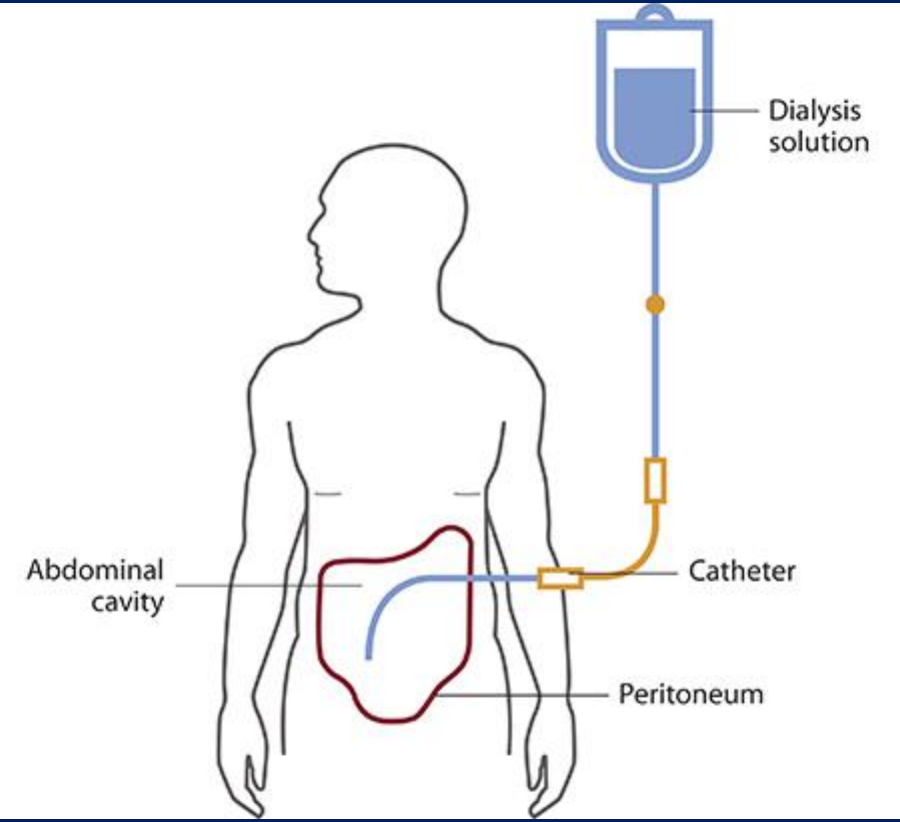
Adequacy of Peritoneal Dialysis



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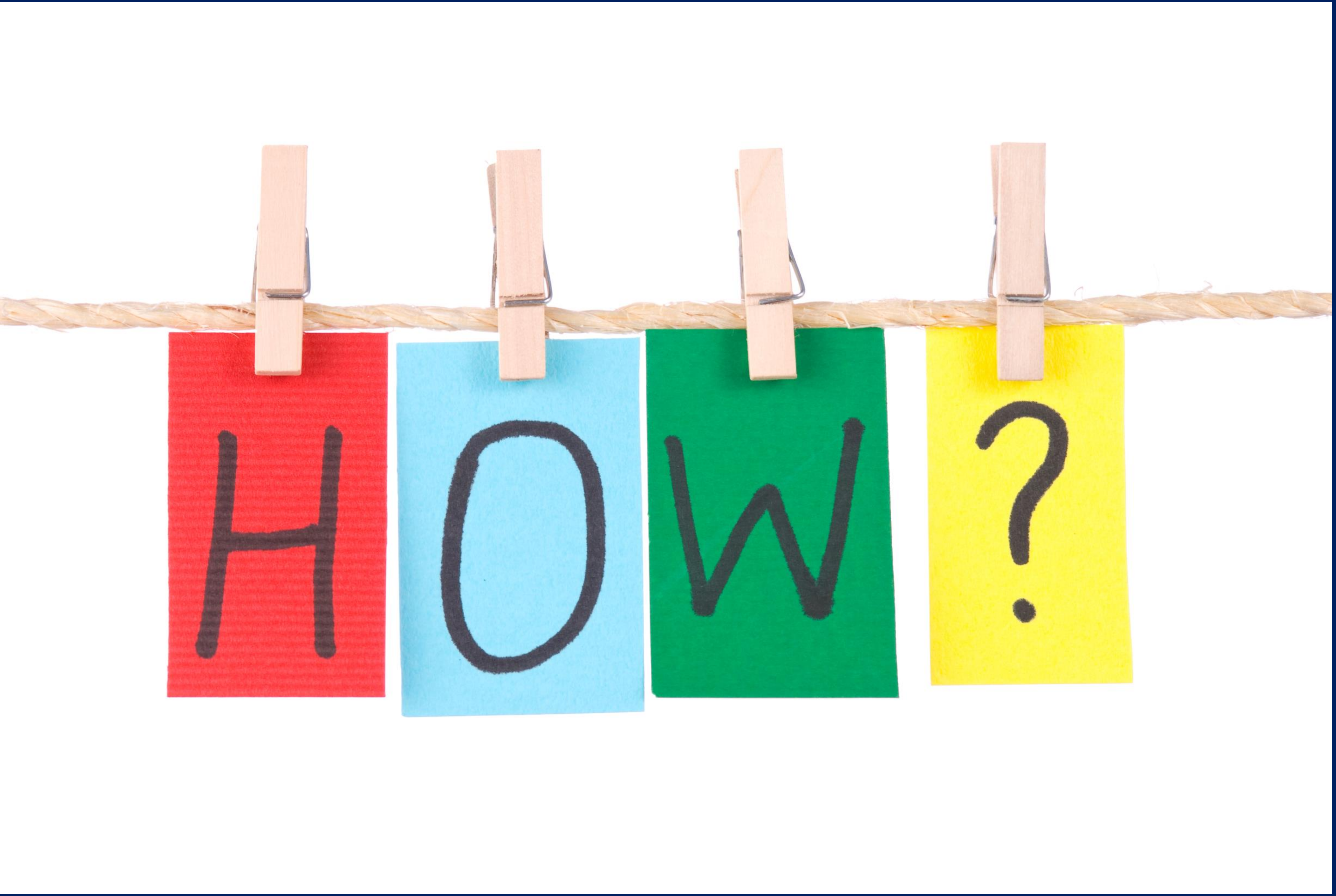
Outline

- How to measure dialysis adequacy in a PD patient?
- When to measure dialysis adequacy in a PD patient?
- What is an adequate PD prescription?
- Does measuring adequacy influence the prescription?


HOW?

