Peritoneal Dialysis Case Discussion

Scenario from the Survey

One of your employees brings a problem to your attention. A "serum" specimen (FLD-05) drawn from a 69 year-old woman exceeded a laboratory critical value. Another serum sample from the same patient sent at the same time had a creatinine concentration of 5.5 mg/dL, a urea nitrogen concentration of 40 mg/dL and a glucose concentration of 200 mg/dL. A concurrent 24 hour urine had a creatinine concentration of 70 mg/dL and urea nitrogen of concentration 300 mg/dL in a total volume of 100 mL.

When the ordering physician was called, he indicated that the first sample was not really serum, but was actually a 24 hour peritoneal dialysate of net volume 9200 mL. The woman is 155 cm tall and weighs 50 kg, and undergoes peritoneal dialysis on a daily basis.

Questions and Responses:

1. Does your lab routinely analyze peritoneal dialysis specimens?
    a. Yes - 17.9%
    b. No - 77.8%
    c. Uncertain - 4.3%

2. Which, if any of the following assays have you validated for either peritoneal fluids or peritoneal dialysates?
    a. Creatinine - 32.3%
    b. Urea Nitrogen - 47.1%
    c. Glucose - 20.6%

3. If you routinely calculate urea clearance (Kt/V), what weekly Kt/V do you calculate for this patient, including dialysate and urine clearance?

Weekly Kt/V	# responses
0.0	5
0.3	1
1.0	1
1.7	1
2.0	3
4.3	1
27.4	1
48.4	1
57.0	1

Peritoneal dialysis (PD) is a safe, cost-effective, and convenient treatment alternative to hemodialysis for many patients with end-stage renal disease (ESRD). The dialysate, typically 2.0 – 2.5 liters per exchange, is introduced into the abdominal cavity through a surgically placed catheter, where osmosis and diffusion are utilized to remove waste products from the patient's blood stream across the semipermeable peritoneal membranes, as well as to maintain electrolyte levels and correct fluid imbalances in these patients. After an equilibration period (dwell time), the waste-laden dialysate is withdrawn through the catheter and discarded, while a new 2.0-2.5 liter volume of dialysate fluid is infused into the peritoneal cavity. This fluid exchange typically takes place 3 to 5 times each day. Approximately every 4 months an aliquot of the 24 hour dialysate fluid will be sent to the lab for assessment of the adequacy of the dialysis. About 18% of our participant laboratories analyze such samples.

The dialysate is typically a solution of salts, lactate, and a highly concentrated glucose (typically 1.5% to 4.25%) and glucose polymers that serve as osmotic agents. The equilibration period, or dwell time, is usually 4 to 6 hours. Continuous ambulatory peritoneal dialysis (CAPD) permits the patient to move about freely during the dwell time, and can be administered in the home or at work. In another form of peritoneal dialysis, the dialysate fluid exchanges are performed by a machine to which the patient is tethered, often while sleeping.

One of the main considerations in PD is the adequacy of the "dose" of dialysis. This is typically measured as either the fractional urea clearance (Kt/V_{urea}). Contributions from dialysis as well as residual kidney function (RKF) are considered. The input for these calculations is the urea excretion in 24-hour collections of dialysate and urine, along with urea concentration in concurrently-collected serum. The calculated clearances are then multiplied by 7 to determine "weekly" clearance. Urea clearance (Kt) is normalized to total body water (V), which depends on height, weight, and gender.

Here is the calculation of Kt/V_{urea} for our case, where we assume measurements for FLD-05 of 5.5 mg/dL creatinine and 35 mg/dL urea.

Kt (L/week) = 7 x (dialysate + urine urea excretion / 24 hour) / serum urea concentration
= 7 x (35 mg/dL x 92 dL + 300 mg/dL x 1 dL) / (40 mg/dL x 10 dL/L)
= 61.6 L

V (L) = -2.097 + 0.1069 x Height (cm) + 0.2466 x Weight (kg) [Watson formula]
= -2.097 + 0.1069 x 155 + 0.2466 x 50
= 26.8 L

Kt/V (weekly) = 2.3

Stable ESRD patients undergoing chronic peritoneal dialysis generally have the weekly Kt/V_{urea} checked approximately every 3-4 months. The National Kidney Foundation Clinical Practice Recommendations for Peritoneal Dialysis Adequacy suggest the minimum weekly Kt/V_{urea} target of at least 1.7. This patient is comfortably meeting this target. But if her Kt/V_{urea} was too low, she might be instructed to make more frequent exchanges, to employ a larger volume of dialysate per exchange and/or to use a higher concentration of glucose or glucose polymer in the dialysate. None of the labs surveyed arrived at a Kt/V of 2.3, as we calculated, but several were close. This may reflect differences in their measurements of creatinine and urea in FLD-05, or their use of ideal body weights in the calculation. One of the web sites referenced below has a web-based Kt/V calculator which you can use to check your work using your measurements.

To our knowledge, there are no FDA-approved methods for the measurement of creatinine, urea, and glucose in peritoneal dialysates. If you are using a conventional FDA-approved serum or urine method to assay such samples, this may constitute a "lab-developed test", and may warrant a more thorough validation. Based upon the survey responses, most labs performing such tests have addressed this requirement.

Read all about it!

Clinical practice recommendations for peritoneal dialysis adequacy. Am J Kidney Dis 2006 Jul; vol 48 Suppl 1:S98-129.

http://kidney.niddk.nih.gov/kudiseases/pubs/peritoneal/index.htm [Overview of PD]

http://www.tinkershop.net/peritoneal.htm [Web-based Kt/V calculator]

http://www.guideline.gov (look for guideline under National Kidney Foundation: NKF-KDOQI Clinical practice guidelines for peritoneal dialysis adequacy: update 2006)

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