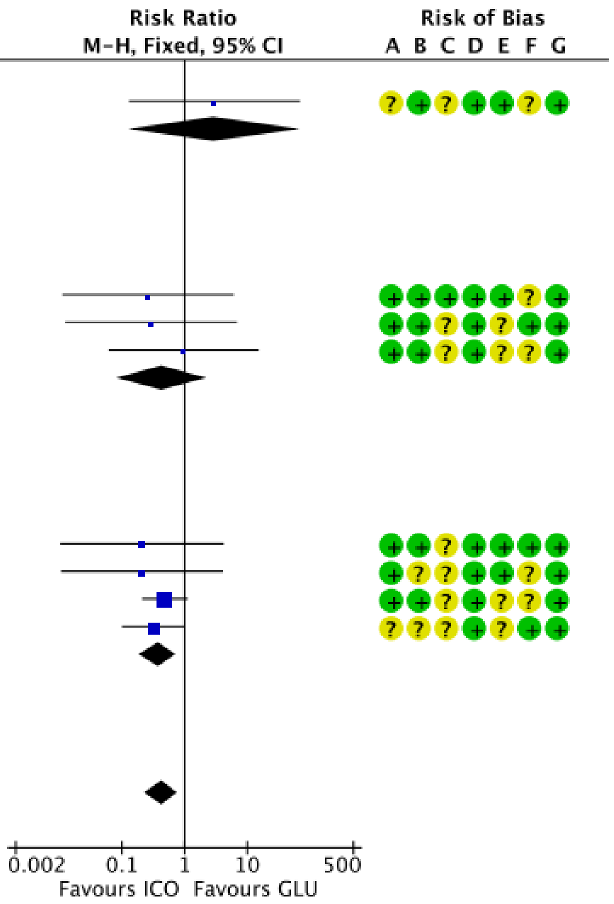


Sodium Removal before and after introduction of icodextrin in 16 CAPD and APD patients.

Rodríguez–Carmona, et al. Peritoneal dialysis international. 2002;22(6):705-713.

Significantly lower risk of uncontrolled fluid overload with icodextrin use

Study or Subgroup	ICO Events	ICO Total	GLU Events	GLU Total	Weight	Risk Ratio M-H, Fixed, 95% CI
2.6.1 ≤ 6 weeks						
Yu 2002	1	22	0	22	1.6%	3.00 [0.13, 69.87]
Subtotal (95% CI)		**22**		**22**	**1.6%**	**3.00 [0.13, 69.87]**
Total events	1		0			
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.68 (P = 0.49)						
2.6.2 3–6 months						
Davies 2003	0	27	1	21	5.4%	0.26 [0.01, 6.12]
de Moraes 2015	0	31	1	27	5.1%	0.29 [0.01, 6.88]
Mistry 1994	1	106	1	103	3.3%	0.97 [0.06, 15.33]
Subtotal (95% CI)		**164**		**151**	**13.8%**	**0.44 [0.08, 2.32]**
Total events	1		3			
Heterogeneity: $Chi^2 = 0.49$, df = 2 (P = 0.78); $I^2 = 0\%$						
Test for overall effect: Z = 0.97 (P = 0.33)						
2.6.3 1–2 years						
Chang 2016	0	49	2	51	7.9%	0.21 [0.01, 4.23]
Chen 2018	0	21	2	22	7.9%	0.21 [0.01, 4.11]
Paniagua 2009	6	30	12	29	39.2%	0.48 [0.21, 1.12]
Takatori 2011	3	21	9	20	29.6%	0.32 [0.10, 1.01]
Subtotal (95% CI)		**121**		**122**	**84.6%**	**0.37 [0.20, 0.72]**
Total events	9		25			
Heterogeneity: $Chi^2 = 0.73$, df = 3 (P = 0.87); $I^2 = 0\%$						
Test for overall effect: Z = 2.97 (P = 0.003)						
Total (95% CI)		**307**		**295**	**100.0%**	**0.43 [0.24, 0.76]**
Total events	11		28			
Heterogeneity: $Chi^2 = 2.74$, df = 7 (P = 0.91); $I^2 = 0\%$						
Test for overall effect: Z = 2.89 (P = 0.004)						
Test for subgroup differences: $Chi^2 = 1.62$, df = 2 (P = 0.45), $I^2 = 0\%$						



