



## Crafting the Prescription for Patients Starting Peritoneal Dialysis

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### Introduction

At present, approximately 10%–11% of patients with ESKD worldwide choose to perform peritoneal dialysis (PD). Whereas the initial hemodialysis prescription tends to be relatively uniform and standardized, the initial PD prescription lends itself to a more individualized approach. In this article, an initial approach to the prescription of PD is discussed.

### Deciding on a PD Modality

As a first step, the patient must decide whether to do PD in a manner that uses strictly manual exchanges, known as continuous ambulatory PD (CAPD), versus one using a cyclor, known as automated PD (APD). The physician can assist the patient with this decision by assessing the responses to the following questions:

- Must his/her dialysis be arranged around a work schedule and, if so, what are the work hours?
- Is the patient comfortable with the use of machinery or would s/he prefer a strictly manual method?
- When does he/she commonly go to sleep and arise?
- Is s/he willing to be connected to a machine, and therefore be “tethered” in place for an hour or two before and/or after usual sleep hours?

The physician and patient must work together to design a prescription that best fits the patient’s lifestyle and achieves the desired clinical goals. The ensuing discussion addresses some of the factors to consider in crafting this prescription.

### Considerations Regarding the Initial PD Prescription

#### Deciding on Timing and Duration of Treatment, Dwell Volume, and Number of Cycles

The timing and duration of treatment should be tailored to the individual patient’s lifestyle, matching the patient’s wake–sleep pattern and accommodating the need to continue employment. Rarely do patients sleep more than 8 hours; an APD prescription that ties the patient down for longer periods may cause him/her to retire for the evening early and lose precious family time. Similarly, the patient who wishes to continue

working should not be expected to perform a manual exchange during work hours.

Patients are generally able to tolerate intraperitoneal volumes of 1.25–1.5 L/m<sup>2</sup> BSA. As intraperitoneal pressure is lowest when supine, intermediate when erect, and highest when sitting, patients will often tolerate larger volumes when recumbent at night than when upright during the day (1). Dwell volumes need not be prescribed in increments of 0.5 L. Patients performing CAPD can estimate volumes of intermediate volume and the currently available cyclers for APD can easily be programmed to deliver volumes in increments of 0.1 L. Note that increasing fill volume is often preferred by the patient over increasing the number of dwells and has a greater effect on increasing small solute clearance.

Care should be taken not to prescribe more than four or five exchanges per APD session. Each exchange requires 15 minutes (at least) of drain and fill time, during which no dialysis occurs. Furthermore, although beneficial for small solute clearance, rapid exchanges adversely affect clearance of sodium (due to sodium sieving), phosphorus, and middle molecules.

#### Incremental PD

Although the definition of incremental PD varies between authors, the term generally refers to the practice of using residual kidney function (RKF) to achieve the total desired solute removal, and initially prescribing only a modest dose of PD. This may take any of several forms: prescribing a smaller total volume of fluid (*e.g.*, only two or three CAPD exchanges daily); using only part of the day (*e.g.*, nocturnal APD with a dry day); or performing PD for fewer than 7 days per week (2). Many patients find this a more acceptable manner to begin RRT and, in fact, this may attract some patients to PD in the first place. Kinetic simulation of incremental PD demonstrated that patients with a GFR as low as 4–5 ml/min per 1.73 m<sup>2</sup> could be successfully managed in this fashion (3). As RKF declines the PD prescription may be increased incrementally as needed to further augment solute clearance. Recent reports regarding the use of incremental dialysis have demonstrated good clinical outcomes (2,4).

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Some patients initiate RRT because of volume overload rather than the need for solute clearance. They may often be managed with just two or three dextrose-based exchanges overnight. Keeping the patient dry during the day has the advantage of avoiding the risk of fluid absorption during the long day dwell. Even more simply, some patients will achieve the additional ultrafiltration needed with the use of a single long dwell of icodextrin, which may be done manually and, at the patient's discretion, may be performed during the day or overnight. As the patient becomes resistant to increasing doses of diuretics, the PD prescription is increased as needed to further augment volume removal.

### Estimating the Minimum Necessary Dialysis Dose to Achieve Adequate Small Solute Clearance

Recognizing that  $Kt/V_{\text{urea}}$  is an imperfect measure of dialysis adequacy, it may nevertheless be useful as a starting point from which to estimate the initial volume of dialysis fluid to prescribe (5). Standardized weekly  $Kt/V_{\text{urea}}$  in PD is expressed as:

$$\frac{D_{\text{urea}}/P_{\text{urea}} \times DV \times 7}{V_{d_{\text{urea}}}}, \quad (1)$$

in which  $D_{\text{urea}}$  and  $P_{\text{urea}}$  are the urea concentrations measured in dialysate and plasma respectively; DV, the drain volume per day, is the algebraic sum of the instilled volume and net ultrafiltration; and  $V_{d_{\text{urea}}}$ , the volume of distribution of urea, is assumed to be total body water (TBW). Let us examine the application of this equation in two scenarios: patients without or with significant RKF.

