

Hemodialysis Dose and Adequacy

When kidneys fail, dialysis is necessary to remove waste products such as urea from the blood. By itself, urea is only mildly toxic, but a high urea level means that the levels of many other waste products that are more harmful and not as easily measured are also building up.

To see whether dialysis is removing enough urea, the dialysis clinic should periodically—normally once a month—test a patient’s blood to measure dialysis adequacy. Blood is sampled at the start of dialysis and at the end. The levels of urea in the two blood samples are then compared. Two methods are generally used to assess dialysis adequacy, URR and Kt/V.

What is the URR?

URR stands for urea reduction ratio, meaning the reduction in urea as a result of dialysis. The URR is one measure of how effectively a dialysis treatment removed waste products from the body and is commonly expressed as a percentage.

Example: If the initial, or predialysis, urea level was 50 milligrams per deciliter (mg/dL) and the postdialysis urea level was 15 mg/dL, the amount of urea removed was 35 mg/dL.

$$50 \text{ mg/dL} - 15 \text{ mg/dL} = 35 \text{ mg/dL}$$

The amount of urea removed (35 mg/dL) is expressed as a percentage of the predialysis urea level (50 mg/dL).

$$35/50 = 70/100 = 70\%$$

Although no fixed percentage can be said to represent an adequate dialysis, patients generally live longer and have fewer hospitalizations if the URR is at least 60 percent. As a result, some experts recommend a minimum URR of 65 percent.

The URR is usually measured only once every 12 to 14 treatments, which is once a month. The URR may vary considerably from treatment to treatment. Therefore, a single value below 65 percent should not be of great concern, but a patient’s average URR should exceed 65 percent.

What is the Kt/V?

Kt/V is another way of measuring dialysis adequacy. In this measurement,

- K stands for the dialyzer clearance, the rate at which blood passes through the dialyzer, expressed in milliliters per minute (mL/min)
- t stands for time
- Kt, the top part of the fraction, is clearance multiplied by time, representing the volume of fluid completely cleared of urea during a single treatment



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- V, the bottom part of the fraction, is the volume of water a patient's body contains

Example: If the dialyzer's clearance is 300 mL/min and a dialysis session lasts for 180 minutes (3 hours), Kt will be 300 mL/min multiplied by 180 minutes. The result comes to 54,000 mL, or 54 liters.

$$\begin{aligned} Kt &= 300 \text{ mL/min multiplied by } 180 \text{ minutes} \\ Kt &= 54,000 \text{ mL} = 54 \text{ liters} \end{aligned}$$

The body is about 60 percent water by weight. If a patient weighs 70 kilograms (kg), or 154 pounds (lbs), V will be 42 liters.

$$V = 70 \text{ kg multiplied by } .60 = 42 \text{ liters}$$

So the ratio—K multiplied by t to V, or Kt/V—compares the amount of fluid that passes through the dialyzer with the amount of fluid in the patient's body. The Kt/V for this patient would be 1.3.

$$Kt/V = 54/42 = 1.3$$

How does the Kt/V compare with the URR?

The Kt/V is mathematically related to the URR and is in fact derived from it, except that the Kt/V also takes into account two additional factors:

- urea generated by the body during dialysis
- extra urea removed during dialysis along with excess fluid

The Kt/V is more accurate than the URR in measuring how much urea is removed during dialysis, primarily because the Kt/V also considers the amount of urea removed with excess fluid. Consider two patients with the same URR and the same postdialysis weight, one with a weight loss of 1 kg—about 2.2 lbs—during the treatment and the other with a weight loss of 3 kg—about 6.6 lbs. The patient who loses 3 kg will have a higher Kt/V, even though both have the same URR.

The fact that a patient who loses more weight during dialysis will have a higher Kt/V does not mean it is better to gain more water weight between dialysis sessions so more fluid has to be removed, because the extra fluid puts a strain on the heart and circulation. However, patients who lose more weight during dialysis will have a higher Kt/V for the same level of URR.

Name <i>Mary C.</i>					
Name of Test	Goal	Jan	Feb	Mar	Apr
Kt/V	≥ 1.2	1.3	1.2	1.2	1.1
URR	$\geq 65\%$	67	65	65	67
Hemoglobin	11-12	12.1	11.0	11.4	12.1
Target Weight	132 lbs	134	134	133	132

A patient's monthly lab tests should include either a URR or a Kt/V.

On average, a Kt/V of 1.2 is roughly equivalent to a URR of about 63 percent. Thus, another standard of adequate dialysis is a minimum Kt/V of 1.2. The Kidney Disease Outcomes Quality Initiative (KDOQI) group has adopted the Kt/V of 1.2 as the standard for dialysis adequacy.¹ Like the URR, the Kt/V may vary considerably from treatment to treatment because of measurement error and other factors. So while a single low value is not always of concern, the average Kt/V should be at least 1.2. In some patients with large fluid losses during dialysis, the Kt/V can be greater than 1.2 with a URR slightly below 65 percent—in the range of 58 to 65 percent. In such cases, the KDOQI guidelines consider the Kt/V to be the primary measure of adequacy.

