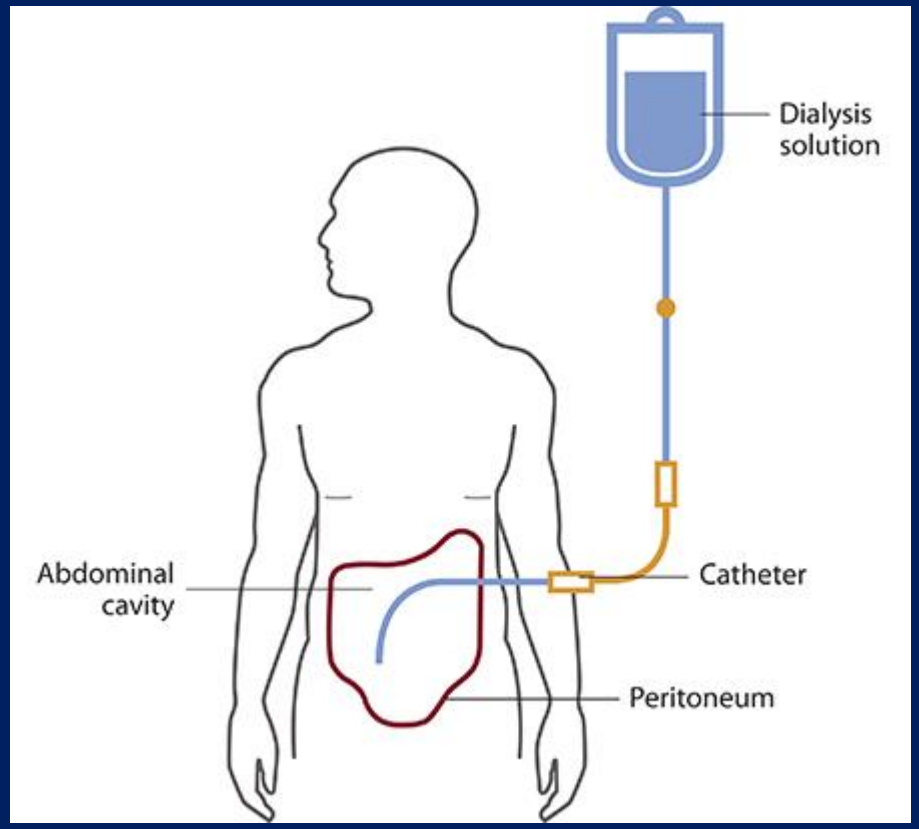
Adequacy of Peritoneal Dialysis

Dr. Shahrokh Ezzatzadegan

Department of Medicine

Shiraz University of Medical Sciences



BUN: 27
Crt.: 5.1
K: 4.9
Ph: 3.9
Hb: 11.5

- آقای 70 ساله
- تحت درمان با CAPD
- محلول شماره 1
- 3 بار در روز
- ورم ندارد.
- فشار خون 130/80.

میشه بجای 3 بار 2 بار دیالیز کنم؟

PERITONEAL DIALYSIS INTERNATIONAL

Guidelines

Peritoneal Dialysis International
2020, Vol. 40(3) 244–253

DOI: 10.1177/0896860819895364
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SAGE

International Society for Peritoneal Dialysis practice recommendations: Prescribing high-quality goal-directed peritoneal dialysis

Edwina A Brown[1], Peter G Blake[2], Neil Boudv
Javier de Arteaga[6], Jie Dong[7], Fred Finkelstein[8]

AJKD

Peritoneal Dialysis Prescription and Adequacy in Clinical Practice: Core Curriculum 2023

Bourne L. Auguste and Joanne M. Bargman

As the global prevalence of peritoneal dialysis (PD) continues to grow with prescribing strategies that focus on the needs and preferences of patients. PD is an effective form of kidney replacement therapy that offers numerous benefits to patients, including more flexibility in schedules compared with in-center hemodialysis (HD). Additional benefits of PD include salt and water removal without significant changes in patient hemodynamics. This continuous yet gentle removal of solutes and fluid is associated with better-preserved residual kidney function. Unfortunately, sometimes these advantages are overlooked at the expense of an emphasis on achieving small solute clearance targets. A more patient-centered approach emphasizes the importance of individualized treatment, particularly when considering incremental PD and other prescriptions that align with lifestyle preferences. In shifting the focus from small solute clearance targets to patient needs and clinical goals, PD remains an attractive, patient-centered form of kidney replacement therapy.

Review Article

Kidney Res Clin Pract 2022;41(2):150-155
pISSN: 2211-9132 • eISSN: 2211-9140
https://doi.org/10.23876/j.krcp.21.208

Check for updates

KIDNEY RESEAR AND CLINICAL PRACT

Peritoneal dialysis adequacy: a paradigm shift

Chang Huei Chen, Isaac Teitelbaum

Department of Medicine, University of Colorado Anschutz Medical Campus, Aurora, CO, USA

of article.

Am J Kidney Dis. 81(1):100-109. Published online October 5, 2022.

doi: 10.1053/j.ajkd.2022.07.004

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?