Solute clearance

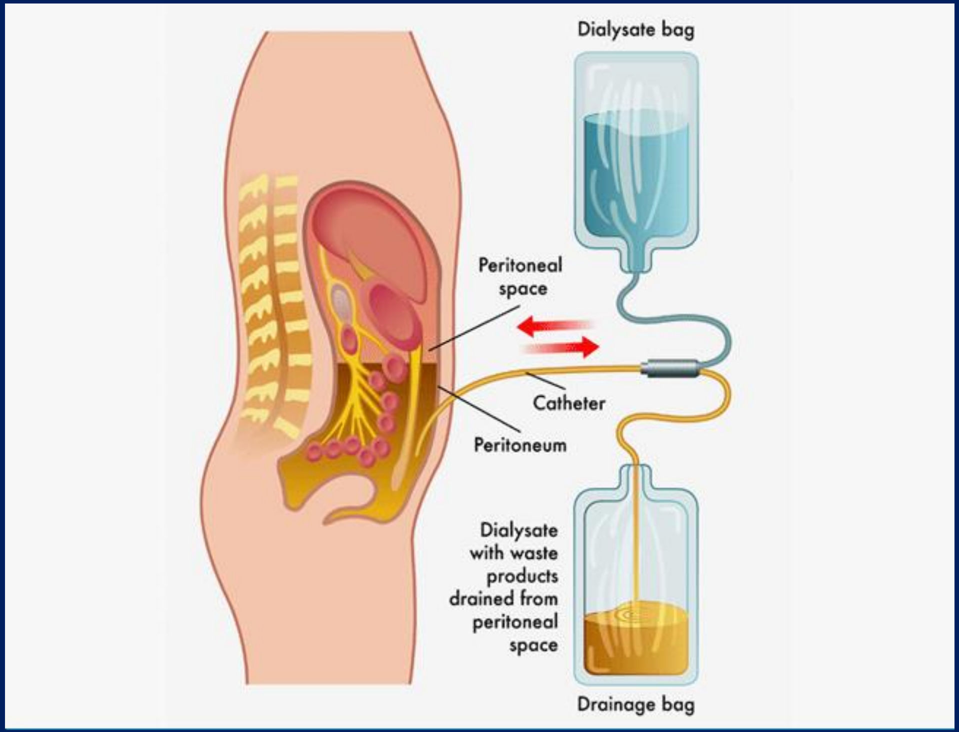
~~Fluid removal~~

ROUTINE MONITORING FOR ADEQUATE CLEARANCE

- Volume status
- Uremic symptoms
- BUN, creatinine, and electrolytes

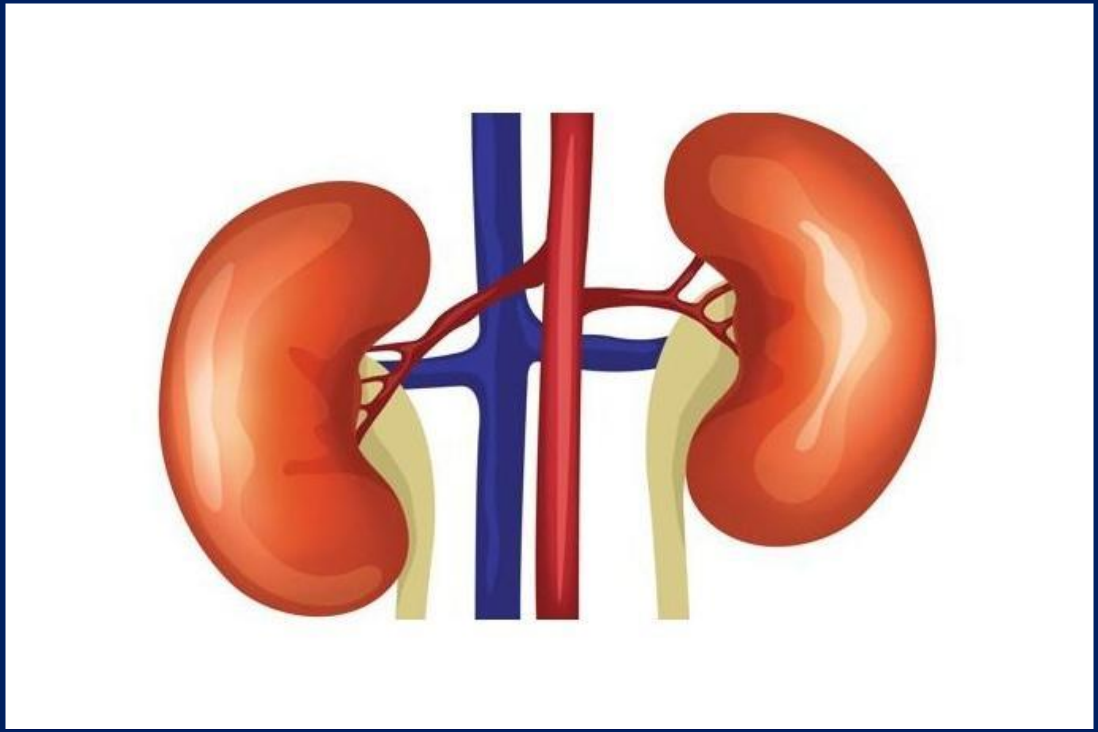
Solute clearance is the amount of blood that is cleared of a substance over a unit of time (ie, in mL/min).

Dialysis



Native kidney function

(residual renal function)



Measurement of Solute Clearance

- Dialysis adequacy is an important issue for patients treated with PD.
- The minimum effective dialysis dose is typically determined by measuring small solute clearance.
- Common methods used to measure small solute clearance include Kt/Vurea and the peritoneal creatinine clearance (CCr).

WEEKLY DIALYSIS CLEARANCE

Weekly Dialysis Clearance is calculated using the simple formula:
24-hr D/P* x 24-hr Drained Volume (Liters) x 7[11]

$$\text{DIALYSIS } KT/V_{UREA} = \frac{\text{24-hr D/P Urea} \times \text{24-hr Drained Volume} \times 7}{\text{Volume of Urea Distribution}}$$

$$\text{RENAL } KT/V = \frac{\text{24-hr U/P** Urea} \times \text{24-hr Urine Volume} \times 7}{\text{Volume of Urea Distribution}}$$

$$\text{*D/P} = \frac{\text{Dialysate concentration}}{\text{Plasma concentration}} \qquad \text{**U/P} = \frac{\text{Urine concentration}}{\text{Plasma concentration}}$$

CREATININE CLEARANCE (C_{CR})

Creatinine Clearance (C_{Cr}) is normalized to a set standard of 1.73m^2 Body Surface Area (BSA). Please refer to the Body Surface Area chart in the Appendix of this guide to determine BSA.

