






Peritoneal Dialysis Dose and Adequacy

When kidneys fail, waste products such as urea and creatinine build up in the blood. One way to remove these wastes is a process called peritoneal dialysis (PD). The walls of the abdominal cavity are lined with a membrane called the peritoneum. During PD, a mixture of dextrose (sugar), salt, and other minerals dissolved in water, called dialysis solution, is placed in a person's abdominal cavity through a catheter. The body's peritoneal membrane enclosing the digestive organs allows waste products and extra body fluid to pass from the blood into the dialysis solution. These wastes then leave the body when the used solution is drained from the abdomen. Each cycle of draining and refilling is called an exchange. The time the solution remains in the abdomen between exchanges is called the dwell time. During this dwell time, some of the dextrose in the solution crosses the membrane and is absorbed by the body.

Many factors affect how much waste and extra fluid are removed from the blood. Some factors—such as the patient's size and the permeability, or speed of diffusion, of the peritoneum—cannot be controlled. Dialysis solution comes in 1.5-, 2-, 2.5-, or 3-liter bags. The dialysis dose can be increased by using a larger bag, but only within the limits of the person's abdominal capacity. Everyone's peritoneum filters wastes at a different rate. In some people, the peritoneum does not allow wastes to enter the dialysis solution efficiently enough to make PD feasible.

Other factors that determine how efficiently a person's blood is filtered can be controlled. Controllable factors include the number of daily exchanges and the dwell times. When fresh solution is first placed in the abdomen, it draws in wastes rapidly. As the solution becomes more nearly saturated with wastes, it cleans the blood less efficiently. For example, a patient may perform one exchange with a 6-hour dwell time, during which the solution becomes nearly saturated with urea. But in the second half of that dwell time, urea is being removed from the blood very slowly. If the patient performed two exchanges with 3-hour dwell times instead, the amount of urea removed would be substantially greater than that removed in one 6-hour dwell time.

Another way to increase the amount of fluid and waste drawn into the peritoneal cavity is to use dialysis solution with a higher concentration of dextrose. A higher dextrose concentration moves fluid and more wastes into the abdominal cavity, increasing both early and long-dwell exchange efficiency. Eventually, however, the body absorbs dextrose from the solution. As the concentration of dextrose in the body comes closer to that in the solution, dialysis becomes less effective, and fluid is slowly absorbed from the abdominal cavity.

National Institute of Diabetes and Digestive and Kidney Diseases
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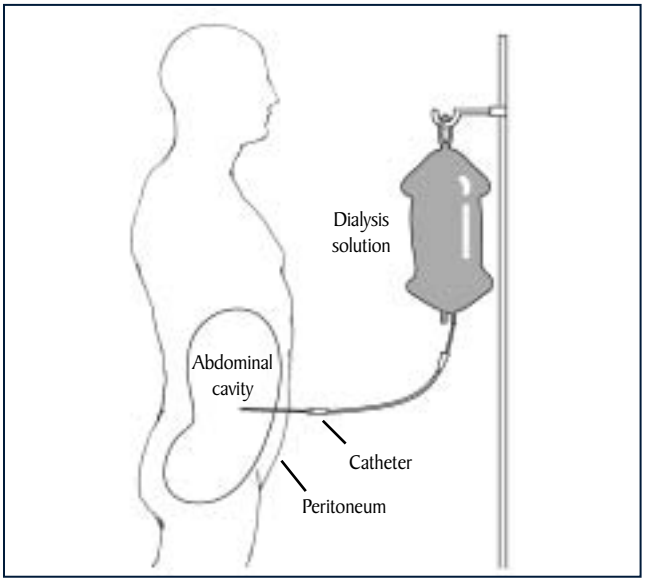
Types of Peritoneal Dialysis

The three types of peritoneal dialysis differ mainly in the schedule of exchanges. In continuous ambulatory peritoneal dialysis (CAPD), the patient empties a fresh bag of dialysis solution into the abdomen. After 4 to 6 hours of dwell time (during the day), the patient returns the solution containing wastes to the bag. The patient then repeats the cycle with a fresh bag of solution. CAPD does not require a machine; the process uses gravity to fill and empty the abdomen. A typical prescription for CAPD requires three or four exchanges during the day and one long (usually 8 to 10 hours) overnight exchange as the patient sleeps. The dialysis solution used for the overnight exchange may have a higher concentration of dextrose so that it removes wastes and fluid for a longer time.

For added clearance, a mini-cycler machine can be used to exchange the dialysis solution once or several times overnight as the patient sleeps. Such additional exchanges may also help prevent the body from absorbing excessive amounts of dextrose and dialysis solution from the overnight exchange.



Continuous ambulatory peritoneal dialysis (CAPD) is the most common form of peritoneal dialysis.