بررسی مقدماتی کافی بودن دیالیز

وجود ادم اندامها

وجود علایم اورمی

آزمایشات

Kidney International, Vol. 64 (2003), pp. 649–656

DIALYSIS–TRANSPLANTATION

Effect of Kt/V on survival and clinical outcome in CAPD patients in a randomized prospective study

WAI-KEI LO, YIU-WING HO, CHUN-SANG LI, KIN-SHING WONG, TAK-MAO CHAN, ALEX WAI-YIN YU, FLORA SO-KING NG, and IGNATIUS KUM-PO CHENG

Method. A total of 320 new CAPD patients with baseline renal Kt/V <1.0 were recruited from six centers in Hong Kong and were randomized into three Kt/V targets: group A, 1.5 to 1.7; group B, 1.7 to 2.0; and group C, >2.0. Kt/V and nutritional status were assessed every 6 months and dialysis prescription

Lo WK, et al. Kidney Int. 2003;64(2):649-56.

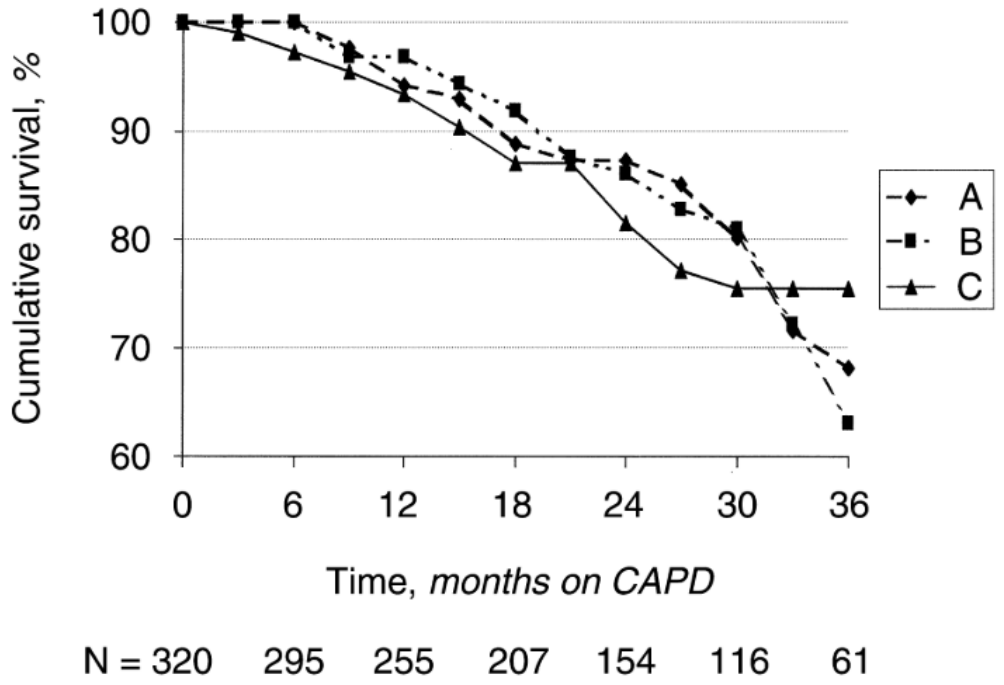


Fig. 4. Cumulative patient survival of the three groups. The difference was not statistically significant ($P = 0.9924$).

Table 3. Hemoglobin levels and percentage of patients on EPO of the study groups at different time point

Groups	A	B	C	*P* value
Hemoglobin level *g/dL*				
Baseline	8.4 ± 1.4	8.6 ± 1.4	8.6 ± 1.6	0.771
Months				
7	9.0 ± 1.7	9.2 ± 2.0	9.2 ± 1.9	0.551
13	9.0 ± 1.7	9.2 ± 2.0	9.2 ± 1.9	0.754
19	9.0 ± 2.2	9.0 ± 2.0	9.1 ± 1.6	0.890
25	9.3 ± 2.4	8.8 ± 2.0	9.0 ± 1.4	0.591
31	10.0 ± 2.2	8.8 ± 2.1	8.9 ± 1.5	0.096
Percentage of patients on EPO				
Baseline	10.6%	5%	5.7%	0.311
Months				
7	16.7%	9.9%	5%	0.009[a]
13	19.4%	10.1%	8.6%	0.030[a]
19	32%	14.8%	13%	0.007[a]
25	37.1%	19.5%	14%	0.014[a]
31	50%	18.2%	28%	0.067

[a] By test of linear trend

Conclusion. Patients with total Kt/V maintained below 1.7 had significantly more clinical problems and severe anemia but there was no difference in outcome demonstrated for patients with Kt/V maintained above 2.0 and between 1.7 and 2.0. We recommended that the minimal target of total Kt/V should be above 1.7.

Lo WK, et al. Kidney Int. 2003;64(2):649-56.

