Zbylut J. Twardowski, MD


Peritoneal transfer rates of urea, creatinine, glucose, protein, potassium, and sodium as well as drain and residual volumes were measured during 103 equilibration tests performed in 18 diabetic and 68 non-diabetic patients. Equilibration tests were performed over a 4-hour dwell exchange with 2 L of 2.5% peritoneal dialysis solution. Excellent reproducibility was seen after tests were standardized for length of preceding exchange, times of inflow and drainage, patient position, methods of obtaining and processing samples and laboratory assays. Peritoneal solute transfers tended to be higher in diabetics.

Wide variations were found in the study population. The transport rates were classified into four categories: The values within one standard deviation from the mean were categorized as high and low average; those outside one standard deviation were categorized as high or low.

Measurements of creatinine, glucose, and sodium transfer were particularly useful in predicting the patient's response to standard CAPD.

- **Patients with high average peritoneal solute transport** did well on standard CAPD even after losing residual renal function.
- **Patients with high peritoneal solute transfer** rates were likely to have inadequate ultrafiltration on standard CAPD. These patients did much better on dialysis modalities with short-dwell exchanges, i.e., nightly peritoneal dialysis (NPD) or daytime ambulatory peritoneal dialysis (DAPD).
- **Patients with low average, and particularly low peritoneal transport rates** were likely to develop symptoms and signs of inadequate dialysis as their residual renal function became negligible, particularly in individuals with high body surface area.

Repeated tests were helpful in evaluating causes of insufficient ultrafiltration and/or inadequate dialysis.

**Commentary by Zbylut J. Twardowski, MD**

PET is the most widely used peritoneal function test, because of its standardization, simplicity, and usefulness in diagnostic and prognostic purposes. An abridged test looking only for D/D0 glucose and D/P creatinine ratios, and drain volumes, is commonly used.
Based on PET, a computer model (PD ADEQUEST, Baxter Healthcare Corporation, Round Lake, Illinois, USA) has been developed that permits prediction of small solute clearances and ultrafiltration for various alternative prescriptions of peritoneal dialysis. Excellent agreement between predicted and measured values has been validated in 111 patients.

In the original PET, which established standard values for membrane categorization in 1987, the glucose solution was used for the preceding exchange. Recently many patients, particularly those with ultrafiltration problems, use polyglucose solution for nightly exchanges. Lilaj et al. found that polyglucose-containing solution used for the preceding exchange increases D/P ratios of creatinine, phosphate, and sodium, as well as glucose absorption, measured during the test. Therefore, they recommend that patients using icodextrin solution during the nighttime should perform their nighttime exchange with conventional glucose solution before a scheduled PET.

The preceding exchange dwell time was 8 or more hours in the original PET. This was convenient when almost all patients were on continuous ambulatory peritoneal dialysis; however, now that many patients are on some form of automated peritoneal dialysis (APD), an 8-hr exchange prior to the PET requires changes in the dialysis schedule. Our recent study evaluated the differences in 2-hr equilibration curves with standard, 8-hr and 3-hr preceding exchanges. The values for D/P creatinine and urea, as well as D/D0 glucose, were almost identical throughout the 2-hr PET dwell after long and short exchanges. D/P protein values tended to be higher in the PET after the long exchange. We concluded that for creatinine and glucose equilibrations, any dwell time between 3 and 12 hours was acceptable for the preceding exchange, and the equilibration test might be performed with a 2-hr or 4-hr dwell. The protein values obtained with a 3-hr prior dwell are different from those with a long prior exchange. However, for a full characterization of peritoneal membrane function, an unabridged test as described in 1987, which includes D/P urea, protein, creatinine, and D/D0 glucose as well as D/P potassium, sodium, and corrected creatinine, drain volume and residual volumes should be used. Although this test is extremely reliable and valuable in characterization of peritoneal function, it is rarely used because of its complexity and considerable nursing time requirement; nonetheless, it should be used in cases where full characterization of peritoneal function is necessary. An unabridged test should be performed shortly after the break-in period of peritoneal dialysis as a baseline for future comparisons.

**Peritoneal Function after Long-term Exposure to Peritoneal Dialysis Solutions**

Long-term peritoneal dialysis is associated with progressive loss of ultrafiltration capability. There are two possible mechanisms leading to this phenomenon:

- First, effective peritoneal surface area progressively increases in long-term PD patients. This is related to increased number and surface area of peritoneal capillaries as a response to an increase of nitric oxide synthase (NOS) activity and upregulation of vascular endothelial growth factor (VEGF).
• Second, peritoneal membrane is gradually denuded of mesothelial cells, leading to loss of mesothelial aquaporins, which are ultra-small pores responsible for free water transport. Gradual decline of Cancer Antigen (CA) 125 concentration in dialysate, a marker of mesothelial cell mass, has been found in long-term peritoneal dialysis patients and loss of mesothelial cells in patients with ultrafiltration failure has been determined by peritoneal biopsy. On an unabridged PET in these patients, an initial dip of dialysate to plasma sodium concentration is missing and extremely high dialysate protein concentrations are seen.

**References:**

**Commentary by Todd S. Ing, MD**

Universally used, Dr. Twardowski's PET test has become the gold standard for the measurement of peritoneal membrane function.