**A. The Patient with Virtually No RKF.** Let us begin by considering an anuric patient, for example, a patient who has failed hemodialysis. Recall that the target for weekly  $Kt/V_{\text{urea}}$  recommended by the International Society for Peritoneal Dialysis is 1.7 (6). Therefore, the daily  $Kt/V$  would need to be one seventh of this, or 0.243; for the sake of simplicity, this may be rounded to 0.25. Thus, for daily  $Kt/V$  to equal 0.25, the following relationship pertains:

$$\frac{D_{\text{urea}}/P_{\text{urea}} \times DV}{\text{TBW}} = 0.25. \quad (2)$$

The maximum ratio of  $D_{\text{urea}}/P_{\text{urea}}$  obtainable is 1. Although not achieved in practice (certainly not when performing APD with multiple short dwells) if we assume this to be the case, the DV needed to achieve the daily  $Kt/V$  of 0.25 is then equal to  $0.25 \times \text{TBW}$  (note that using the common approximation that  $\text{TBW} = 0.6 \times \text{weight [kg]}$  will generally overestimate TBW, thereby partially compensating for the overestimate of  $D/P_{\text{urea}}$ ). This value, minus some arbitrarily selected value for net ultrafiltration (1 L is a reasonable first approximation), would then be the minimum volume of dialysis fluid one could prescribe and hope to have adequate small solute removal. So, if our patient weighs 80 kg, we would estimate an initial prescription of at least 11 L of dialysis fluid ( $[80 \times 0.6 \times 0.25] - 1$ ). Therefore, we might initially prescribe four nightly exchanges of 2.5 L each and a last fill of 1 L.

**B. The Patient with Significant RKF.** For the patient coming to PD with RKF, this approach may be adapted by measuring the daily residual urinary  $Kt/V$  ( $U_{\text{urea}}/P_{\text{urea}} \times \text{urine}$

volume/TBW), subtracting the resulting value from 0.25, and using this number instead of 0.25 in Equation 2 to solve for DV. So, if the same 80 kg patient has a plasma urea of 50 mg/dl and produces 1 L of urine daily with a urea concentration of 240 mg/dl, the daily residual urinary  $Kt/V_{\text{urea}}$  would be  $(240/50 \times 1/48) = 0.1$ . Subtracting this from 0.25 and then substituting 0.15 in place of 0.25 in Equation 2 yields an estimate of 7.2 L for the needed DV. Assuming the same 1 L of daily UF one would need a dose of just 6.2 L of dialysate; one might therefore prescribe just three nightly exchanges of 2.1 L each. This approach may feel cumbersome at first but, once used with frequency, becomes easy to use and practical.

### Other Considerations

#### Urgent Start PD

Urgent start PD—the initiation of PD within 2 weeks of catheter placement in a patient with no prior planned RRT—has become increasingly prevalent in the past few years. Because of the concern of leakage around a newly placed catheter, the volume of fluid infused is generally smaller than for standard PD. The volume is tailored to body size: one algorithm is for patients with body surface area  $< 1.65 \text{ m}^2$  to begin with 750 ml; those up to  $1.8 \text{ m}^2$ , 1000 ml; and larger patients receive 1250 ml. The total dialysis time and number of exchanges may be adjusted depending on the degree of residual GFR and the severity of uremic signs or symptoms (7).

#### Tidal PD

Some patients may experience discomfort in the pelvic/rectal region when draining. This is likely due to the catheter approaching and irritating the rectum or other adjacent viscus as intraperitoneal volume decreases. This sensation generally diminishes over time but may be problematic early in the course of PD, particularly in patients on APD who are attempting to sleep during the performance of their dialysis. The solution may be to use tidal PD. In tidal PD, the abdomen is not fully drained at the end of each dwell. Rather a residual volume (usually 15%–25%) is kept in the abdomen at the end of each dwell as a cushion; this helps to prevent the catheter from irritating a viscus. Obviously, the dialysate and ultrafiltrate cannot continue to accumulate indefinitely and must be drained at some point; this is done in the morning when the patient is awake and therefore more tolerant of the discomfort.

#### Is CAPD Training Necessary for Patients on APD?

One question often raised regarding PD training relates to the need for training in manual exchange techniques (CAPD) for patients who choose to perform APD. The argument has been made that if patients are not trained in the performance of manual exchanges, they will be incapable of dialyzing in the event of a natural disaster such as a hurricane or tornado, during which electric power is lost. Although there is some merit to this concern, it should be recognized that patients on APD are trained to drain and disconnect manually. The inability to connect manually and perform CAPD exchanges is generally not problematic as patients can usually safely tolerate a day or two without dialysis (remember that patients on hemodialysis go nearly 72 hours without dialysis over the weekend), by which time power will almost certainly have been restored. Note

also that training in APD only is standard in areas where assisted APD is available.

### Timing of the First Peritoneal Equilibration Test

Recent data indicates that peritoneal transport status has prognostic value regarding mortality and frequency of hospitalization (8). However, because transport characteristics may change during the first few weeks on PD, the peritoneal equilibration test is generally not performed until the patient has been on PD for 4–6 weeks (9). Therefore, results of the peritoneal equilibration test are not used in formulating the initial PD prescription. That said, the astute clinician, and very commonly the astute PD nurse, may notice that a patient has negative ultrafiltration (*i.e.*, absorbs fluid) during a long dwell, suggesting that s/he is a rapid transporter. The prescription should then be modified to avoid this if better ultrafiltration is needed. The recent availability of remote monitoring of PD treatments allows for adjustment of prescriptions even when the patient is not physically present in the clinic.

### A Concluding Thought

“(T)he secret of the care of the patient is in caring for the patient” (10). We must pay careful attention to the patient’s lifestyle and his/her needs and desires. Coupled with the appropriate application of physiology and sound medical judgement, this will culminate in a prescription that meets the patient’s clinical needs and is one with which s/he is able to comply.

### Disclosures

None.

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