DIALYSIS C_{CR} L/WEEK =	24-hr D/P Cr x 24-hr Drained Volume x 7 x (1.73m^2 BSA/Patient's BSA)
RENAL C_{CR} L/WEEK =	24-hr U/P Cr x 24-hr Urine Volume x 7 x (1.73m^2 BSA/Patient's BSA)

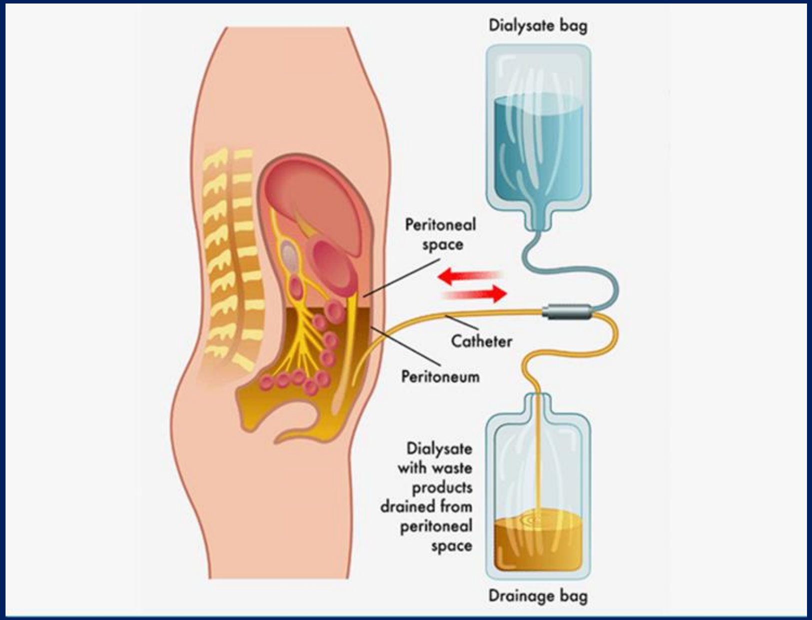
For those patients with renal function, their residual function is added to the calculated dialysate clearance for a total clearance. For further information about calculating clearance, contact your Baxter Clinical Educator.

Measurement of Solute Clearance

The weekly Kt/Vurea is now the preferred method for measuring small solute clearance.

Although the Kt/V and peritoneal CCr usually correlate, they are occasionally discrepant.

Total clearance= PD + Renal



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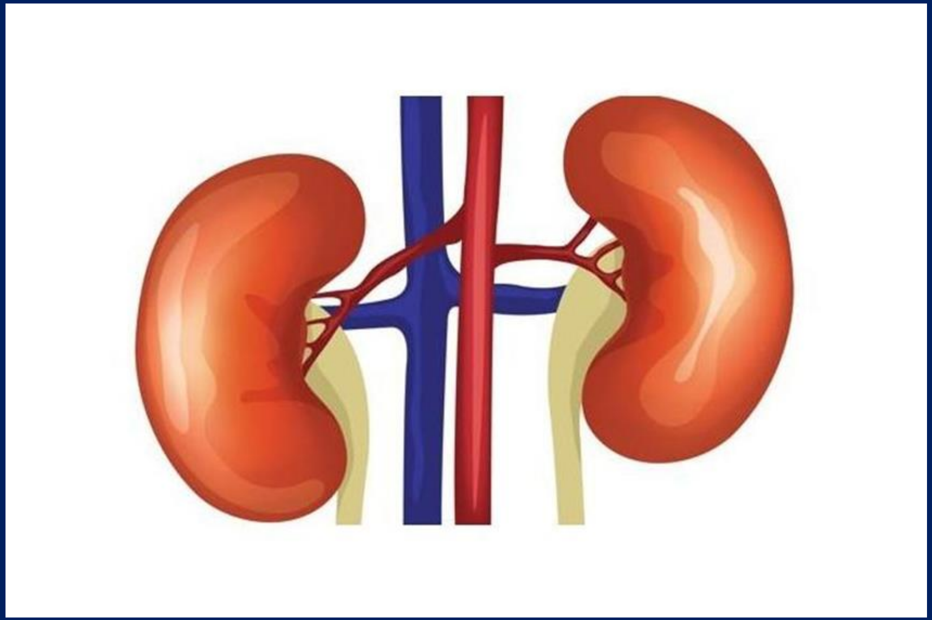
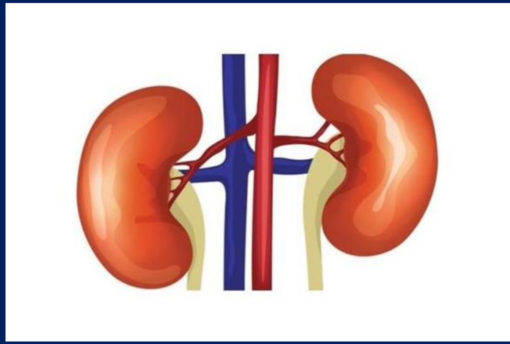


RRF and solute clearance

- RRF has historically been included in total clearance for PD for the following reasons:
  - Easy for PD patients to provide 24-hour urine collections
  - RRF is often preserved in PD patients but not in hemodialysis patients. As a result, RRF contributes a greater proportion to total clearance and typically for longer periods of time.



INTERNATIONAL CLINICAL PRACTICE GUIDELINE RECOMMENDATIONS

	KT/V_{UREA} (PER WEEK) RENAL + PERITONEAL	C_{CR} (PER WEEK) RENAL+ PERITONEAL	UF (PER DAY)
KDOQI (US) 2006[4]	≥ 1.7	X	X
ISPD 2006[6]	≥ 1.7	APD > 45 L/wk	X
Canadian Society of Nephrology 2011[5]	≥ 1.7	X	X
European Best Practice Guidelines 2005[7]	≥ 1.7	APD > 45 L/wk for patients with slow transport status	1.0 L/day in anuric patients
CARI (Australia) 2005[9]	≥ 1.6	High/high-average transport > 60 L/wk Low/low-average transport > 50 L/wk	X
UK Renal Association 2007[8]	≥ 1.7	≥ 50 L/wk	≥ 750 mL/day in anuric patients

X = no recommendation


WHEN?

ROUTINE MONITORING FOR ADEQUATE CLEARANCE

- Volume status
- Uremic symptoms
- BUN, creatinine, and electrolytes

SUGGESTED TIMETABLE FOR INITIAL AND SUBSEQUENT CLEARANCE MEASUREMENTS

MEASUREMENT	FREQUENCY
Peritoneal Kt/V_{urea}	Baseline within first month, then every 4 months (or as needed if clinical change warrants)
Renal Kt/V_{urea} (only if urine volume is >100 mL/day and residual kidney clearance is being considered as part of the patient's total weekly solute clearance goal)	Baseline at first month, then every 2 months (or sooner if clinical change warrants)
PET	Baseline at 4–8 weeks (then as needed if clinical change warrants)*

Inadequate Solute Clearance in Peritoneal Dialysis

EVALUATION

- The major clinical findings associated with inadequate dialysis are volume overload, a progressively increasing blood urea nitrogen (BUN), and, occasionally, uremic symptoms.

