PD Calculator

Instructions for Use and References
Version 2.2

Description

The online PD (Peritoneal Dialysis) Calculator is a tool for use by healthcare professionals for modeling the dialysis dose (Kt/V) for different dialysis prescription options.

For users in **countries in the region of Europe, Middle East and Africa (EMEA)**, the PD Calculator is for simulation, education, and training purposes only. It must not be used in a clinical setting and/or to calculate doses for the treatment of specific patients. This educational tool provides clinicians with the ability to familiarize themselves with different therapy options by modeling the dialysis dose for different prescription options based on generalized formulas and assumptions derived from patient population.

Modeling a PD dose is based on generalized formulas and assumptions derived from patient populations. The output of a modeled prescription is limited in its accuracy and cannot account for the variability seen in individual patients. The algorithms are not designed for simulation, education and training on modeling the dialysis dose for pediatric patients or patients with amputations.

The PD calculator is not intended to replace the judgment or experience of the prescribing healthcare provider. The PD prescription is the sole responsibility of the prescriber.

Important Information

The PD Calculator cannot address the full range of topics related to a PD prescription that are critical for the overall management and ongoing monitoring of a PD patient. This tool must never be used as a substitute for physician judgment.

The PD Calculator requires anthropomorphic (age, gender, height, weight) and clinical (transport status, residual kidney function) data to model a PD prescription. The algorithms used in the PD calculator are based upon published literature (see PD Calculator Formulas and References section).

The Fresenius Medical Care Global Medical Office has made every reasonable effort to ensure the accuracy of the calculations provided by the PD Calculator. In no event will Fresenius Medical Care be liable for any losses or damages arising from or relating to your use of the PD Calculator, whether direct, indirect, incidental, or consequential.

Support

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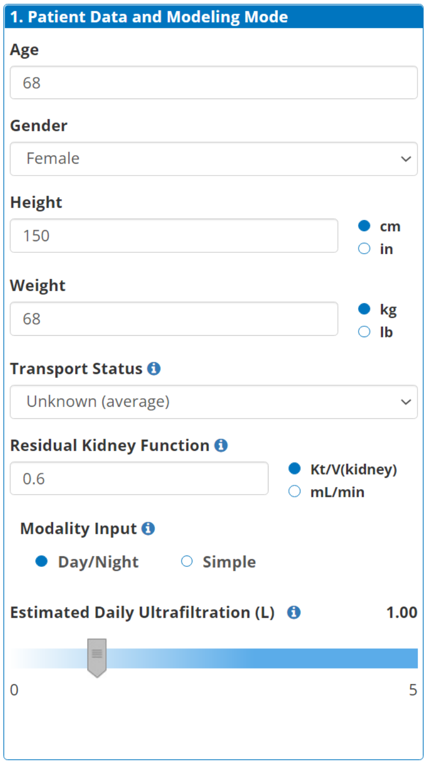
Minimum System Requirements

Internet Explorer 11, Firefox 56, Google Chrome 62, Safari 11, Android Google Chrome, iOS Safari

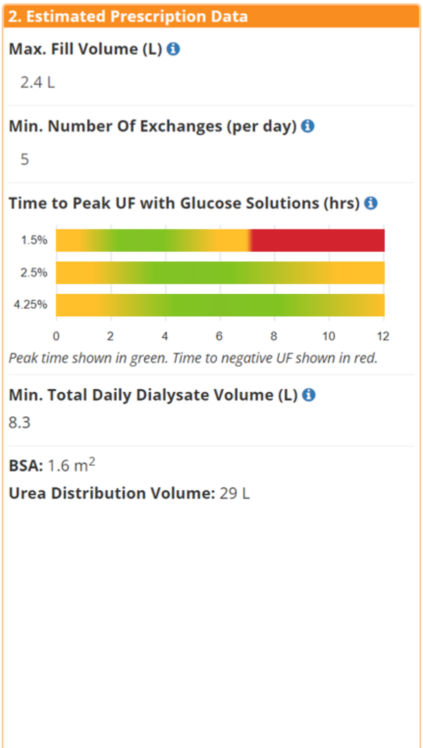
Instructions for Using the PD Calculator

