When Do Plasma Levels of Azotemic Indices Indicate Inadequacy of Peritoneal Dialysis?

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Dear Sir,

Plasma concentrations of creatinine greater than 1,600 $\mu\text{mol/l}$ (18 mg/dl) and urea greater than 35 mmol/l (BUN > 100 mg/dl) were proposed as indicators of inadequate peritoneal dialysis [1, 2]. However, the range of plasma concentrations of these two substances is almost identical in CAPD patients with clinical manifestations of inadequate dialysis and those adequately dialyzed clinically [3]. Thus, the use of plasma creatinine or urea concentration to assess the adequacy of peritoneal dialysis is, in general, questionable [3]. We report two cases illustrating the circumstances under which plasma creatinine is a strong indicator of peritoneal dialysis inadequacy.

Both patients were men on CAPD. Renal failure was caused by hypertensive nephro-sclerosis and idiopathic proliferative glomer-ulonephritis. Age at onset of CAPD was 39 and 43 years, respectively. The first patient has had no peritonitis or exit site infection. The second patient had an exit site infection 7 months before the first clearance study and lost his peritoneal catheter to Candida para-psilosis peritonitis 6 months after the last clearance study. A few months after the first study both patients noticed progressive decrease in daily urinary volume followed within 2-4 months by anorexia, decreased food intake and occasional vomiting. In addition, the first patient developed severe hypertension, which responded to increasing doses of antihypertensive agents only after reduction of body weight by 3 kg. The second patient developed progressive neuropathy and impotence. Sequential 24-hour fractional clearance of urea and creatinine clear-

ance studies were performed. Instilled dialy-sate volumes did not change, at 10 l/day, between the first and second study in both patients. However, while the clearance indices were in the adequate range (weekly fractional clearance of urea > 1.70, weekly creatinine clearance > 50 l/1.73 m²) in the first study, the second study produced inadequate clearance indices, primarily because of loss of urinary clearance. After the second study, instillation volume was increased to 16 liters daily in both patients. The first patient reported complete disappearance of the symptoms, while uremic symptoms persisted in the second patient. Instillation volume was further increased to 22 liters daily in the second patient with disappearance of anorexia and nausea and improvement of neuropathy.

Weekly total (dialysate plus urine) fractional clearance of urea and creatinine clearance were computed according to the method of Nolph et al. [4]. Glucose concentration (G) in the

mixed 24-hour sample of spent dialysate was measured, and creatinine concentration (Cr) in the same sample was corrected for glucose interference with the creatinine assay by the formula:

$$\text{corrected Cr} = 0.000531415 \times \text{Gl},$$

where both Cr and Gl are expressed in milligrams per deciliter [5].

Daily urea nitrogen excretion and creatinine excretion in dialysate plus urine per kilogram standard weight (SW = V_{urea}/0.58) were also calculated [3].

Table 1 shows clearance indices, corresponding serum and blood values and excretion rates.

Table 1. Clearance indices, blood values and excretion rates. In the first patient, study A was performed during the 49th month of CAPD, study B during the 55th month, study C during the 56th month and study D during the 57th month. Corresponding months for the second patient were the 16th, 22nd, 24th and 29th, respectively. Table 1 shows the following: (1) clearance indices decreased as urine output decreased. Simultaneously, serum creatinine increased to levels higher than 1,600 $\mu\text{mol/l}$ in both patients. This increase in serum creatinine had been progressive for several months and required several months to return toward baseline levels after increase in the instillation volume. Serum urea concentration, however, increased only in the second patient. In the first patient, clearance indices and serum urea decreased in conjunction with a dramatic decrease in urea excretion (study B) indicating a decreasing rate of urea formation. Creatinine excretion during study B was not much lower than that in study A in the same patient. Thus a rising serum creatinine, with or without a parallel rise in serum urea concentration, indicates decreasing azotemic solute clearance and may be an indicator of inadequate peritoneal dialysis.

Changes in serum albumin levels mirrored changes in clearance indices. In studies of populations on CAPD, serum albumin and clearance indices do not correlate [6]. However, a decrease in serum albumin may be an indicator of inadequate dialysis in individuals on CAPD free of catabolic disease.

Changes in blood hematocrit also paralleled changes in clearance indices. During the period of inadequate dialysis both patients developed normocytic normochromic anemia with low reticulocyte counts, repeatedly negative stool examinations for occult blood and normal serum iron, ferritin, folate and cyanocobalamin levels. Increasing the dose of erythropoietin did not correct the anemia while the clearance indices remained inadequate. Hematocrit was corrected rapidly after the clearance indices were restored to adequate levels and erythropoietin doses were reduced to the baseline levels. It appears that inadequate peritoneal dialysis should be added to the list of conditions causing poor response to exogenous erythropoietin.

KT/V = Sequential 24-hour fractional clearance; C_{Cr} = creatinine clearance; 1 = patient 1; 2 = patient 2; UNE = urea nitrogen excretion; SW = standard weight; CrE = creatinine excretion.

References

Twardowski ZJ, Nolph KD, Khanna R, Pro-want BF, Ryan LP, Moore HL, Nielsen MP: Peritoneal equilibration test. *Periton Dial Bull* 1987;7:138-147.

Blake PG, Sombolos K, Abraham G, Weiss-garten J, Pemberton R, Chu GL, Oreopoulos DG: Lack of correlation between urea kinetic indices and clinical outcomes in CAPD patients. *Kidney Int* 1991;39:700-706.

Oreopoulos DG. Criteria for adequacy of peritoneal dialysis. *Periton Dial Bull* 1983;3:1-2.

Nolph KD: The adequacy of dialysis in patients on CAPD. *Periton Dial Bull* 1983;3:2-3.

Tzamaloukas AH, Murata GH: Adequacy of continuous ambulatory peritoneal dialysis. *Int J Artif Organs* 1993;16:557-569. Nolph KD, Moore HL, Twardowski ZJ, Khanna R, Prowant B, Meyer M, Ponferrada L: Cross-sectional assessment of weekly urea and creatinine clearances in patients on continuous ambulatory peritoneal dialysis. *ASAIO J* 1992; 38:M139-M142.

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