ISPD GUIDELINES/RECOMMENDATIONS

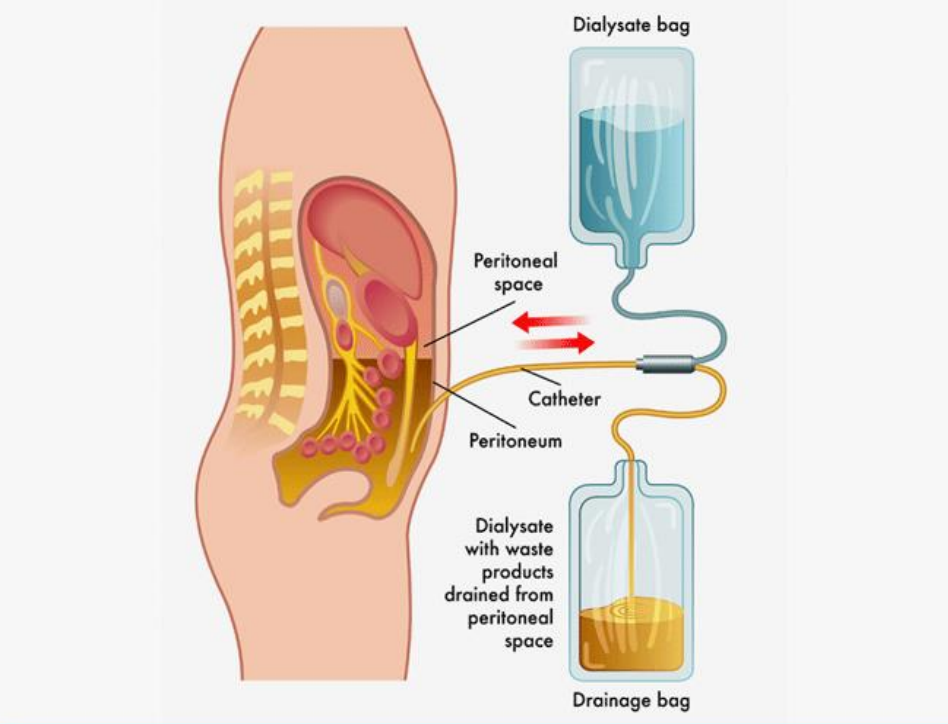
GUIDELINE ON TARGETS FOR SOLUTE AND FLUID REMOVAL IN ADULT PATIENTS ON CHRONIC PERITONEAL DIALYSIS

The 2006 ISPD guidelines on PD recommended that the total (renal + peritoneal) Kt/Vurea not be less than 1.7 at any time.

Lo W-K. Peritoneal Dialysis International. 2006;26(5):520-2.

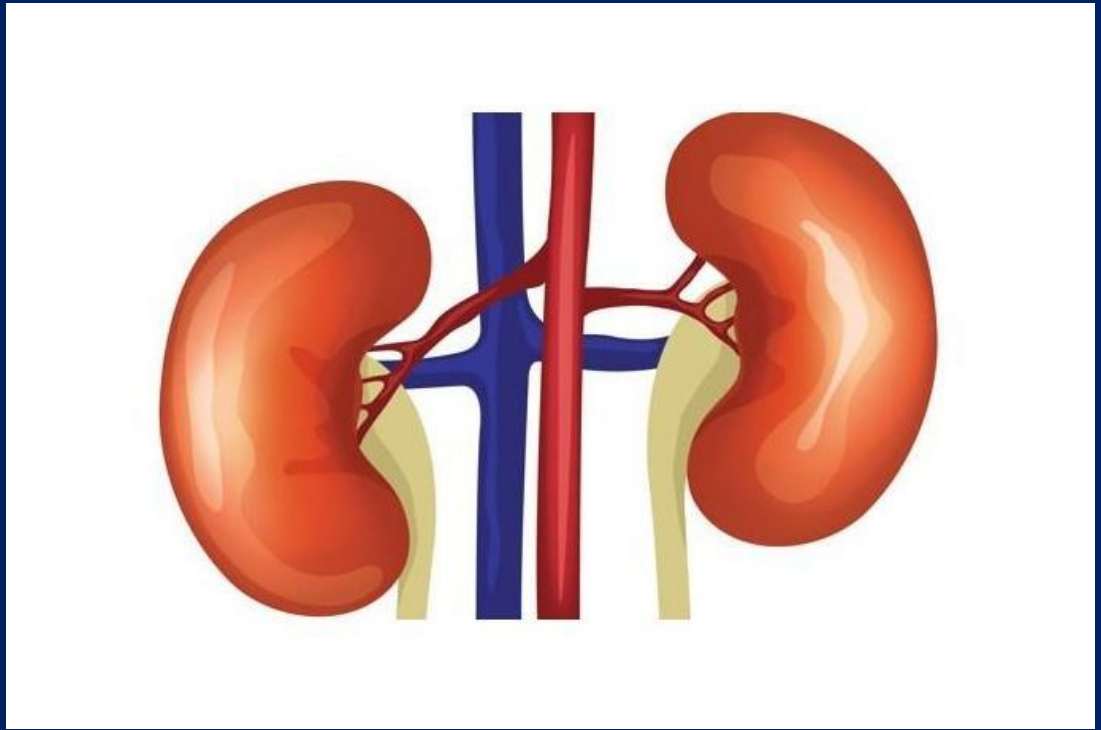
Solute clearance is the amount of blood that is cleared of a substance over a unit of time (ie, in mL/min).