Continuous cycler-assisted peritoneal dialysis (CCPD) uses a machine to fill and empty the abdomen three to five times during the night while the person sleeps. In the morning, the CCPD patient performs one exchange with a dwell time that lasts the entire day. Sometimes one additional exchange is done in the mid-afternoon to increase the amount of waste removed and to prevent excessive absorption of fluid. The dialysis solution used for the long daytime exchange may have a higher concentration of dextrose.

Nocturnal intermittent peritoneal dialysis (NIPD) is like CCPD, only the number of overnight exchanges is greater (six or more), and the patient does not perform an exchange during the day.

NIPD is usually reserved for patients with a peritoneum that is able to transport waste products very rapidly, or for patients who still have substantial residual (remaining) kidney function.

Testing for Efficiency

The tests to see whether the exchanges are removing enough urea are especially important during the first weeks of dialysis, when the health care team needs to determine whether the patient is receiving an adequate amount, or dose, of dialysis.

The peritoneal equilibration test (often called the PET) measures how much dextrose has been absorbed from a bag of infused dialysis solution, and how much urea and creatinine have entered into the solution, during a 4-hour exchange. The peritoneal transport rate varies from person to person. People who have a high rate of transport absorb dextrose from the dialysis solution quickly, and they should be given a dialysis schedule that avoids exchanges with a very long dwell time because they tend to absorb too much dextrose and dialysis solution from such exchanges.

In the clearance test, samples of used solution drained over a 24-hour period are collected, and a blood sample is obtained during the day when the solution is collected. The amount of urea in the solution is compared with the amount in the blood, to see how effective the current PD schedule is in clearing the blood of urea. If the patient has more than a few ounces of urine output per day, the urine should also be collected during this period to measure its urea concentration.

From the used solution, urine, and blood measurements, one can compute a urea clearance, called Kt/V, and a creatinine clearance rate (normalized to body surface area). The residual clearance of the kidneys is also considered. Based on these measurements, one can determine whether the PD dose is adequate.

If the laboratory results show that the dialysis schedule is not removing enough urea and creatinine, the doctor may change the prescription by

- increasing the number of exchanges per day for patients treated with CAPD or per night for patients treated with CCPD or NIPD
- increasing the volume (amount of solution in the bag) of each exchange in CAPD
- adding an extra, automated middle-of-the-night exchange to the CAPD schedule
- adding an extra middle-of-the-day exchange to the CCPD schedule

Compliance

One of the big problems with PD is that patients sometimes do not perform all of the exchanges recommended by their medical team. They either skip exchanges or sometimes skip entire treatment days when using CCPD or NIPD. Skipping PD treatments has been shown to increase the risk of hospitalization and death.

Residual Kidney Function

Normally the PD prescription factors in the amount of residual kidney function. Residual function typically falls, although slowly, over the months or even years of treatment with PD. This means that, more often than not, the number of PD exchanges prescribed, or the volume of exchanges, needs to be increased as residual function falls.

The doctor should determine the patient's dose of PD on the basis of practice guidelines published by the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (K/DOQI) (see For More Information below). Health care providers should work closely with their patients to ensure that the proper PD dose is administered. To maximize health and prolong life, patients should follow instructions carefully to make sure they get the most out of their dialysis exchanges.

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 PD.

- **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 research focuses on reusing hemodialysis membranes and on using alternative dialyzer sterilization methods; on devising more efficient, biocompatible membranes; on refining high-flux hemodialysis; and on developing criteria for dialysis adequacy. The program also seeks to increase kidney graft and patient survival and to maximize quality of life.

- **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 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 treatment modalities. The report, available at *www.usrds.org* on the Internet, also helps identify problems and opportunities for more focused special research on kidney issues.

For More Information

For more information, contact the following organizations:

Centers for Medicare & Medicaid Services
7500 Security Boulevard
Baltimore, MD 21244–1850
Phone: 1–877–267–2323
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National Kidney Foundation Inc.
30 East 33rd Street
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National Kidney and Urologic Diseases Information Clearinghouse

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Internet: www.kidney.niddk.nih.gov

The National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The NIDDK is part of the National Institutes of Health under the U.S. Department of Health and Human Services. Established in 1987, the clearinghouse provides information about diseases of the kidneys and urologic system to people with kidney and urologic disorders and to their families, health care professionals, and the public. NKUDIC answers inquiries, develops and distributes publications, and works closely with professional and patient organizations and Government agencies to coordinate resources about kidney and urologic diseases.

Publications produced by the clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This fact sheet was reviewed by Dr. John Daugirdas, University of Illinois College of Medicine, and Dr. Karl Nolph, University of Missouri Department of Internal Medicine.

This fact sheet is also available at *www.kidney.niddk.nih.gov.*

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