Causes of increased BUN

Causes of increased BUN

- **Increased production:**
  - Dietary noncompliance
  - Hypercatabolism:
    - Illness (such as infection), increased tissue breakdown, metabolic acidosis, hyperthyroidism, or glucocorticoid use
  - Gastrointestinal bleeding

- **Decreased clearance**:
  - Noncompliance with the dialysis
  - Loss of RRF
  - Low PD solute clearance

→ PET

Reduced PD solute clearance (Kt/Vurea)

- Low transporters:
  - ↑ volume of inflow dialysate per exchange.
  - Transfer of the patient to hemodialysis may be necessary if no improvement.

- High transporters:
  - ↑ volume per exchange and ↓ the dwell time.

kt/V vs ClCrt?

Total clearance= PD + Renal

Total kt/V= PD + Renal

Total ClCrt= PD + Renal

Total weekly kt/V=1.7

Total weekly ClCrt.=45 L

Correlation Between kt/V & Crt clearance

- The correlation between Kt/Vurea and ClCr is affected by three factors:
  - RRF
  - Peritoneal transport rate
  - Weight

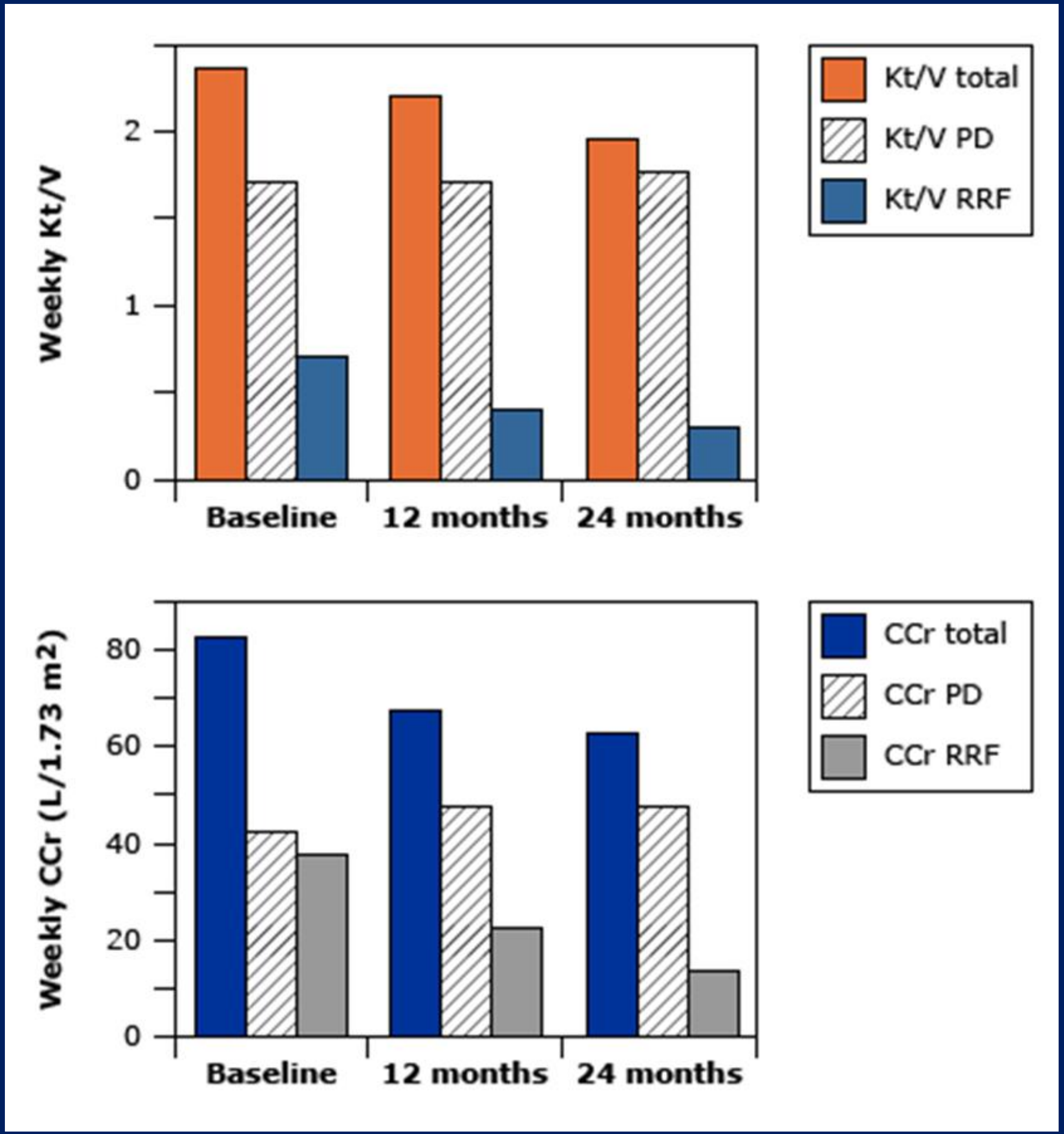
CCr/Kt/V =30

RRF ≈ CCr/Kt/V

CCr overestimates and urea clearance underestimates renal solute clearance.

Total solute clearance over time, as measured by weekly Kt/V (top panel) and CCr (lower panel)

Although peritoneal clearance (middle columns) remains constant, total clearance (left columns) falls because of a progressive loss in RRF (right columns).



Burkart JM, Schreiber M, Korbet SM, et al. Solute clearance approach to adequacy of peritoneal dialysis. Perit Dial Int 1996; 16:457.

Correlation Between kt/V & ClCrt Peritoneal Transport Rate

- Peritoneal clearance of solute is primarily by diffusion.

