Chapter 4

WHAT IS PERITONEAL DIALYSIS?

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Peritoneal dialysis is similar in principle to hemodialysis. Both of these forms of renal replacement therapy depend upon the passive movement of water and dissolved substances (solutes) across a semipermeable membrane. This process is called *diffusion*. The direction of movement of solute is determined by the relative concentration on each side of the membrane, so that a substance goes from the side of greater to lesser concentration.

But that is pretty much where the similarities end, for the techniques themselves are very different from one another. Those differences are what provide for true treatment options for the person who requires dialysis therapy. Hemodialysis is a very efficient method of ridding the body of accumulated metabolic waste; the patient's blood is circulated outside the body through a filter (the artificial kidney) and then returned continuously for several hours, usually two or three times each week. In between treatments, the levels of solute (waste products) and water increase gradually: the rate of accumulation depending primarily upon what the patient eats and drinks between treatments. The treatment itself removes the waste products fairly rapidly. This rapid change in body composition can lead to dialysis disequilibrium syndrome, which may explain symptoms, such as fatigue and headache, which patients often experience after a hemodialysis treatment.

Peritoneal dialysis, on the other hand, is a slower, more gradual process which utilizes the natural lining of the abdomen, the *peritoneum*, as the exchange membrane. In the past, peritoneal dialysis was performed intermittently: the patient would do a series of fluid exchanges over a period of eight hours or more (usually overnight), three or four times a week. A number of automated machines were developed to help make the process simpler and easier. Using this intermittent technique, however, many patients were underdialyzed.

While peritoneal dialysis has been available for many years, even pre-dating hemodialysis, it was not until the mid-1970's that it gained substantial popularity with the development of the technique of *Continuous Ambulatory Peritoneal Dialysis, CAPD*. With CAPD, the apparent dis-advantages of peritoneal dialysis have become the strengths of this form of renal replacement therapy. Variations of CAPD have also been developed. For example, *Continuous Cycling Peritoneal Dialysis*, *CCPD*, uses an automated machine called a cycler to perform fluid exchanges while the patient is sleeping at night. The principles, and problems, of both CAPD and CCPD are very similar, and since CAPD has been more popular, the remainder of this discussion will focus on CAPD.

The technique of CAPD is quite simple, and there have been a variety of devices developed to make the solution exchanges even easier, especially for individuals with reduced manual dexterity or with visual handicap. Briefly, the patient's abdomen (body cavity) is always filled with dialysis fluid, *dialysate*, a specially designed solution consisting of electrolytes and dextrose. This fluid needs to be changed periodically, as the concentration of waste products, which diffuse from the patient's blood, across the peritoneal tissue, and into the peritoneal fluid, increases. The dextrose, or sugar, in the dialysate draws water, by the process of *osmosis*, from the body into the peritoneal space. As some of the dextrose is absorbed (by diffusion) *into* the patient, and as the concentration of dextrose within the abdomen decreases as water from the patient is added, fluid removal decreases.

Access to the peritoneum is by means of a small tube, or *catheter*, which is inserted surgically into the abdomen. Since the incision is small, and the procedure is fairly quick, it is best, and safer, to use a local, rather than general, anesthesia for this operation. The catheter should exit the abdomen towards the patient's side, and away from the belt line.

To do a solution exchange, the patient should first find a quiet place, with no drafts or air currents, which might increase the chances of contamination. After washing his hands carefully, and then preparing the few pieces of equipment, he begins to let gravity drain the old solution from his abdomen. This usually takes about ten to twenty minutes.

The next step is to disconnect the dialysis tubing from the old dialysate bag, and connect the tubing to the bag with fresh solution. This can be done manually, which requires a fair amount of hand-eye coordination, as well as physical strength, or with the aid of any one of a number of mechanical (and easily portable) devices. For example, one very popular machine combines mechanical transfer capability with ultraviolet light for sterilization of the plastic “spike” which is at the end of the tubing. A battery pack is available to allow freedom of travel. With these earlier devices, the patient was always connected from the catheter to the tubing and empty dialysate bag, which was tucked beneath the clothing. There has recently been introduced a technique to permit separation of the bag and tubing from the catheter, so that patients no longer need to find ways to “store” the bag between exchanges.

Once the tubing transfer has been accomplished, the bag must be lifted above the patient’s abdomen, so that the new dialysate can be drained into the patient. The patient then puts his supplies away, discards the used solution and disposable bag, and goes on his way. A complete solution exchange takes about twenty to thirty minutes.

Most patients do four solution exchanges daily: first thing in the morning, around noon time, late afternoon, and at bedtime. The exact timing is not critical. For maximum efficiency, the *dwell* time, or time that the solution remains in the abdomen, should be at least four hours. Unless a cycler is being used (as in CCPD), no exchanges are done during the night: this dwell time is therefore substantially longer, depending upon the patient’s sleep habits.

