Home Hemodialysis Calculator

Instructions for Use and References
Version 1.1

Description

The online Home Hemodialysis (HHD) 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 HHD 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 HHD 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 HHD calculator is not intended to replace the judgment or experience of the prescribing healthcare provider. The HHD prescription is the sole responsibility of the prescriber.

Important Information

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

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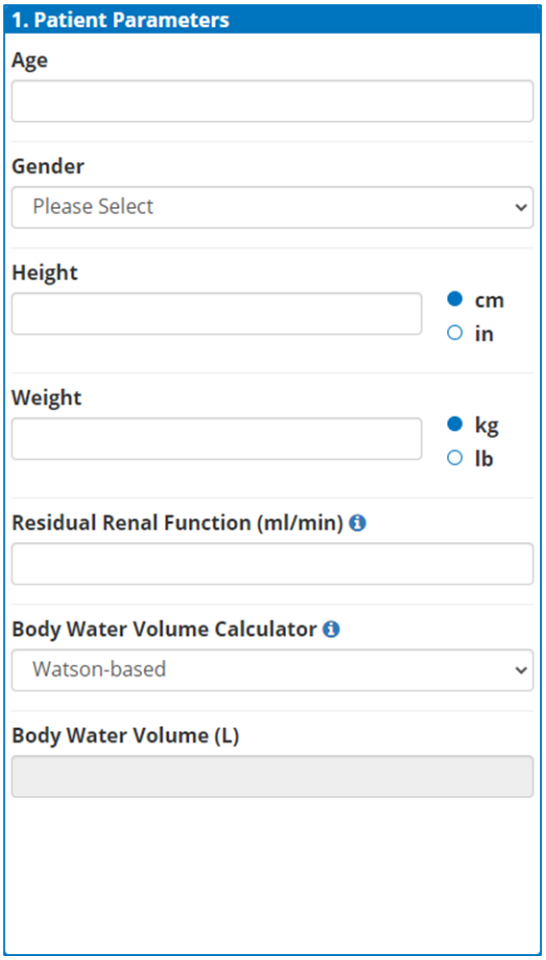
Minimum System Requirements

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

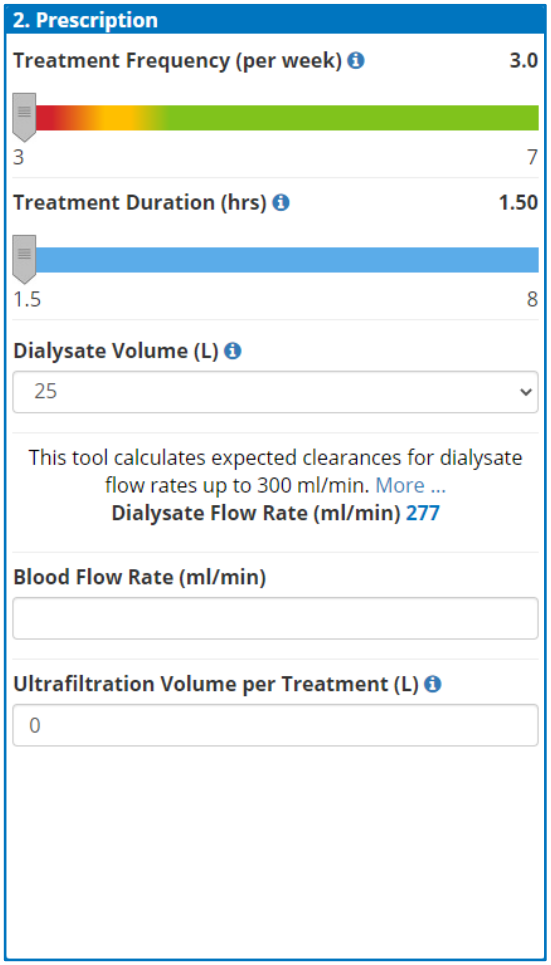
Instructions for Using the Home HD Calculator