Dialysis

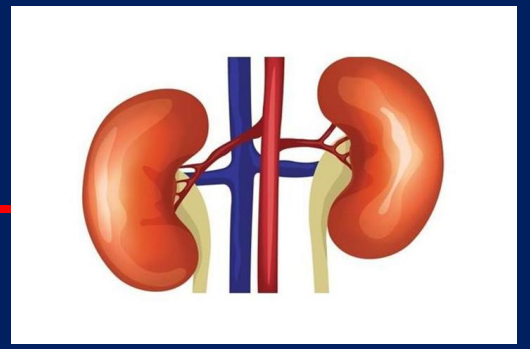


Native kidney function

(residual renal function)



RRF and solute clearance



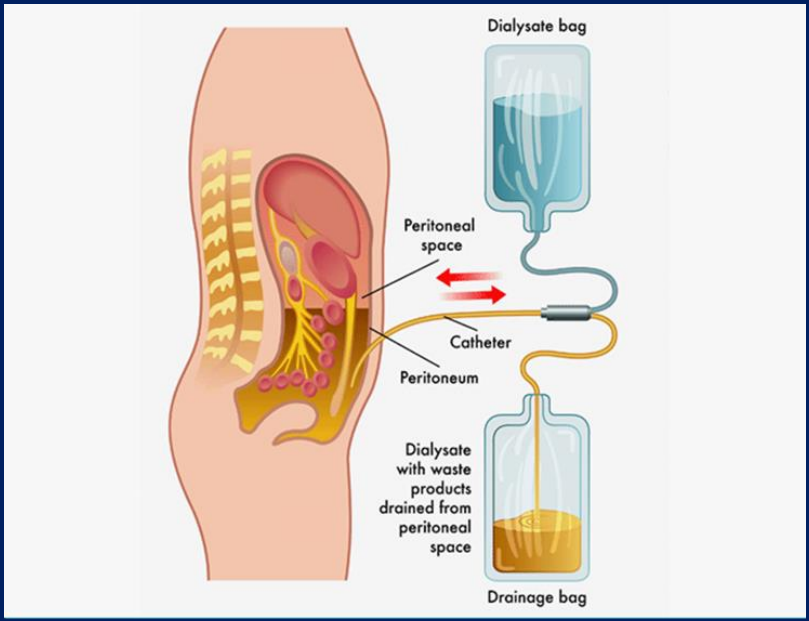
- RRF has historically been included in total clearance for PD for the following reasons:
  - Easy for PD patients to provide 24-hour urine collections.
  - RRF is often preserved in PD patients but not in hemodialysis patients.

اندازه گیری میزان دفع BUN در

محلول خروجی 24 ساعته

ادرار 24 ساعته

Total clearance= PD + Renal



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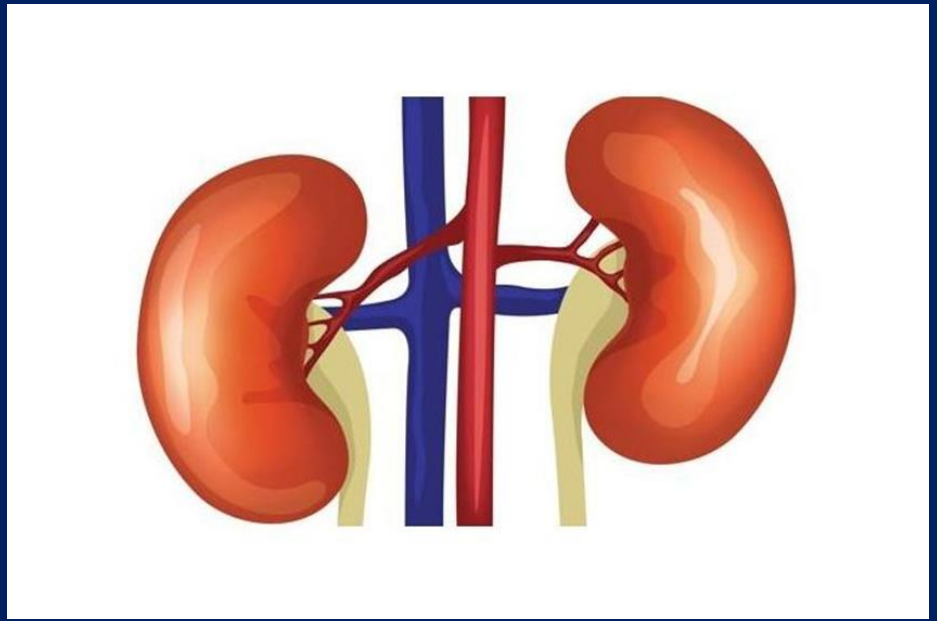

WEEKLY DIALYSIS CLEARANCE

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

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

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

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

CREATININE CLEARANCE (C_{CR})

Creatinine Clearance (C_{Cr}) is normalized to a set standard of 1.73m² 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 (1.73m² BSA/Patient's BSA)
RENAL C_{CR} L/WEEK =	24-hr U/P Cr x 24-hr Urine Volume x 7 x (1.73m² 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.