1. Enter patient and modeling parameters in the Patient Data and Modeling Mode section



- Age: Enter the patient's age in years. Age must be 22 – 120
- Gender: Select Male or Female from the drop-down menu
- Height: Enter the patient's height in cm (centimeters) or inch (inches). Choose the correct units from the radio buttons. Height must be 141 – 196 cm (56 – 77 in).
- Weight: Enter the patient's weight in kg (kilograms) or lb (pounds). Choose the correct units from the radio buttons. Weight must be 38 – 160 kg (83 – 352 lb).
- Transport Status: Select the patient's transport status from the drop-down menu.
    - Transport status indicates how quickly solutes and water move between the dialysate and the patient's blood plasma and is classified as high, high average, low average, or low. If the transport status is unknown, Average can be selected.
- Residual Kidney Function (RKF): Enter the patient's RKF as Kidney Urea Clearance (mL/min) or Kidney weekly Kt/V. Choose the correct units from the radio buttons.
    - A patient's residual kidney function (RKF) can be considered when modeling a PD prescription. However, it is important to ensure that all clinical values are current. Incorrectly entering RKF can lead to over- or under-estimation of Kt/V. RKF can be entered as residual Kt/V or kidney urea clearance in mL/min. If you do not want to include RKF in modeling predictions, this can be left at 0.
- Modality Input: Select "Simple" or "Day/Night".
    - In "Simple" mode, the calculator assumes that all exchanges will be the same volume and dwell time. In "Day/Night" mode, two different sets of volumes and dwell times can be modeled, one for daytime and the other for overnight exchanges. Both modes can be used for manual or cycler-based prescriptions. Note: In "Simple" mode, it is assumed that all exchanges are upright (ambulatory). In "Day/Night" mode, it is assumed that daytime exchanges are upright (ambulatory) and nighttime exchanges are lying down (supine). The patient's position affects distribution of fluid in the peritoneum and therefore impacts clearance and modeled Kt/V.
- Estimated Daily Ultrafiltration (UF): Use the slider to choose an estimated daily UF to be used in modeling calculations. Must be 0 L – 5 L.
    - Ultrafiltration is the fluid removed during PD and contributes to achieved solute clearance. In practice, daily ultrafiltration volume varies. Enter an estimated value that is typical for total ultrafiltration volume, if you would like that considered in the model. You can also enter 0, in which case the model assumes no ultrafiltration occurs.

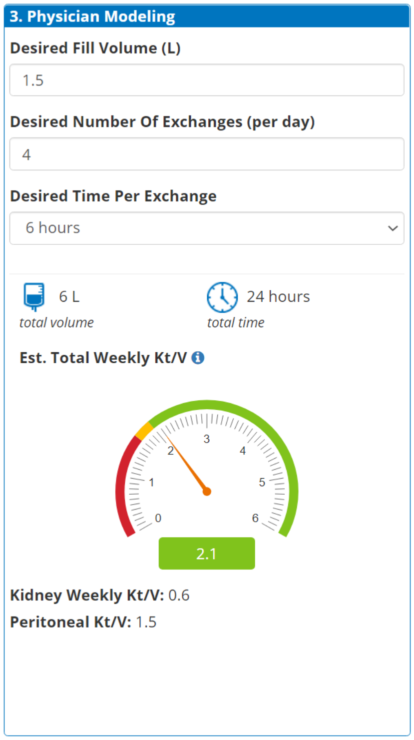
2. Review the information provided in the Estimated Prescription Data section