1. Enter patient data in the Patient Parameters Section



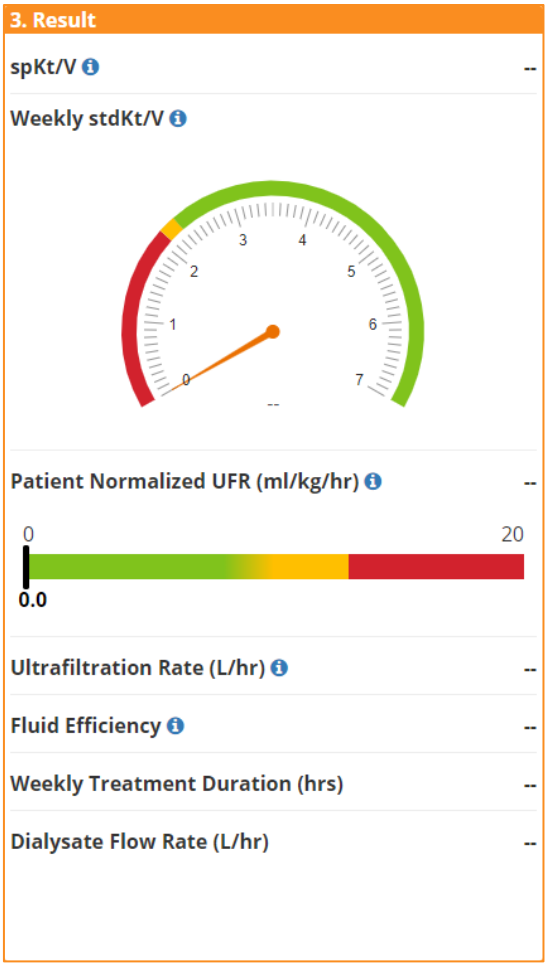
- Age: Enter the patient's age in years. Age must be a whole number from 18–120
- Gender: Select Male or Female from the drop-down menu
- Height: Enter the patient's height in cm (centimeters) or inch (inches). Choose the correct units from the radio buttons. Height must be 124–213 cm (49–84 in), entered as a whole number.
- Weight: Enter the patient's weight in kg (kilograms) or lb (pounds). Choose the correct units from the radio buttons. Weight must be greater than 0 lb or kg, and a whole number.
- Residual Kidney Function (RKF): Enter the patient's RKF as Kidney Urea Clearance (mL/min). RKF must be a whole number from 0–20 ml/min.
  - A patient's residual kidney function (RKF) can be considered when modeling an HHD 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. If you do not want to include RKF in modeling predictions, this can be left at 0.
- Body Water Volume Calculator: From the drop-down select Watson-based or Direct Entry. If Watson-based is selected, body water volume will be calculated based on Age, Gender, Height, and Weight and will display in the Body Water Volume field. If Direct-Entry is selected, enter the desired volume in the Body Water Volume field.
  - The determination of body water volume in the patient is an important part of estimating dialysis dose. Many methods for doing this exist. The HHD Calculator allows the use of the common Watson Body Water Calculator (slightly modified)[1,2], or direct entry of a body water volume. This volume is the urea distribution volume used in the calculation of Kt/V.
- Body Water Volume (L): The Watson-based calculation of Body Water Volume is displayed. Or, if Direct Entry is selected above, enter the body water desired volume.

2. Enter treatment parameters into the Prescription Section



- Treatment Frequency (per week): Move the slider to select the how many days per week the patient will do treatments.
  - Treatment frequency is the number of treatments the patient will do each week. The frequency of 3.5 is used in the weekly standard Kt/V calculation to model every other day therapy.
- Treatment Duration: Move the slider to select how long (in hours) each treatment will be.
  - Treatment Duration is the total amount of time the patient spends receiving dialysis each treatment. If the Treatment Frequency is 5 and the Treatment Duration is 3 hr, this would mean the patient would dialyze 15 hours per week. Best practices suggest a minimum of 12-15 hours per week; some benefits may occur with >15 hours/week[3].
- Dialysate Volume: The volume of dialysate used during a single treatment. Select a volume from the drop-down list for modeling.
  - Dialysate Volume is the amount of fluid used per treatment by the patient. Dialysate for HHD is typically available in 5-liter bags or produced in batches of 40, 50, or 60-liters.
- Dialysate Flow Rate (DFR) is calculated from Treatment Duration and Dialysate Volume. The calculator uses these parameters to calculate and immediately display a DFR.
  - This tool calculates expected clearances for dialysate flow rates up to 300 ml/min. If the dialysate flow rate is above 300 ml/min, the Dialysate Volume must be lowered, or Treatment Duration must be increased.
- Blood Flow Rate: Blood flow rate used during dialysis in ml/min.
- Ultrafiltration Volume per Treatment: The expected ultrafiltration (UF) volume that will be removed during each treatment. This volume will be applied to every treatment.
  - Ultrafiltration (UF) Volume is the amount of excess fluid that is to be removed from the patient each session. In actual practice, UF volume will vary each treatment, but for modeling purposes an expected amount is required. Keep in mind that even if no UF volume is needed in a treatment, the equipment will put fluid on at the end of the treatment when it rinses back the blood.