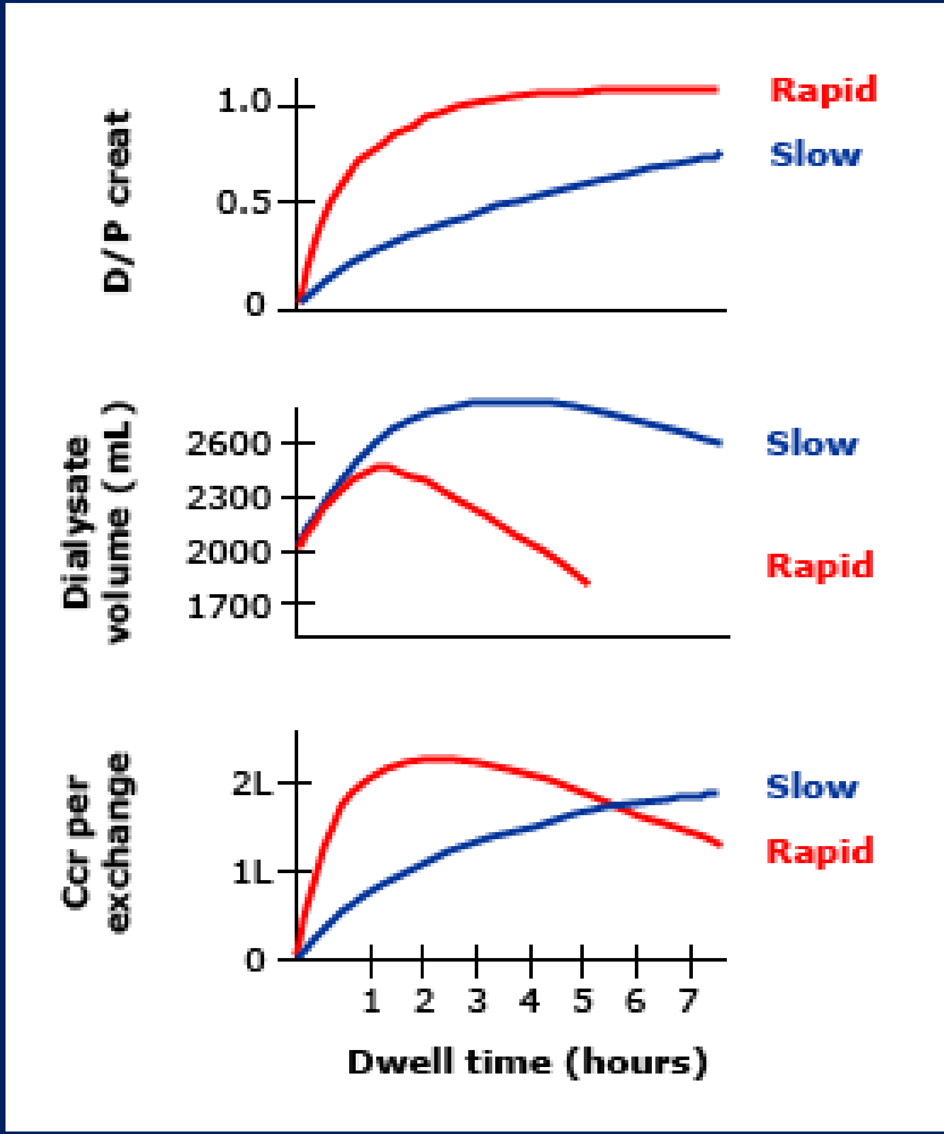
- The rate of clearance of any solute by diffusion is inversely related to the size of the solute.

Peritoneal clearance: urea > creatinine

Correlation Between kt/V & ClCrt Peritoneal transport rate

- Thus, for shorter dwells, the urea clearance per dwell tends to exceed that for creatinine.

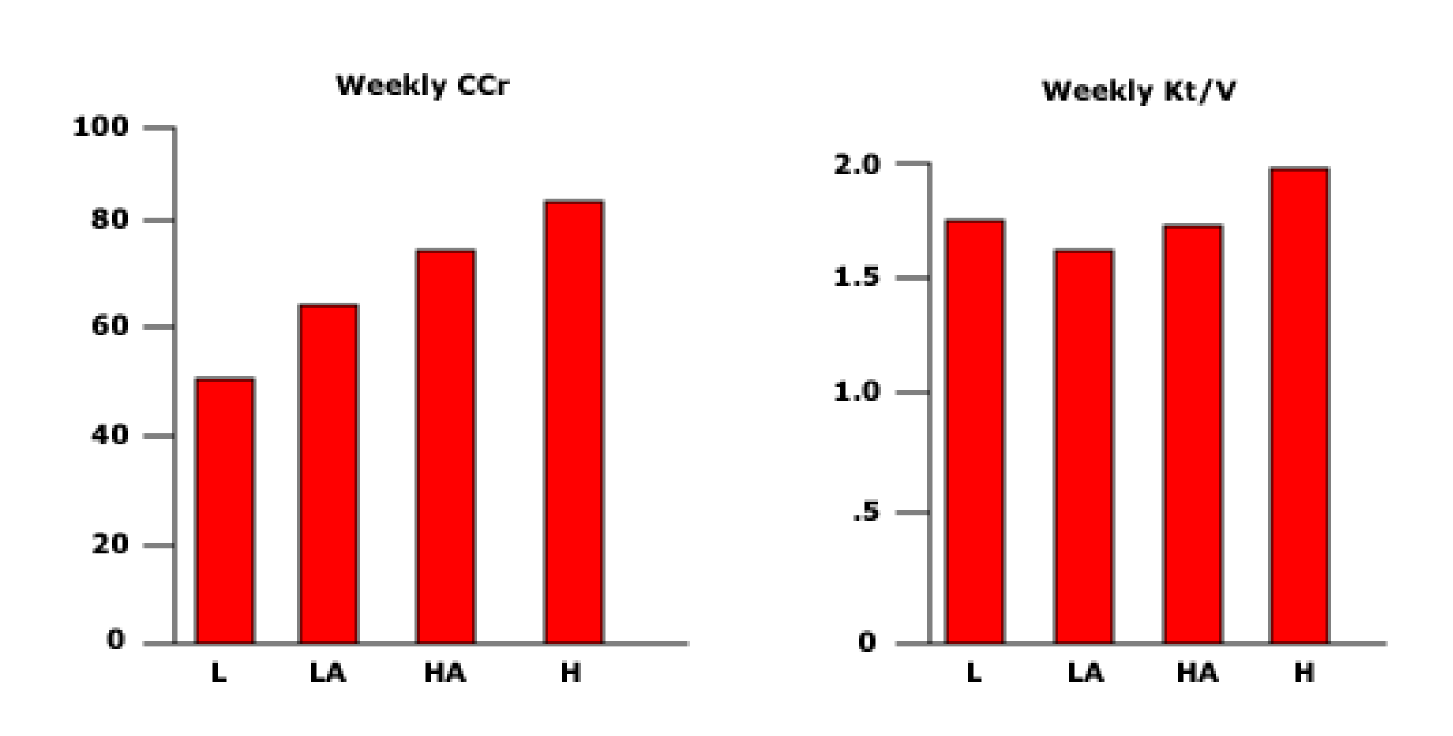
- CCr/Kt/V: low transporters<high transporters.



Twardowsky ZJ. Nightly peritoneal dialysis: Why, who, how, and when? ASAIO Trans 1990; 36:8.

Weekly Ccr And Kt/V Among CAPD Patients According To Transporter Type

The weekly Kt/V is relatively independent of transporter type, while the weekly CCr increases progressively from low to high transporters.



Weight and normalization

- Patient weight has a greater effect on Kt/V than on CCr.
- If the actual (rather than ideal) body weight is used.

  - Malnourished patients: ↑ Kt/V
  - Obese patients: ↓ Kt/V

For calculating solute clearance, use of the ideal body weight is preferred to the actual weight.