Goosen K et al, AJKD 2020; 75(6): 830-6

Utility of Hybrid dialysis

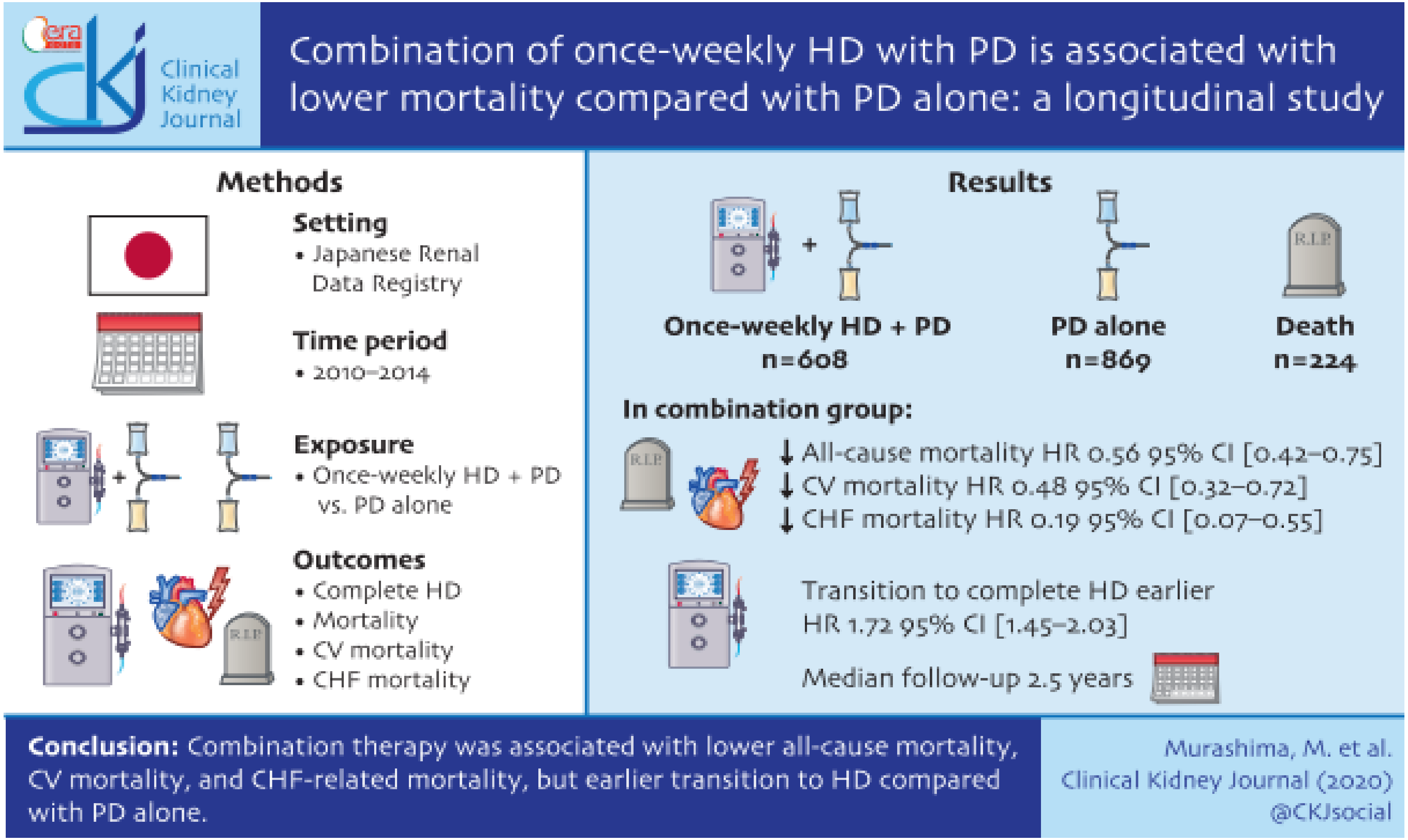
- Combining PD with HD to achieve better solute and volume control
- Involves adding 1-2 HD sessions/week to a 5- to 7-day per week PD regimen.
- Majority of the published reports on hybrid dialysis comes from Japan