3. Review the results



- Single Pool Kt/V (spKt/V): Predicted spKt/V based on patient parameters and entered prescription.
  - Note: spKt/V measures the dialysis dose of a single treatment, expressed as the product of dialyzer urea clearance (K) and treatment time (t), divided by the urea distribution volume (V) of the patient. The spKt/V is recommended as the main target parameter only if frequency is 3 days/week which typically applies to in center. The KDOQI guidelines suggest targeting a spKt/V of 1.4 per hemodialysis session, with a minimum delivered spKt/V of 1.2 [4,5].
- Weekly stdKt/V: Predicted weekly standard Kt/V based on patient parameters and entered prescription.
  - Note: Weekly stdKt/V measures the dialysis dose of all treatments within one week, expressed as the product of dialyzer urea clearance (K) and treatment time (t), divided by the urea distribution volume (V) of the patient and an adjustment accounting for the treatment frequency. The stdKt/V is recommended as the main target parameter only for hemodialysis schedules other than thrice weekly which typically applies to HHD. The KDOQI guidelines suggest targeting a weekly stdKt/V of 2.3, with a minimum delivered dose of 2.1[4,5].
- Patient-Normalized UFR (ml/kg/hr): Calculated ultrafiltration rate (UFR) normalized to the entered patient weight.
  - The Patient-normalized UFR is calculated based on the patient weight, treatment duration, and UF volume in the calculator inputs. The calculator assumes that the UF volume will be removed over the entire duration of the treatment, i.e. as slowly as possible. Literature suggests that slower Patient-Normalized UFRs are associated with better survival[6].
- Weekly Treatment Duration: The total dialysis treatment time expected per week.
  - Weekly Treatment Duration is the product of the Treatment Duration and Treatment Frequency. Data has shown that increasing Weekly Treatment Duration may improve outcomes. Best practices suggest a minimum of 12-15 hrs./week; some benefits may occur with >15 hours/week[6].
- Dialysate Flow Rate (L/hr): The calculated dialysate flow rate for each treatment.
- Ultrafiltration Rate (L/hr): Calculated UFR
  - The UFR is calculated based on the treatment duration and UF volume in the calculator inputs. The calculator assumes that the UF volume will be removed over the entire duration of the treatment, i.e. as slowly as possible. Literature suggests that slower UF rates are associated with better survival[6].
- Fluid Efficiency: calculated percentage of prepared or bagged dialysate that is used each treatment.
  - The generation of dialysate fluid in the home is one of the key logistical and cost challenges for the therapy. For that reason, using dialysate fluid as efficiently as possible may be desirable. Fluid efficiency has no effect on therapy or patient outcome.

HHD Calculator Formulas and References

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

Urea Distribution Volume[1,2]

$$V = \begin{cases} \text{Male: } (2.447 - 0.09516A + 0.1074H + 0.3362W) \times 0.9 \\ \text{Female: } (-2.097 + 0.1069H + 0.2466W) \times 0.9 \end{cases}$$

V = body water volume (liters)
A = age (years)
H = height (cm)
W = weight (kg)

Urea Clearance[4,7–9]

$$K_u = \frac{Q_e\left(e^{K_oA\frac{\left(1-\frac{Q_e}{Q_d}\right)}{Q_e}} - 1\right)}{e^{K_oA\frac{\left(1-\frac{Q_e}{Q_d}\right)}{Q_e}} - \frac{Q_e}{Q_d}}\left(1 - \frac{Q_f}{Q_e}\right) + Qf$$

$K_oA_{in\ vivo} = 472.7 + 0.35 \times Q_d$

(DFR 200–300 ml/min)

$K_oA_{in\ vivo} = 62 + 2.4 \times Q_d$

(DFR < 200 ml/min)

$Q_e = 0.86 \times Q_b$

K_u = urea clearance (ml/min)
K_oA_{invivo} = estimated in vivo K_oA (dialyzer mass transfer area coefficient) (ml/min)
Q_e = equilibrated blood flow rate (ml/min)
Q_d = dialysate flow rate (ml/min)
Q_b = blood flow rate (ml/min)
Q_f = ultrafiltration rate (ml/min)

Weekly Standard Kt/V[5]

$$stdKt/V = \frac{10{,}080\,\frac{1 - e^{-eKt/V}}{t}}{\frac{1 - e^{-eKt/V}}{eKt/V} + \frac{10{,}080}{Nt} - 1} + K_r\,\frac{10{,}080}{V}$$

$$1 - \frac{0.74}{F}\left[\frac{U_f}{V}\right]$$

$$eKt/V = spKt/V(t/(t+30))$$

Where:

- stdKt/V = standard Kt/V
- spKt/V = single pool Kt/V
- eKt/V = equilibrated Kt/V
- V = body water volume (liters)
- F = N = number of treatments per week
- 10,080 = number of minutes in a week
- t = treatment duration (minutes)
- U_f = weekly ultrafiltration volume (liters)
- K_r = residual renal function (ml/min)

References:

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