Table showing the effect of body weight on Kt/V and creatinine clearance among peritoneal dialysis patients

	Body weight ratio, actual to desired		
	<0.9	**0.9 to 1.1**	**>1.1**
Percent of patients	19	33	48
BWa/BWd	0.82	1.01	1.37
Kt/Va	1.95	2.08	1.94
Kt/Vd	1.74	2.08	2.25
CCra, L/week	68.1	71.5	64.1
CCrd, L/week	62.6	71.7	72.4

Effect of body weight, using actual (a) and desired (d) values, on Kt/V and weekly creatinine clearance (CCr). If the actual weight is used, patients well below the desired weight (ratio between actual and desired weight below 0.9) will overestimate solute clearance, while those well above the desired weight (ratio above 1.1) will underestimate solute clearance.

Does measuring adequacy influence the prescription?

Contribution of RRF

- The contribution of renal clearance should not be ignored when calculating total solute clearance, since increasing the amount of PD to meet minimum target values may unnecessarily increase the burden of dialysis for the patient.

- The residual CCr is an overestimate and the urea clearance is an underestimate of the glomerular filtration rate (GFR).

Optimal Amount of Dialysis
(target Kt/V)

Optimal Amount of Dialysis

Total Kt/V should be ≥1.7 per week.

Prescribe a sufficient amount of dialysis to achieve a Kt/V of 1.8/week.

- In a 70 kg anuric man

Assume that urea is being fully equilibrated in the peritoneal dialysate (D/P urea = 1.0).

As a result, drained dialysate volume=urea clearance.

- Drained dialysate=11 L
- 11 L – 1 L of expected UF= 10 L dialysate dwell volume

Addition of residual kidney function

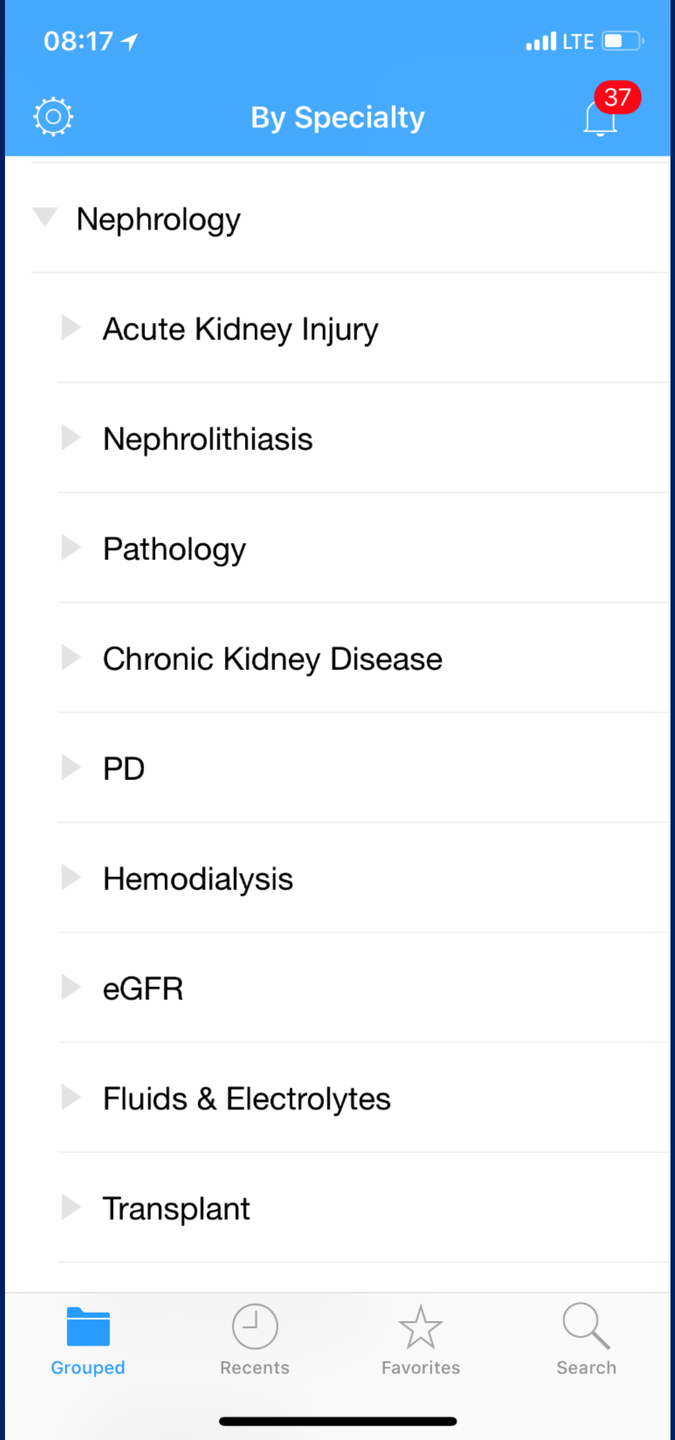
- If the patient has significant kidney function, the solute clearance provided by kidney function should be added to the Kt/Vurea provided by peritoneal dialysis for total solute clearance.

Significant kidney function is defined by KDOQI as a urine volume >100 mL/day.

70 kg man with residual kidney function

- 24-hour urine volume = 1 L
- 24-hour urine urea = 200 mg/dL
- Plasma blood u
- Renal Kt/V= 0.1
- New target dai
- Kt/42 L = 0.15
- Kt urea = 6.3 L/day= 6.3 of drained dialysate volume