Total clearance= PD + Renal

Total kt/V= PD + Renal

Total ClCrt= PD + Renal

Total weekly kt/V>=1.7

Total weekly ClCrt.>=45 L

J Am Soc Nephrol 13: 1307–1320, 2002

Effects of Increased Peritoneal Clearances on Mortality Rates in Peritoneal Dialysis: ADEMEX, a Prospective, Randomized, Controlled Trial

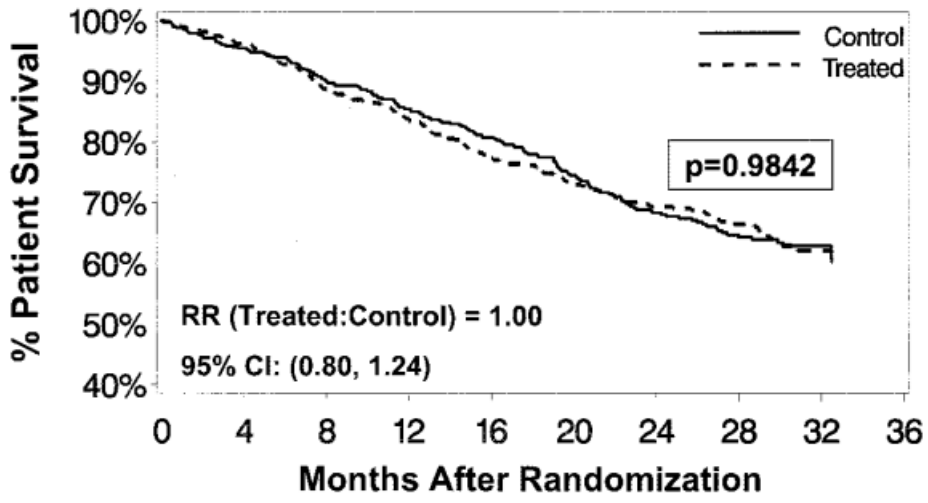

Figure 3. Life-table intent-to-treat (ITT) analysis of patient survival, comparing the study groups. The *P* value was 0.9842 (log-rank test). RR, relative risk; CI, confidence interval.

Paniagua, R., et al. J Am Soc Nephrol, 2002. 13(5): p. 1307-1320.


WHEN?

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)*

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.

BUN: 27
Crt.: 5.1
K: 4.9
Ph: 3.9
Hb: 11.5

- آقای 70 ساله
- تحت درمان با CAPD
- محلول شماره 1
- 3 بار در روز
- ورم ندارد.
- فشار خون 130/80.

میشه بجای 3 بار 2 بار دیالیز کنم؟

Baxter

PD ADEQUEST 2.0

Current Patient Report

01/25/2020
Page 1 of 1

Patient Name				Collection Date:	06/09/2019
ID Number:	28-188	Gender:	M	Modality:	CAPD
Birth Date:	06/10/1948	Age:	70	BSA (m²):	1.55
Height (cm):	162.00	Weight (kg):	53.00	Est. Total Body Water (Liters):	31.00

Serum Concentrations:

BUN (mg/dL):	24.00	Glucose (mg/dL):	153.00
Creatinine (mg/dL):	5.10	Albumin (g/dL):	1.80

24 hour Dialysate and Urine Collection:

	BUN		Creatinine	
Dialysate:	23.00	(mg/dL)	4.60	(mg/dL)
Urine:	0.00	(mg/dL)	0.00	(mg/dL)

	Volume In (mLs)	Volume Out (mLs)	Net Volume (mLs)
Dialysate:	6000	6500	500
Urine:		0	0

Calculated Values:

Estimated GFR (mL/min):	0.00
Protein Catobolic Rate (nPCR) (g/kg/day):	0.51
Fluid Removal (L/day):	0.50

Weekly Clearances:

	Total	Dialysate	Residual
BUN Clearance (L/week):	43.60	43.60	0.00
Weekly Kt/V:	1.41	1.41	0.00
Creatinine Clearance (L/week):	41.04	41.04	0.00
Creatinine Clearance (L/week/1.73m²):	45.73	45.73	0.00

	BUN		Creatinine	
Dialysate:	23.00	(mg/dL)	4.60	(mg/dL)
Urine:	0.00	(mg/dL)	0.00	(mg/dL)

	Volume In (mLs)	Volume Out (mLs)	Net Volume (mLs)
Dialysate:	6000	6500	500
Urine:		0	0

Calculated Values:

Estimated GFR (mL/min):	0.00
Protein Catobolic Rate (nPCR) (g/kg/day):	0.51
Fluid Removal (L/day):	0.50

Weekly Clearances:

	Total	Dialysate	Residual
BUN Clearance (L/week):	43.60	43.60	0.00
Weekly Kt/V:	1.41	1.41	0.00
Creatinine Clearance (L/week):	41.04	41.04	0.00
Creatinine Clearance (L/week/1.73m²):	45.73	45.73	0.00

programmed by Stephen Z Fadem

PD KT/V CALCULATOR

Beta version

THE PATIENT

Male ◉ Female ○

Feet inches ○ Centimeters ◉

Check anthropometric equations

175 cms

Weight in kg 70

Age in years 30

RESIDUAL KIDNEY UREA CLEARANCE

$V_{24\ hr\ urine}$: 800 cc

$U_{urine\ urea\ nitrogen}$: 700 mg/dL

$P_{plasma\ urea\ nitrogen}$: 63 mg/dL

$RKC_{uncorrected\ for\ BSA}$ (Residual Kidney Function): 6.2 cc/min

RKC (Residual Kidney Function): 5.8 cc/min/1.73m^2

RKC/V_{Watson}: 1.39L/wk

RKC/V_{Hume}: 1.43L/wk

DIALYSATE CLEARANCE

$V_{dialysate}$: 12 Liters/24 hr

$U_{dialysate\ urea}$: 49 mg/dL

P_{urea}: 63 mg/dL

$C_{dialysate}$: 65.33 L/week

$C_{dialysate}$: 61.16 L/week/1.73m^2

http://touchcalc.com/calculators/ktv_pd

kt/V_{Watson}: 2.84

kt/V_{Hume}: 2.92

TBW_{Watson}: 42.03 (anthropometric volume)

TBW_{Hume}: 40.85(anthropometric volume)

BSA_{Dubois}: 1.85 (Body Surface Area)

Weight and normalization

- 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.

Perit Dial Int. 2020 May;40(3):302-309. doi: 10.1177/0896860819893803. Epub 2020 Jan 21.

Person-centered peritoneal dialysis prescription and the role of shared decision-making

Peter

Treating a person receiving healthcare with dignity and respect and involving them in all decisions about their health.

International Society for Peritoneal Dialysis Practice Recommendations: The view of the person who is doing or who has done peritoneal dialysis

Richard W Corbett [1], George Goodlet [2], Brian MacLaren [2], Anne Jolliffe [3], Ann Joseph [3], Chunping Lu [4], Camila C Fernandes da Silva [5], Bansi Soni [3], Madeline Wicks [6], Edwina A Brown [1], Peter G Blake [7]

For some individuals, particularly those who are old, frail or have a poor prognosis, there may be a quality of life benefit from a modified dialysis prescription to minimize the burden of treatment (**practice point**).

Brown, E.A., et al. Perit Dial Int, 2020. 40(3): p. 244-253.

Review Article

Kidney Res Clin Pract 2022;41(2):150-155
pISSN: 2211-9132 • eISSN: 2211-9140
https://doi.org/10.23876/j.krcp.21.208

KIDNEY RESEARCH AND CLINICAL PRACTICE

Peritoneal dialysis adequacy: a paradigm shift

Chang Huei Chen, Isaac Teitelbaum

Department of Medicine, University of Colorado Anschutz Medical Campus, Aurora, CO, USA

Chen, C.H. Kidney Res Clin Pract, 2022. 41(2): p. 150-155.

PERITONEAL DIALYSIS INTERNATIONAL

Guidelines

Peritoneal Dialysis International
2020, Vol. 40(3) 244–253

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DOI: 10.1177/0896860819895364
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SAGE

International Society for Peritoneal Dialysis practice recommendations: Prescribing high-quality goal-directed peritor

There is no specific clearance target that guarantees sufficient dialysis for an individual. Increasing small solute clearance to a Kt/V $\geq$ 1.7 may improve uraemia-related symptoms, if present, but there is only low certainty evidence showing that increasing urea clearance has any impact on quality of life, technique survival or mortality (**practice point**).

Brown, E.A., et al. Perit Dial Int, 2020. 40(3): p. 244-253.

Guidelines

PERITONEAL DIALYSIS INTERNATIONAL

International Society for Peritoneal Dialysis practice recommendations: Prescribing high-quality goal-directed peritoneal dialysis

Peritoneal Dialysis International
2020, Vol. 40(3) 244–253

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The presence of residual kidney function at the start of PD may enable individuals to start on a low dose prescription that may be increased incrementally as residual kidney function declines or as clinically indicated. This may allow patients more time for life participation, less treatment burden and better quality of life (**practice point**).

Brown, E.A., et al. Perit Dial Int, 2020. 40(3): p. 244-253.

If symptoms, nutrition and volume are all controlled, no PD prescription change is needed for the sole purpose of reaching an arbitrary clearance target (**practice point**).

Brown, E.A., et al. Perit Dial Int, 2020. 40(3): p. 244-253.

Perit Dial Int. 2020 May;40(3):320-326. doi: 10.1177/0896860819895362. Epub 2020 Jan 17.