Table 4 Changes in clinical and biochemical parameters

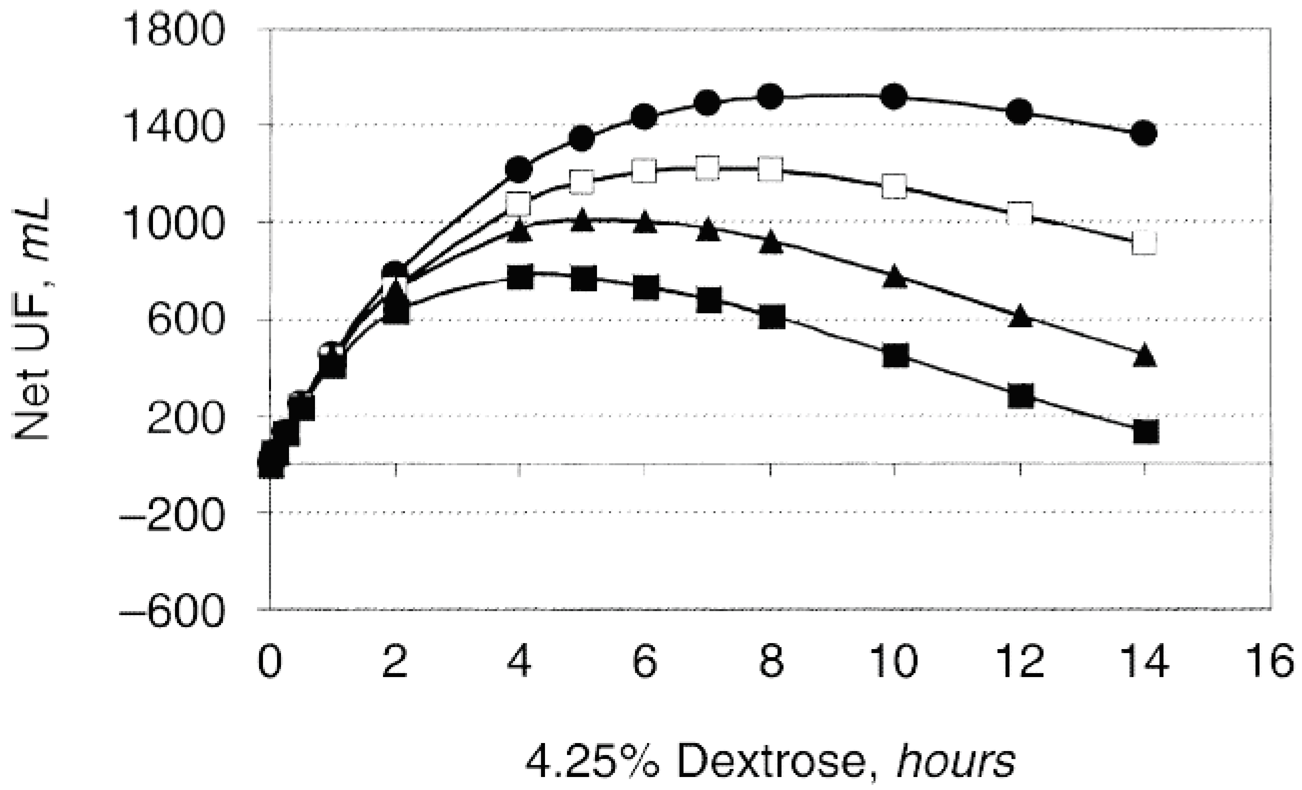
Author, year	Follow-up	BW	BP	Urine volume	Cr	β2m	Hb	D/P Cr
Kanno, 2003 [11]	3 months				Decreased			
Kawanishi, 2006 [14]	24 months	Decreased	Decreased	Decreased	Decreased	Unchanged		
Hoshi, 2006 [15]	36 months		Decreased		Unchanged		Increased	
Kawanishi, 2007 [16]	6 months					Decreased		Unchanged or decreased
Matsuo, 2010 [18]	12 months	Decreased	Decreased	Decreased	Decreased	Decreased	Increased	Decreased
Tanaka, 2011 [19]	9 months	Decreased	Decreased	Unchanged	Decreased		Increased	
Maruyama, 2014 [21]	3 months	Decreased	Unchanged	Decreased	Decreased	Unchanged	Increased	Decreased

BW body weight, *BP* blood pressure, *Cr* creatinine, *β2m* β2 microglobulin, *Hb* hemoglobin, *D/P Cr* dialysate-to-plasma ratio of creatinine

Maruyama Y & Yokoyama K, Renal Replace T 2016


era
Clinical Kidney Journal
Combination of once-weekly HD with PD is associated with lower mortality compared with PD alone: a longitudinal study
Methods
Setting
• Japanese Renal Data Registry
Time period
• 2010–2014
Exposure
• Once-weekly HD + PD vs. PD alone
Outcomes
• Complete HD
• Mortality
• CV mortality
• CHF mortality
Results
+
Once-weekly HD + PD n=608
PD alone n=869
R.I.P.
Death n=224
In combination group:
↓ All-cause mortality HR 0.56 95% CI [0.42–0.75]
↓ CV mortality HR 0.48 95% CI [0.32–0.72]
↓ CHF mortality HR 0.19 95% CI [0.07–0.55]
Transition to complete HD earlier HR 1.72 95% CI [1.45–2.03]
Median follow-up 2.5 years
Conclusion: Combination therapy was associated with lower all-cause mortality, CV mortality, and CHF-related mortality, but earlier transition to HD compared with PD alone.
Murashima, M. et al.
Clinical Kidney Journal (2020)
@CKJsocial

What about in Acute Fluid Overload – is it time for



Mujais S & Vonesh E, KI 2002; 62 (81): S17-S22

Take Home Message

- Fluid overload is common in PD (in both incident and prevalent patients) and an important (modifiable) cause of harm (including CVE, mortality, HD t/f)
- Target weight = symptom free + euvolaemic + normotensive
- In order to succeed in fluid management, we need to address both non-PD and PD-related issues:
  - Salt, fluid, glycaemic control
  - Maximise RKF – diuretic use
  - Optimal bowel management
  - Tailored PD prescription (and ensure adherence)

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