6 lit vs 10 lit!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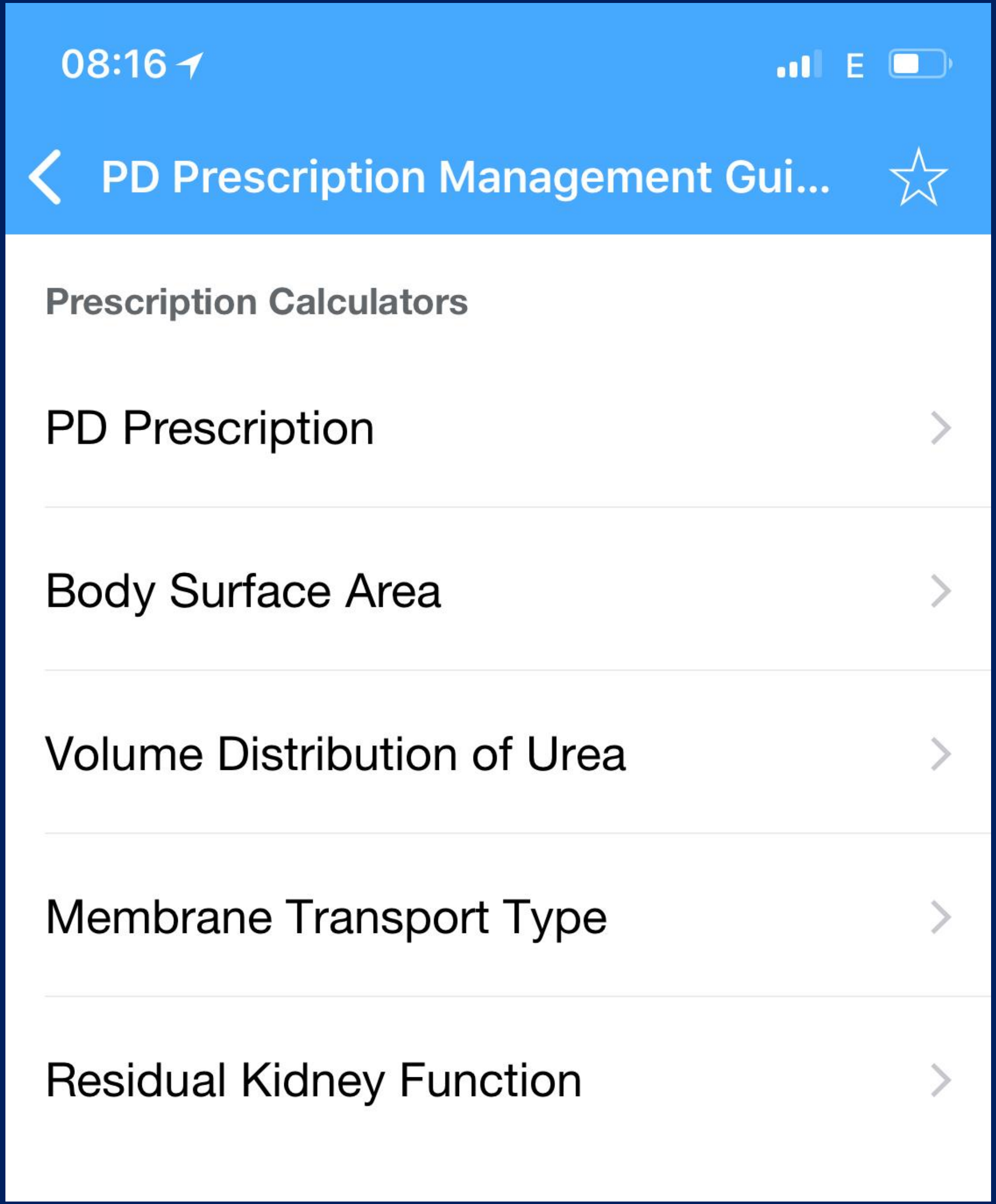
LTE
By Specialty
37
Nephrology
Acute Kidney Injury
Nephrolithiasis
Pathology
Chronic Kidney Disease
PD
Hemodialysis
eGFR
Fluids & Electrolytes
Transplant
Grouped
Recents
Favorites
Search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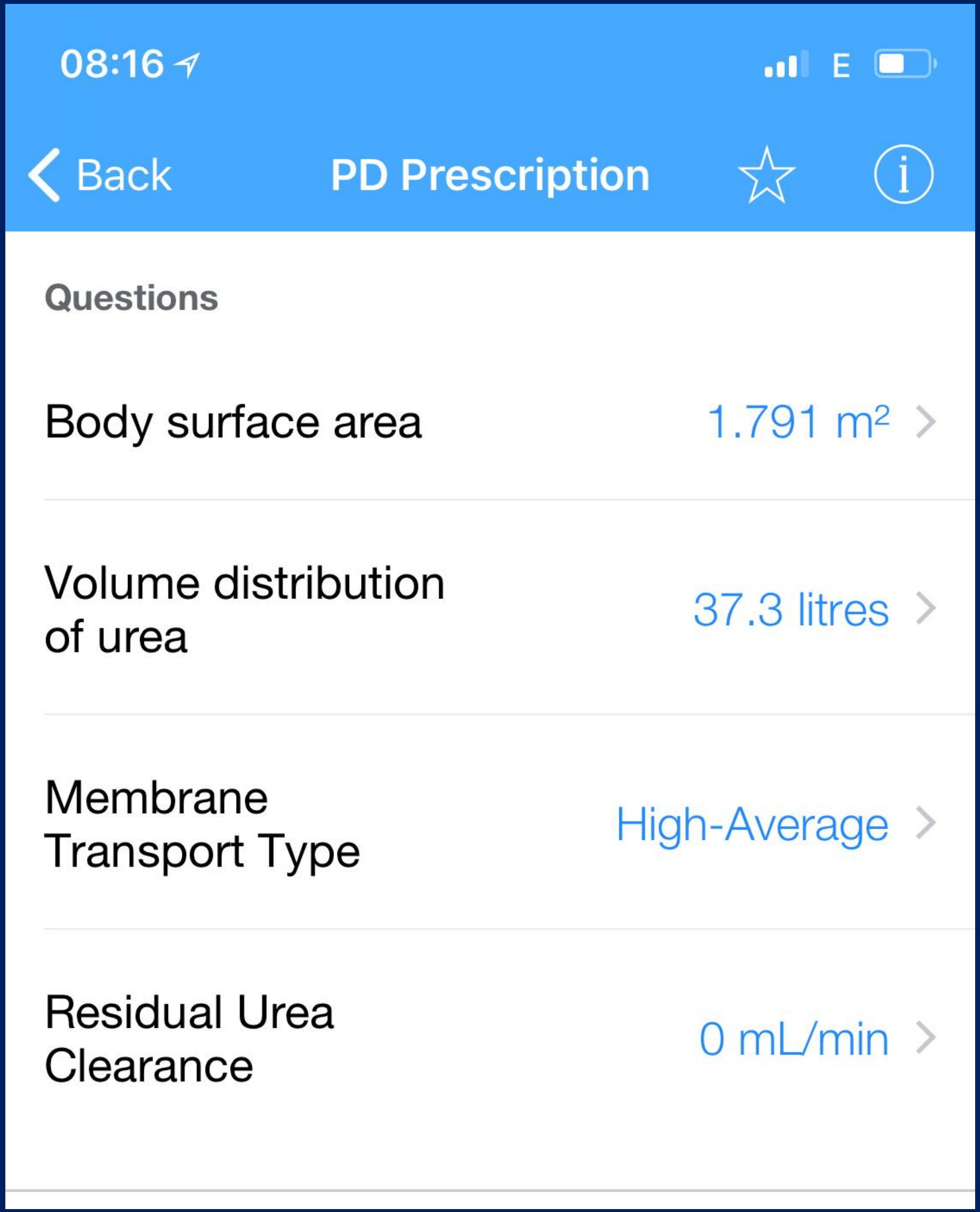
PD Prescription Management Gui...
Prescription Calculators
PD Prescription
Body Surface Area
Volume Distribution of Urea
Membrane Transport Type
Residual Kidney Function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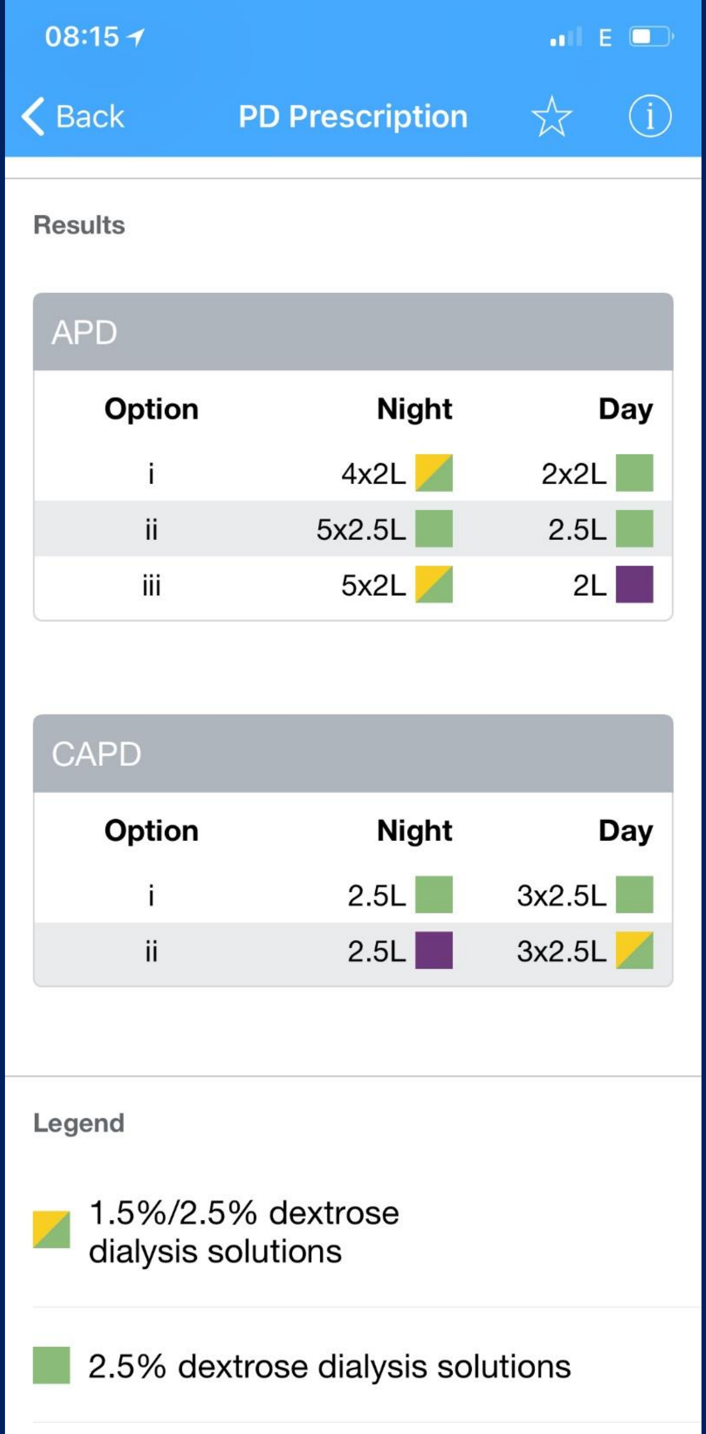
Back
PD Prescription
Questions
Body surface area
1.791 m²
Volume distribution of urea
37.3 litres
Membrane Transport Type
High-Average
Residual Urea Clearance
0 mL/min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E
Back
PD Prescription
Results
APD
Option
Night
Day
i
4x2L
2x2L
ii
5x2.5L
2.5L
iii
5x2L
2L
CAPD
Option
Night
Day
i
2.5L
3x2.5L
ii
2.5L
3x2.5L
Legend
1.5%/2.5% dextrose dialysis solutions
2.5% dextrose dialysis solutions