¹National Kidney Foundation: K/DOQI clinical practice guidelines for hemodialysis adequacy, 2000. *American Journal of Kidney Disease*. 2001;37(suppl 1):S7-S64.

Is a URR of 65 percent or a Kt/V of 1.2 good enough?

These dialysis adequacy guidelines were determined on the basis of studies in large groups of patients. These studies generally showed that patients with lower Kt/V and URR numbers had more health problems and a greater risk of death. However, the HEMO study—see Hope through Research—showed that a Kt/V greater than 1.2 did not result in improved outcomes.

If a patient's Kt/V is always above 1.2 and the URR is close to 65 percent, then the patient's treatment is meeting adequacy guidelines. The patient's URR may be a few points below 65 if the person has large fluid losses during dialysis.

What can patients do to improve their Kt/V?

If a patient's average Kt/V—usually the average of three measurements—is consistently below 1.2, the patient and the nephrologist need to discuss ways to improve it. Since the V value is fixed, Kt/V can be improved either by increasing K or t.

Increase Blood Flow through the Dialyzer

Increasing K depends primarily on the rate of blood flow through the dialyzer. No matter how good a dialyzer is, how well it works depends primarily on moving blood through it. In many patients, a good rate is difficult to achieve because of vascular access problems.

If a patient's blood flow rate is good, further improvements in clearance can be obtained by using a big dialyzer or, in some cases, by increasing the flow rate for dialysis solution from the

usual 500 mL/min to 600 or 800 mL/min. A good flow rate for adult patients is 350 mL/min and higher. A few centers are even using two dialyzers at the same time to increase K in larger than average patients.

However, the rate of blood flow through the dialyzer is key, and a good vascular access is crucial to make sure a patient is getting good clearance.

Increase Time on Dialysis

The other way to improve the Kt in Kt/V is to increase t by dialyzing for a longer period. For example, if the Kt/V is 0.9 and the goal is 1.2, then $1.2/0.9 = 1.33$, so 1.33 times more Kt is needed. If K is not changed, this means the length of the session needs to increase by 33 percent. If the inadequate sessions lasted 3 hours, they should be increased to 4 hours.

Identify and Eliminate Circulation Problems

If during any given month a patient's Kt/V is extremely low, the measurement should be repeated, unless a reason for the low Kt/V is obvious. Obvious reasons include treatment interruption, problems with blood or solution flow, and a problem in sampling either the pre- or postdialysis blood. If no reason for the sudden drop is apparent, then a problem with needle placement, like accidental needle reversal, or with the vascular access, such as recirculation, should be suspected.

Points to Remember

- The two methods generally used to assess dialysis adequacy are URR and Kt/V.
- A patient's average URR should exceed 65 percent.
- A patient's average Kt/V should be at least 1.2.
- A patient's URR or Kt/V can be increased either by increasing time on dialysis or increasing blood flow through the dialyzer.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), through its Division of Kidney, Urologic, and Hematologic Diseases, supports several programs and studies devoted to improving treatment for patients with progressive kidney disease and permanent kidney failure, including patients on hemodialysis.

- **The End-Stage Renal Disease Program** promotes research to reduce medical problems from bone, blood, nervous system, metabolic, gastrointestinal, cardiovascular, and endocrine abnormalities in kidney failure and to improve the effectiveness of dialysis and transplantation.
- **The HEMO Study**, completed in 2002, tested the theory that a higher dialysis dose or high-flux membranes would reduce patient mortality—death—and morbidity—medical problems. Doctors at 15 medical centers recruited more than 1,800 hemodialysis patients and randomly assigned them to high or standard dialysis doses. The study found no increase in the health or survival of patients who had a higher dialysis dose.

- **The Frequent Hemodialysis Clinical Trials** will compare the conventional, three-times-a-week schedule of hemodialysis with schedules that include shorter daily sessions or longer overnight sessions. Researchers will determine whether more frequent hemodialysis improves blood pressure control, nutritional status, anemia, quality of life, heart health, and vascular access condition.
- **The U.S. Renal Data System (USRDS)** collects, analyzes, and distributes information about kidney failure in the United States. The USRDS is funded directly by the NIDDK in conjunction with the Centers for Medicare & Medicaid Services. The USRDS publishes an *Annual Data Report*, which characterizes the total population of people with kidney failure; reports on incidence, prevalence, mortality rates, and trends over time; and develops data on the effects of various treatments. The report, available at www.usrds.org, also helps identify problems and opportunities for more focused special research on kidney issues.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit www.ClinicalTrials.gov.

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About the Kidney Failure Series

The NIDDK Kidney Failure Series includes booklets and fact sheets that can help the reader learn more about treatment methods for kidney failure, complications of dialysis, financial help for the treatment of kidney failure, and eating right on hemodialysis. Free single printed copies of this series can be obtained by contacting the National Kidney and Urologic Diseases Information Clearinghouse.

You may also find additional information about this topic by visiting MedlinePlus at www.medlineplus.gov.

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