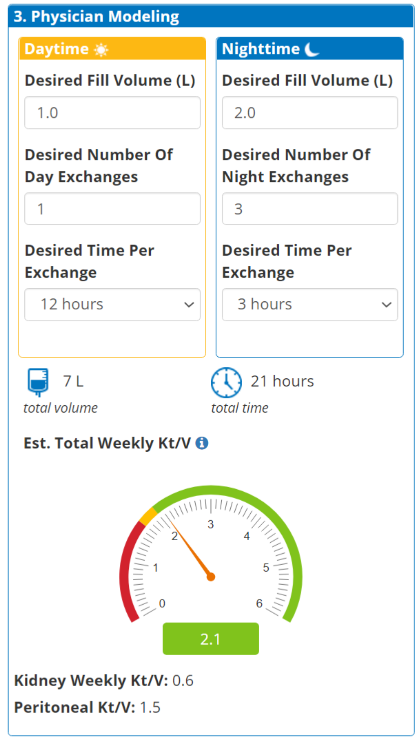
- Maximum Fill Volume (L): Estimated maximum fill volume.
  - Estimations for maximum fill volume are generally based on a patient's body surface area (BSA). In patients who are new or who have just had a catheter placed, appropriate fill volumes may start well below the estimated maximum. The estimated maximum fill volume may not be applicable to extremely large or very small patients.
- Minimum Number of Exchanges (per day): Estimated minimum number of daily exchanges.
  - The estimated minimum number of exchanges a patient would require, per day, to meet a total Kt/V adequacy goal of 2.0. This estimate is based on the entered transport type, residual kidney function, and estimated daily ultrafiltration. The calculation assumes ambulatory therapy, 2.0 L fill volumes, and exchange times equal to the time to peak UF for 1.5% dextrose solutions.
- Time to Peak UF with Glucose Solutions (Hrs): Time, in hours, to estimated peak UF for 1.5%, 2.5%, and 4.25% Glucose Solutions. This information is for guidance in choosing appropriate dwell times; these times are not used for modeling. Green represents estimated times for peak UF, yellow is less than 75% of the peak, and red is when negative net ultrafiltration may occur. Note that with higher dextrose solutions, the absolute ultrafiltration will be substantially higher than with lower dextrose solutions. Therefore, with 4.25% solutions it is less crucial for dwell times to fall strictly with the peak range (green).
  - Ultrafiltration (UF) and solute clearance profiles are highly dependent on a patient's transport status. The time to peak UF is shorter than the time to peak urea clearance. Both factors are important considerations when determining a patient's optimal dwell time. The times presented here are for single dwells with indicated glucose PD solutions as described by Mujais and colleagues.
  - Glucose concentrations of PD solutions vary regionally. Small differences in glucose may have small effects on time to peak UF. For example, 2.3% glucose solutions will likely have a slightly shorter time to peak UF than 2.5% glucose solutions. However, direct comparisons have not been made. Additionally, some manufacturers use the amount of anhydrous glucose, versus hydrated glucose, in their labeling. In terms of glucose content, 1.36%, 2.27%, and 3.86% PD solutions are equivalent to 1.5%, 2.5%, and 4.25% PD solutions, respectively.
- Total Daily Dialysate Volume (L): Estimated minimum daily dialysate volume.
  - The estimated minimum total dialysate volume a patient would require, per day, to meet an adequacy goal of 1.7. This estimate is based on the entered transport type, residual kidney function, and estimated daily ultrafiltration. The calculation assumes ambulatory therapy, 2.0 L fill volumes, and exchange times equal to the time to peak UF for 1.5% dextrose solutions.
- BSA: Body Surface Area based on height and weight of the patient.
- Urea Distribution Volume: Volume used to calculate Kt/V based on gender and BSA.

3. Enter desired prescription parameters in Simple or Day/Night Modality Input modes to estimate Total Weekly Kt/V.

Simple Mode



Day/Night



- Desired Fill Volume (L): Enter the desired fill volume for the patient.
  Caution: Exceeding a patient's individual appropriate fill volume may put the patient at increased risk of overfill. An individual patient's appropriate fill volume must be clinically determined by the prescribing provider and may be well below the estimated maximum volume provided by the calculator.
- Desired Number of Exchanges (per day): Enter the desired number of exchanges the patient will perform each day.
- Desired Time per Exchange: Enter the desired time (hours) of each exchange. This time should include dwell time and transit time for fills and drains.
  - Total Volume: Total Daily Dialysate Volume based on entered parameters.
  - Total Time: Total Treatment Time based on entered parameters.
- Estimated Total Weekly Kt/V: Predicted total weekly Kt/V based on entered parameters.
  - The KDOQI guidelines recommend a minimum delivered total (peritoneal plus kidney) Kt/V of 1.7 per week. Targeting a clearance goal above the minimum requirement (e.g. a Kt/V of 2.0 as used in this calculator) may help ensure the minimum target is met.
- Kidney Weekly Kt/V: If RKF was entered as Kt/V, it is displayed here. If RKF was entered as Kidney Urea Clearance (mL/min), this is the calculated kidney weekly Kt/V.
- Peritoneal Weekly Kt/V: Predicted weekly Kt/V from dialysis.