Baxter

Current Patient Report

Patient Name:	seied mohamad shojaadin			Collection Date:	2017/04/05
ID Number:	28-299	Gender:	M	Modality:	CAPD
Birth Date:	1953/08/21	Age:	63	BSA (m²):	1.91
Height (cm):	172.00	Weight (kg):	78.00	Est. Total Body Water (Liters):	41.15

Serum Concentrations:

BUN (mg/dL):	62.00	Glucose (mg/dL):	99.00
Creatinine (mg/dL):	11.20	Albumin (g/dL):	3.80

24 hour Dialysate and Urine Collection:

	BUN		Creatinine			Volume In (mLs)	Volume Out (mLs)	Net Volume (mLs)
Dialysate:	58.00	(mg/dL)	8.10	(mg/dL)	Dialysate:	8000	9000	1000
Urine:	290.00	(mg/dL)	99.00	(mg/dL)	Urine:		500	500

Calculated Values:

Estimated GFR (mL/min):	2.35
Protein Catobolic Rate (nPCR) (g/kg/day):	0.84
Fluid Removal (L/day):	1.50

Weekly Clearances:

	Total	Dialysate	Residual
BUN Clearance (L/week):	75.31	58.94	16.37
Weekly Kt/V:	1.83	1.43	0.40
Creatinine Clearance (L/week):	69.22	45.56	23.65
Creatinine Clearance (L/week/1.73m²):	62.66	41.25	21.41

PET Results:

Overnight Exchange:

		PET Date:	2017/04/05
		Dwell Time (mins):	560
% Dextrose	4.25	Dialysate BUN (mg/dL):	60.00
Volume Infused (mL):	2000	Dialysate Creatinine (mg/dL):	9.20
Volume Drained (mL):	3000		

Four Hour Equilibration Test:

% Dextrose	4.25	Infusion Time (mins):	11.00
Volume Infused (mL):	2000	Drainage Time (mins):	9.00
Volume Drained (mL):	2900		

Data:

	Time (mins)	BUN (mg/dL)	Creatinine (mg/dL)	Glucose (mg/dL)	Corrected Creatinine (mg/dL)	CRT D/P
Serum						
Sample #1	120.00	62.00	11.20	99.00	11.17	
Dialysate						
Sample #1	0.00	7.00	2.70	3980.00	1.51	0.13
Sample #2	120.00	39.00	5.30	2200.00	4.64	0.42
Sample #3	240.00	51.00	7.00	1500.00	6.55	0.59

Other Parameters:

Membrane Transport Type:	HA
Fluid Absorption (mL/min):	0.50
Residual Dialysate Volume (mLs):	500.00
[illegible]	0.000300000

Current Patient R

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PET Results:

Take Home Messages

Take Home Messages

- The weekly Kt/Vurea is now the preferred method for measuring small solute clearance.
- RRF should be included in calculating total clearance for PD.
- Inadequate clearance is one of the causes of increase in BUN.
- The dialysis dose may be decreased in patients with significant renal residual kidney function (defined as >100 mL/day).

Thank You

For Your Attention