PRACTICE POINT

Haemodialysis Adequacy: Practical Understanding

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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 level of many other waste products that are harmful and not easily^{1,2} measured are also building up. To see whether dialysis is removing enough urea the dialysis clinic should periodically, normally once in a month, test the patient's blood to measure dialysis adequacy. Blood is sampled at the start of dialysis and at the end. The level in the two blood samples is then^{3,4,5,6} compared.

Three methods are generally used to assess dialysis adequacy:-

1. URR (Urea reduction ratio)
2. Kt/V
3. HDP (Haemodialysis Product)

What is URR? It means the reduction in urea as a result of dialysis. URR is one measure of how effectively a dialysis treatment removed waste products from the body and is^{3,4} commonly expressed as percentage. For example, if the initial /predialysis urea level was 100 mg/dl and post dialysis urea level was 30mg/dl, the amount of urea removed is 70 mg/dl (100-30). This amount of urea removed (70mg/dl) is expressed as percentage of the predialysis level (100 mg/dl) i.e. $70/100=70\%$. Although no fixed percentage can be said to represent an adequate dialysis, patients generally live longer,^{3,4} have fewer hospitalizations if URR is at least 60%. Some experts recommend a minimum URR of 65%. URR is usually

measured once every 12-14 treatment sessions which 2,3 is once a month. URR may vary considerably from treatment to treatment. Therefore a single value below 65% should not be of great concern but a patient's average URR should exceed 65%.

What is Kt/V? It is another way of calculating dialysis^{5,6} adequacy. In this measurement; K stands for dialyzer clearance i.e. the rate at which the blood passes through the dialyser, expressed in 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. V is the volume of the water a patient's body contains. Example: If the dialyser clearance is 300ml/min and dialysis session lasts for 180 minutes, Kt will be $300 \times 180 = 54,000\text{ml}$ or 54 liters. The body is about 60% water by weight. If patient's weight is 70 kg, V will be $70 \times 0.6 = 42$ liters. So ratio Kt/V is $54/42=1.3$. The Kt/V is mathematically related to URR and is infact derived from it, except that the Kt/V takes into account two additional factors-

1. Urea generated by the body during dialysis.
2. Extra quantity of urea removed during dialysis along with excess fluid.

Kt/V is more accurate than 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. In two patients with same URR and same post dialysis weight, one with a weight loss of 1 kg during treatment and other with weight loss of 3 kg. The patient who loses 3 kg's will have a higher Kt/V, even though both have 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 session so more

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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.

On average, a Kt/V of 1.2 is roughly equivalent to URR of about 63%. Thus another standard of adequate dialysis is a minimum Kt/V of 1.2. The kidney disease outcome quality initiative (K-DOQI) group has adopted the Kt/V of 1.2 as standard of dialysis adequacy^{7,8}. Like 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, 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 URR slightly below 65% (in the range of 58-65%). In such cases the KDOQI guidelines consider the Kt/V to be the primary measure of adequacy⁸.

Is URR of 65% or Kt/V of 1.2 good enough? The dialysis adequacy guidelines were determined on the basis of studies in large groups of patients. The studies generally showed that patients with lower Kt/V and URR had more health problems and a greater risk of death^{9,10,11}. If the patient's Kt/V is always above 1.2 and URR is close to 65% then his treatment is meeting adequacy guidelines⁹. In general, optimal clearance can be defined as that clearance above which further increments do not have clinically significant improvements in patient outcome^{9,10}. Minimum targets are best defined as those that allow the patient to be maintained in reasonably good health without significant uraemic symptoms⁹.

How can we improve Kt/V? If during any month, patient's Kt/V is extremely low, the measurement should be repeated, unless a reason for low Kt/V is obvious. Obvious reasons include treatment interruption, problems with blood or solution flow, and a problem in sampling either pre or post dialysis blood. If no reason for 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.

If the patient's average Kt/V usually the average of 3 measurements- is consistently below 1.2 the patient and the nephrologists need to discuss the ways to improve it. Since V value is fixed /constant, Kt/V can be improved by increasing K or t.

1. Increasing flow through the dialyser; increasing K

depends primarily on the rate of blood flow through the dialyzer¹¹. 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 patients' blood flow is good, further improvements in clearance can be obtained by using a big dialyser or in some cases by increasing flow rate for dialysis solution from usual 500ml/min to 800ml/min. a few centers are even using two dialyzers at the same time to increase K in larger than average patients¹². However, the rate of blood flow through the dialyser is key and a good vascular access is crucial to make sure a patient is getting good clearance.

2. Increasing time on dialysis" the other way to improve Kt in Kt/V is to increase t by dialyzing for longer period e.g. if Kt/V is 0.9 and goal is 1.2 then $1.2/0.9 = 1.33$ that is 1.33 more Kt is needed. If K is not changed, this means that the length of the session needs to increase by 33%. So if inadequate session lasts for 3 hours, it should be increased to 4 hours.

What is HDP? URR & Kt/V are based primarily on removal of urea during a dialysis session. However, there is irrefutable support that it is the adequate removal of middle molecules (MM), rather than the removal of urea, which correlates with 13 survival and well-being among patients on hemodialysis. The HDP incorporates dialysis frequency and is a simple- tocomprehend index. $HDP = (hrs/dialysis\ session) \times (sessions/wk)^2$. A key example is the value of 3 times a week for 3 hours = 27, which has been proved to be totally inadequate and results in severe malnutrition and death. With 5 hours/session, 3 times a week, the HDP is 45 and at 8 hours/session 3 times/week HDP is 72. Since HDP does not take patient size into account large adults will require a high HDP.

There are some advantages for the HDP over URR & Kt/V. First, the HDP does not depend on any test, while Kt/V depends on blood tests that tend to err toward a falsely high value. The HDP assumes that the dialysis being given is basically sound. Second, the HDP is easy for patients to comprehend. Patients can calculate and keep track of their own HDP until they can learn to judge by the way they feel whether they are receiving enough dialysis. The third advantage of the HDP is that the higher the values, the better the chance of obtaining BP control using the dry weight method. However its wide spread applicability is yet to be accepted by many.

Points to Remember

1. Two common methods generally used to assess dialysis adequacy are URR and Kt/V.
2. A patient's average URR should exceed 65%.
3. A patient's average Kt/V should be at least 1.2%.
4. A patient's URR/ Kt/V can be increased either by increasing the time on dialysis or by increasing blood flow through the dialyzer.

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