Incremental peritoneal dialysis

Peter G Blake [1], Jie Dong [2 3 4 5], Simon J Davies [6]

Guidelines

PERITONEAL DIALYSIS INTERNATIONAL

Peritoneal Dialysis International
2020, Vol. 40(3) 244–253

DOI: 10.1177/0896860819895364
journals.sagepub.com/home/ptd
SAGE

International Society for Peritoneal Dialysis practice recommendations: Prescribing high-quality goal-directed peritoneal dialysis

1. There is very low certainty evidence that residual kidney function may be more important than peritoneal clearance (**practice point**)
2. There appears to be no survival advantage in aiming routinely for a weekly Kt/V > 1.70 (**practice point**)
3. There is very low certainty evidence that a weekly Kt/V less than 1.7 may be associated with increased morbidity (**practice point**)

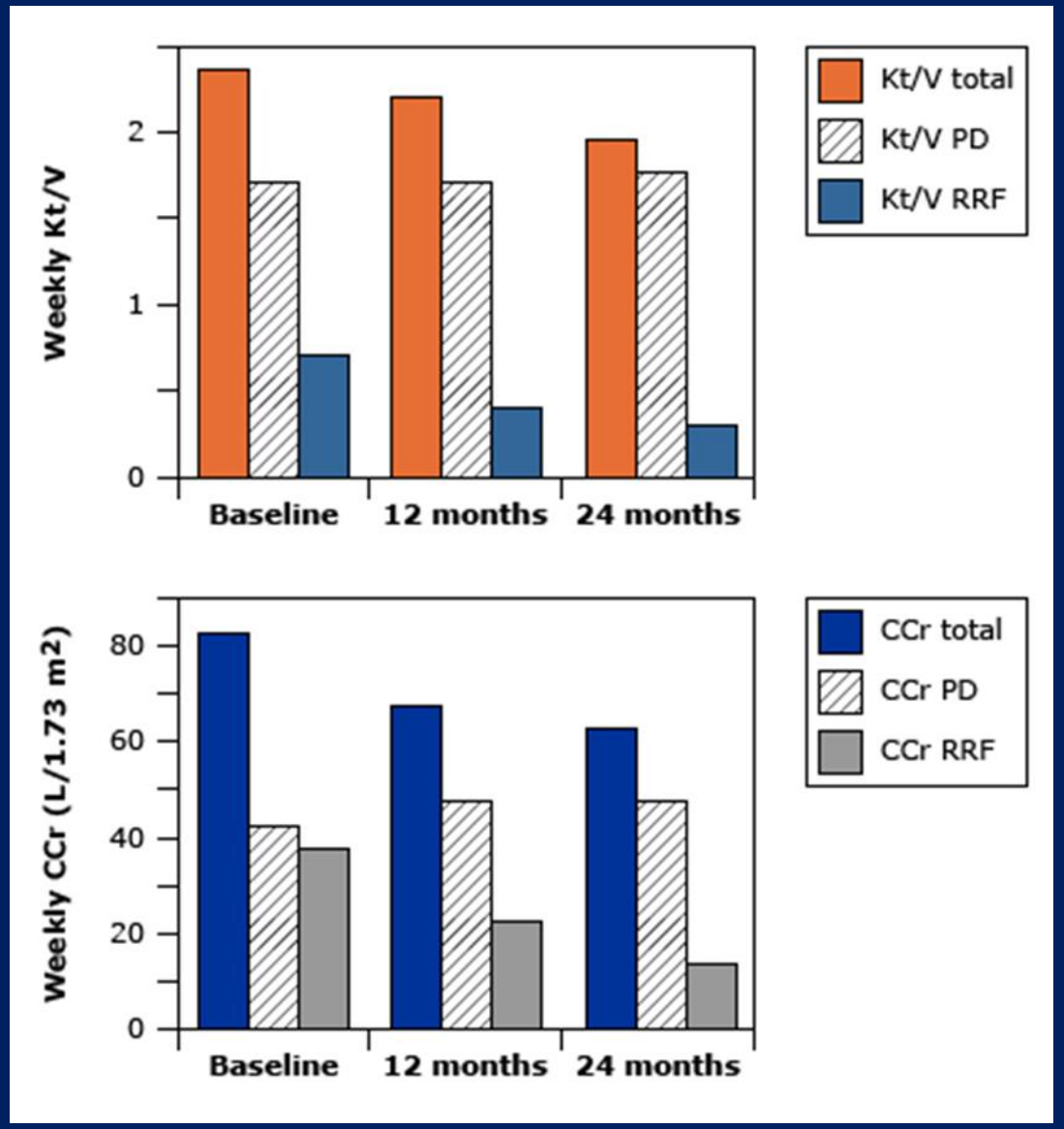
Given the uncertainty of the estimation of V, clinicians should be encouraged to alter the prescribed dialysis dose in response to patient's symptoms, biochemical parameters and treatment goals, rather than solely equating a single value cut-off value with adequate treatment. (**practice point**)

Brown, E.A., et al. Perit Dial Int, 2020. 40(3): p. 244-253.