Since dialysate is always within the abdomen, the patient is always being dialyzed. The removal of waste products and water is therefore both *gradual* and *continuous*. The dialysis, therefore, begins to approximate the excretory function of normal kidneys. Furthermore, there are no symptoms of disequilibrium, because waste product levels remain relatively constant. CAPD is particularly suited to people with severe heart or lung problems. Poorly tolerated fluid build-up is avoided by the continual removal of water.

Many people have enjoyed this liberation from a machine, in spite of having to perform the exchange procedure four, or sometimes even five, times daily. They adjust quickly to the sensation of having two (or more) liters of fluid in their abdomen. Patients have reported an increased sense of well-being, improved appetite (because the treatment is continuous, dietary restrictions can be liberalized, but not entirely eliminated), resolution of symptoms such as itching and insomnia, and better control of blood pressure.

Most of the problems associated with peritoneal dialysis relate to the catheter. Catheter obstruction, abdominal pain, or malpositioning of the catheter tip may all limit the efficiency of the treatment. Infection of the skin exit site, the subcutaneous catheter tunnel, or the peritoneum *(peritonitis)* are all potentially serious, and not uncommon, problems which require prompt attention. While these infectious problems can usually be treated very effectively with antibiotics, occasionally the catheter does need to be removed in order to completely eradicate the infection. If a new catheter cannot be placed immediately, the patient will temporarily require hemodialysis.

Peritonitis is perhaps the most common major problem associated with peritoneal dialysis. Symptoms may be very mild at first, but if ignored, can become quite severe. Patients with peritonitis complain of abdominal pain or discomfort, nausea, vomiting, or diarrhea. Fever may or may not be present. The drainage fluid from the abdomen is usually cloudy. Treatment consists of antibiotics, which can be added to the dialysate, or given intravenously. Unless the patient is very sick and unable to do his or her own exchanges, most episodes of peritonitis can be managed without hospitalization.

Symptoms of peritonitis usually subside within one or two days, and the fluid should clear as well. If the problem does not resolve quickly, or if peritonitis recurs shortly, there may be a more serious underlying complication or a more unusual type of infection. Bacteria have been shown to adhere tightly to the catheter, and even to become encased in a protein called *fibrin*. This may prevent adequate exposure of the bacteria to the antibiotic and prevent treatment. In such a situation, it is best to have the catheter removed to allow complete eradication of the infection.

Hernia may occur in patients treated with CAPD because of the increased pressure within the abdomen caused by the presence of the dialysis solution. A bulge may develop either in the groin, or at the site of a new or old abdominal incision. Coughing and straining also increase the risk of hernia formation. As mentioned earlier, general anesthesia should be avoided during catheter placement to prevent post-operative coughing, which could result in a hernia at the site where the catheter exits the peritoneum. Hernias need to be repaired surgically. CAPD can be continued after repair, but the volume of dialysate should be reduced until wound healing is complete. The patient must exercise great caution to avoid straining.

As noted above, the dextrose, or sugar, which is contained in the dialysate in order to remove fluid, is absorbed to a significant extent. The amount of dextrose absorbed per day depends upon the concentration of dextrose used for each exchange, and on the number of exchanges. The dextrose concentration can be varied to either increase or decrease the amount of fluid removed. As of this writing, there are three concentrations available: 1.5%, 2.5%, and 4.25%. While increasing from the lower to higher amounts will generally increase the amount of water removed, it will also increase the amount of sugar absorbed. This absorbed sugar directly contributes to the number of calories ingested by the patient.

There are several consequences of this sugar absorption. The most obvious is *weight gain*. Fortunately, this usually tends to be limited and generally tolerated, but occasionally, people do have to modify their diets, both to avoid excessive caloric intake, and to reduce the need for aggressive fluid removal. Body fats, especially *cholesterol* and *triglycerides*, have also been observed to be increased during CAPD patients. These elevations are thought to be related to the continuous absorption of sugar. The concern is that elevated blood cholesterol levels are a risk factor for cardiovascular complications.

No one knows yet what the long term effects of the dialysate will be on the peritoneum. There have been a very few reported cases were the ability of the peritoneum to allow adequate solute and water exchange has been lost. At the present time, this topic has received a great deal of interest from researchers In addition, investigators are looking for new substances that will reduce the complications caused by the dialysate.

Drugs can also be put into the dialysate and absorbed. The example of antibiotics was given above. In addition, people with diabetes can add their insulin to each exchange and avoid having to give themselves injections. Because the insulin is given with each exchange (four times daily), blood sugar control is often greatly improved.

CAPD is a valuable adjunct to the treatment of people with chronic kidney failure. It is a simple and safe technique, so that patients can do it themselves at home. For some people, especially those who are prone towards low blood pressure or those with advanced heart problems, CAPD avoids the large changes in fluids that accompany hemodialysis. With careful planning and an appreciation for the strengths and weaknesses of this form of therapy, CAPD can often help increase the ability of the patient to deal with many of the problems of kidney failure.