PD Calculator Formulas and References

The formulas and modeling algorithms used in the PD Calculator are as follows and are based upon the cited references.

Body Surface Area: BSA

$BSA\ (m^2) = 0.007184 \times Height(cm)^{0.725} \times Weight(kg)^{0.425}$

Du Bois D, Du Bois E. A formula to estimate the approximate surface area if height and weight be known. Arch Intern Med. 1916;XVII(6_2):863-871.

Estimated Maximum Fill Volume: V_{max}

$V_{max}(L) = BSA(m^2) \times 1.5 \left(\frac{L}{m^2}\right)$, with a maximum of 3.0 L

Durand PY, Balteau P, Chanliau J, Kessler M. Optimization of fill volumes in automated peritoneal dialysis. Perit Dial Int. 2000;20(6):S83-8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11216546.

Urea Distribution Volume: V(L)

Females: $V = -7.73 + (22.72 \times BSA)$
Males: $V = -8.46 + (25.47 \times BSA)$

Diaz-Buxo JA, Gotch FA, Folden TI, Rosenblum S, Zazra J, Lew N, Crawford TL, Youngblood B, Pesich A, Lazarus JM. Peritoneal dialysis adequacy: A model to assess feasibility with various modalities. Kidney Int. 1999;55(6):2493-2501. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10354299.

Kidney Weekly Kt/V: Kt/V_{kidney}

$Kt/V_{kidney} = \left(\frac{\text{Kidney Urea Clearance}\left(\frac{mL}{min}\right) \times 1440 \left(\frac{min}{day}\right) \times 7 \left(\frac{days}{week}\right)}{V(L) \times 1000 \left(\frac{mL}{L}\right)}\right)$ *-or-* as entered in the patient data section

McCann L. Nutrition Management of the Adult Peritoneal Dialysis Patient. In: Byham-Gray L, Wiesen K, eds. A Clinical Guide to Nutrition Care in Kidney Disease. 1st ed. American Dietetic Association; 2004:57-69.

Estimated Weekly Kt/V: Kt/V_{total}

$Kt/V_{total} = Kt/V_{kidney} + Kt/V_{dialysis}$

$Kt/V_{dialysis} = Kt/V_{per\ exchange} \times \#\text{ of Exchanges} \times 7\ (\text{days/week})$

$Kt/V_{per\ exchange} = \frac{RT \times (\text{Fill Volume} + QFT)}{V}$

Simple Mode or Daytime Exchanges (Ambulatory)

$RT = \frac{QFT + \left[\text{Fill Volume} \times \left(1 - \exp^{\left(-1 \times \frac{KoA}{DV} \times Te\right)}\right)\right]}{QFT + \text{Fill Volume}}$

$DV = \text{Fill Volume} + QFT$

$Te = (\text{Exchange Time} \times 60) - (5.5 \times \text{Fill Volume})$

$KoA = \left[\frac{-\ln\frac{5}{9} \times 2.0}{60 \times Pt50Ur} - (0.0037 \times 2)\right] + (0.0037 \times \text{Fill Volume})$

Nighttime Exchanges (Supine)

$RT = \frac{QFT + \left[\text{Fill Volume} \times \left(1 - \exp^{\left(-1 \times \frac{KoA}{MV} \times tc\right)}\right)\right]}{QFT + \text{Fill Volume}}$

$MV = \text{Fill Volume} + (QFT \times 0.5)$

$tc = \text{Exchange Time} \times 60$

$KoA = \frac{-\ln(0.5) \times \text{Fill Volume}}{60 \times Pt50Ur}$

Pt50 Urea Defaults:	Transport Type	Pt50Ur Value
	Low	2.80
	Low-Average	2.25
	Average	1.60
	High-Average	1.10
	High	0.50

$$QFT = \frac{\text{Exchange Time}}{\text{Total Treatment Time}} \times \text{Ultrafiltration (L)}$$

Gotch FA, Keen ML. Kinetic Modeling in Peritoneal Dialysis. In: Nissenson AR, Fine RN, eds. Clinical Dialysis. 4th ed. New York: McGraw-Hill Medical Publication; 2005:385-420.