Preservation of RKF is an important therapeutic endpoint when evaluating the quality of a PD prescription.

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.

چگونه می توان میزانی از دیالیز را که مناسب وضعیت بیمار است تجویز نمود؟

fresenius.pdcalculator.com

Welcome and Instructions | PD Calculator

Prev | Clear Values

1. Patient Data

Age

Gender

Please Select

Height

cm
in

Weight

kg
lb

Transport Status

Please Select

Residual Renal Function

0

K_{renal}t/V
mL/min

وارد کردن مشخصات بیمار

2. Estimated Prescription Data

Max. Fill Volume (L)

--

Min. Number Of Exchanges (per day)

--

Peak Time UF with 1.5% Glucose (hrs)

0 2 4 6 8 10 12

Peak time shown in green. Time to negative UF shown in red.

Min. Total Daily Volume (L)

--

BSA: --

Urea Distribution Volume: --

Renal Weekly Kt/V: --

پیشنهاد سیستم در مورد دوز دیالیز

3. Physician Modeling

Desired Fill Volume (L)

Desired Number Of Exchanges (per day)

Desired Time Per Exchange

Please Select

-- *total volume*

-- *total time*

Est. Total Weekly Kt/V

0 1 2 3 4 5 6

--

Modality Input

Simple
Day/Night

1. Patient Data

Age

50

Gender

Male

Height

165

- cm
- in

Weight

65

- kg
- lb

Transport Status

High Average

Residual Renal Function

0

- $K_{renal}t/V$
- mL/min

1. Patient Data

Age

50

Gender

Male

Height

165

- cm
- in

Weight

65

- kg
- lb

Transport Status

High Average

Residual Renal Function

0

- $K_{renal}t/V$
- mL/min

2. Estimated Prescription Data

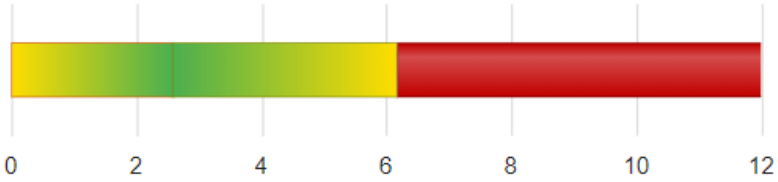
Max. Fill Volume (L)

2.6 L

Min. Number Of Exchanges (per day)

5

Peak Time UF with 1.5% Glucose (hrs)



Peak time shown in green. Time to negative UF shown in red.

Min. Total Daily Volume (L)

11.6

BSA: 1.7 m^2

Urea Distribution Volume: 35 L

Renal Weekly Kt/V: 0

fresenius.pdcalculator.com

Welcome and Instructions | PD Calculator

Prev | Clear Values

1. Patient Data

Age

Gender

Please Select

Height

cm
in

Weight

kg
lb

Transport Status

Please Select

Residual Renal Function

0

K_{renal}t/V
mL/min

وارد کردن مشخصات بیمار

2. Estimated Prescription Data

Max. Fill Volume (L)

--

Min. Number Of Exchanges (per day)

--

Peak Time UF with 1.5% Glucose (hrs)

0 2 4 6 8 10 12

Peak time shown in green. Time to negative UF shown in red.

Min. Total Daily Volume (L)

--

BSA: --

Urea Distribution Volume: --

Renal Weekly Kt/V: --

پیشنهاد سیستم در مورد دوز دیالیز

3. Physician Modeling

Desired Fill Volume (L)

Desired Number Of Exchanges (per day)

Desired Time Per Exchange

Please Select

-- *total volume*

-- *total time*

Est. Total Weekly Kt/V

0 1 2 3 4 5 6

--

Modality Input

Simple
Day/Night

3. Physician Modeling

Desired Fill Volume (L)

Desired Number Of Exchanges (per day)

Desired Time Per Exchange

Please Select

-- *total volume*

-- *total time*

Est. Total Weekly Kt/V

--

- In a 70 kg anuric man

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

- Daily Kt/V= 0.20

As a result, drained dialysate volume=urea clearance.

- Daily Kt = 11 L (urea clearance per day)
- 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!

Does measuring adequacy influence the prescription?

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

kt/V vs ClCrt?

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

$$RRF \approx CCr/Kt/V$$

CCr overestimates and urea clearance underestimates renal solute clearance.

Take Home Messages

BUN: 27
Crt.: 5.1
K: 4.9
Ph: 3.9
Hb: 11.5

- آقای 70 ساله
- تحت درمان با CAPD
- محلول شماره 1
- 3 بار در روز
- ورم ندارد.
- فشار خون 130/80.

میشه بجای 3 بار 2 بار دیالیز کنم؟

Take Home Messages

- PD should be prescribed using shared decision-making.
- The weekly Kt/Vurea is now the preferred method for measuring small solute clearance.
- There is no specific clearance target that guarantees sufficient dialysis.
- RRF should be included in calculating total clearance for PD.
- The dialysis dose may be decreased in patients with significant renal residual kidney function (defined as >100 mL/day).


Thanks For Your Attention