Total Treatment Time (hrs):

$\text{Treatment Time}_{simple}$ = (# of exchanges) x (time per exchange)

$\text{Treatment Time}_{day/night}$ = $[(\text{\#of exchanges}) \times (\text{time per exchange})]_{day}$ + $[(\text{\# of exchanges}) \times (\text{time per exchange})]_{night}$

Total Daily Dialysate Fill Volume (L):

$\text{Daily Fill Volume}_{simple}$ = (Fill Volume) x (# of exchanges)

$\text{Daily Fill Volume}_{day/night}$ = $[(\text{Fill Volume}) \times (\text{\# of exchanges})]_{day}$ + $[(\text{Fill Volume}) \times (\text{\# of exchanges})]_{night}$

Minimum Number of Exchanges per Day

$$QFT = \left(\frac{Peak\ UF\ Time\ 1.5\%\ glc}{24}\right) \times Estimated\ Daily\ UF$$

$$AA = \frac{-ln\frac{5}{9}\ x\ 2.0}{60\ x\ Pt50Ur} - (0.0037\ \times 2)$$

$$KoA_{amb} = AA + (0.0037\ \times\ 2.0)$$

$$Te = (4 \times 60) - (5.5 \times 2.0)$$

$$MV = 2.0 + QFT$$

$$RT = \frac{QFT + \left[2.0\ \times\ \left(1\ -\ exp^{-1 \times \frac{KoAamb}{MV}}\ \times Te\right)\right]}{QFT\ + 2.0}$$

$$\frac{Kt}{V}\ (per\ exchange) = \frac{RT\ \times\ (2.0\ + QFT)}{Urea\ Dist\ Volume}$$

$$\#exchanges = \frac{2.0\ -\ \frac{Kt}{V}\ (renal)}{\frac{Kt}{V}\ (per\ exchange)\ \times 7}$$

Additional References

Burkhart JM. Adequacy of Peritoneal Dialysis. In: Henrich WL, ed. Principles and Practice of Dialysis. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2009.

Davis ID, Cizman B, Mundt K, Wu L, Childers R, Mell R, Prichard S. Relationship between drain volume/fill volume ratio and clinical outcomes associated with overfill complaints in peritoneal dialysis patients. Perit Dial Int. 2011;31(2):148-153. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21282375.

Durand PY, Balteau P, Chanliau J, Kessler M. Optimization of fill volumes in automated peritoneal dialysis. Perit Dial Int. 2000;20(6):S83-8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11216546.

K/DOQI Clinical practice guidelines for peritoneal adequacy, update 2006. Am J Kidney Dis. 2006;48 Suppl 1:S91-7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16813997.

Mujais S, Childers RW. Profiles of automated peritoneal dialysis prescriptions in the US 1997-2003. Kidney Int Suppl. 2006;(103):S84-90. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17080117.

Mujais S, Story K. Improving cycler prescriptions in peritoneal dialysis through informatic profiling. Adv Chronic Kidney Dis. 2007;14(3):263-268. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17603980.

Mujais S, Vonesh EEF. Profiling of peritoneal ultrafiltration. Kidney Int Suppl. 2002;62(81):S17-S22. Available from: https://www.ncbi.nlm.nih.gov/pubmed/12230478.

Van Biesen W, Williams JD, Covic AC, Fan S, Claes K, Lichodziejewska-Niemierko M, Verger C, Steiger J, Schoder V, Wabel P, et al. Fluid status in peritoneal dialysis patients: the European Body Composition Monitoring (EuroBCM) study cohort. PLoS One. 2011;6(2):e17148. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21390320.

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