

**NUTRITIONAL  
REQUIREMENTS OF  
PERITONEAL DIALYSIS**

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## Outline

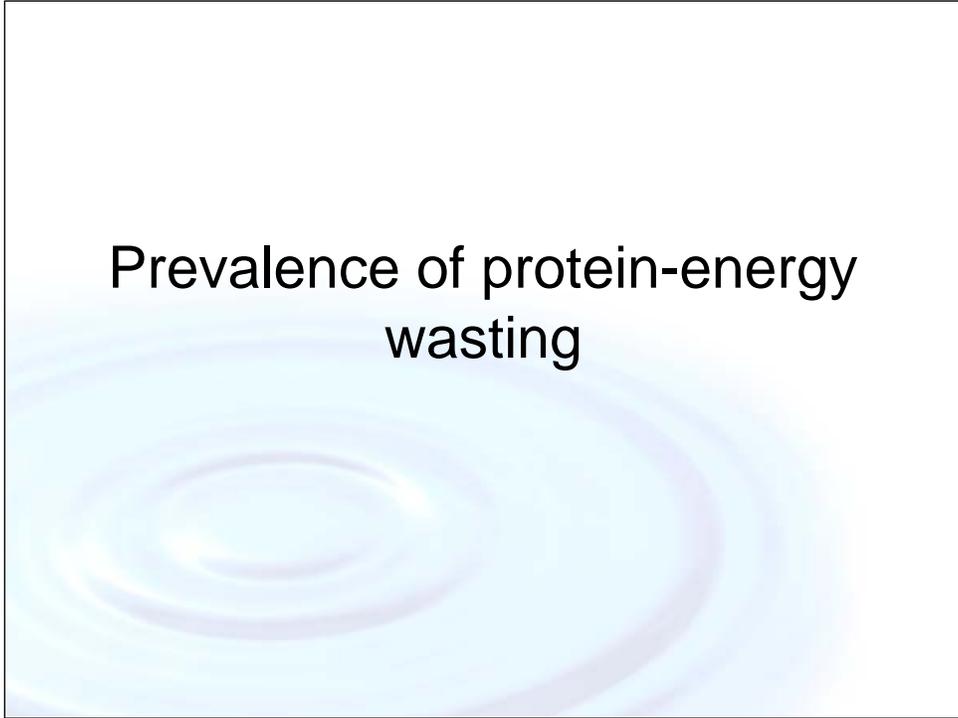
- ⇒ Prevalence of protein-energy wasting in peritoneal dialysis
- ⇒ Nutritional predictors of outcomes in peritoneal dialysis
  - ⇒ Albumin as a predictor of outcomes in peritoneal dialysis
- ⇒ Assessing nutritional status in peritoneal dialysis patients
- ⇒ Protein and energy intake in dialysis patients
- ⇒ Metabolic acidosis
- ⇒ Nutritional interventions
- ⇒ Questions
- ⇒ Suggested readings

## Nomenclature

- The term protein-energy wasting will be used for the commonly encountered clinical problems of protein malnutrition and energy malnutrition. This nomenclature has been suggested by an expert panel of the International Society of Renal Nutrition and Metabolism.

Fouque D *et al*, *Kidney Int* 2008; 73: 391-398

# Prevalence of protein-energy wasting



## How common is protein-energy wasting in dialysis patients?

- Estimates of protein-energy wasting among dialysis patients vary.
- Average is about 40%
  - Most have mild to moderate protein-energy wasting
  - 6-8% have severe protein-energy wasting

Mehrotra and Kopple, Annu Rev Nutr 2001; 21: 343-70

## How does nutritional status compare in HD versus PD?

- Few studies have compared the nutritional status of HD compared to PD.
- Using five objective and subjective nutrition-related indicators (percentage IBW, serum albumin, percentage unplanned weight loss, appetite and intake, GI symptoms), Park and colleagues classified a group of Korean HD and PD patients as well nourished, mildly malnourished, moderately malnourished, or severely malnourished:

## Nutritional status of PD and HD patients

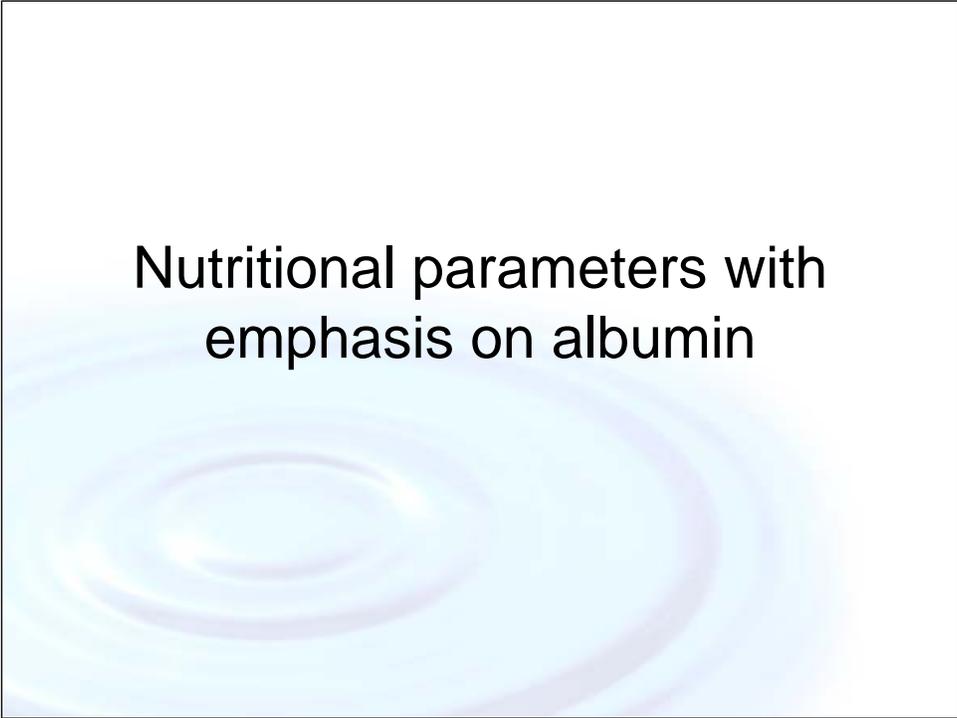
		PD	HD
Total		51	169
	Well-nourished	34 (67%)	139 (82%)
	Mildly malnourished	8 (15%)	24 (14%)
	Moderately malnourished	7 (14%)	6 (4%)
	Severely malnourished	2 (4%)	0

33% of PD patients were malnourished compared to 18% of HD patients.

Park YK *et al*, J Ren Nutr 1999; 9: 149-56

This cross-sectional study from Korea examined the nutritional status of hemodialysis and peritoneal dialysis patients. Patients were excluded for the following criteria: age below 16 years, hospitalization or peritonitis within the preceding month, dialysis treatment for less than 4 months, and HD treatment less than three times per week. Hemodialysis patients typically underwent dialysis three times weekly for 4 hours each treatment. Peritoneal dialysis patients were typically prescribed 2L x 4 exchanges daily.

An Italian study by Cianciaruso *et al* (Am J Kidney Dis 1995; 26: 475-486) reported a higher incidence of malnutrition in peritoneal dialysis patients relative to hemodialysis patients (42.3% vs. 30.8%) using the SGA method.



Nutritional parameters with  
emphasis on albumin

## Nutritional parameters as predictors of outcomes

- In both chronic hemodialysis and peritoneal dialysis, nutritional status is associated with outcomes.
- In peritoneal dialysis, each of the following nutritional parameters has been associated with outcomes:

## Nutritional parameters predictive of outcomes in PD

- Low serum albumin levels
- Reduced urea nitrogen appearance
- Decreased edema free/fat-free mass
- Low serum creatinine
- Creatinine appearance rates
- Poorer overall protein and energy nutritional status as assessed by subjective global assessment
- Decreased total body nitrogen content

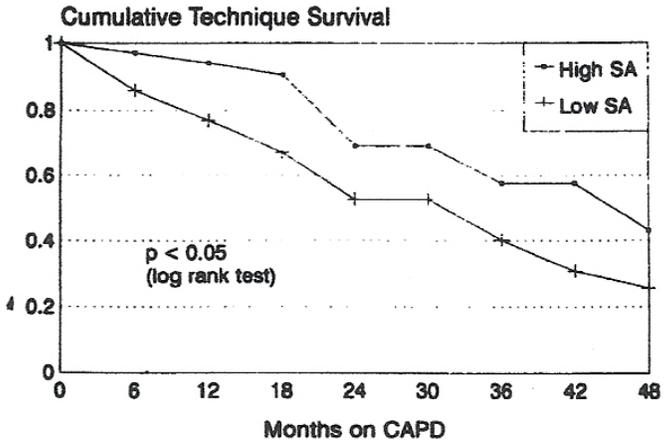
Mehrotra and Kopple, Annu Rev Nutr 2001; 21: 343-70

## Albumin as a marker of nutritional status

- Albumin *by itself* is not a good predictor of nutritional status:
  - Influenced (negatively) by inflammation
  - Tends to go down as inflammatory markers (e.g, CRP, IL-6, ferritin) go up
  - Influenced (negatively) by albuminuria and peritoneal albumin losses
  - Affected by hydration status
- Easily measured
- One of the monthly labs routinely measured by dialysis providers
- Used by dialysis providers as a quality indicator

Han DS *et al*, Adv Perit Dial 1996; 12: 288-292

# Albumin and CAPD Technique survival



Blake *et al*, J Am Soc Nephrol 1993; 3: 1501-10

# Albumin and SGA in the CANUSA Study

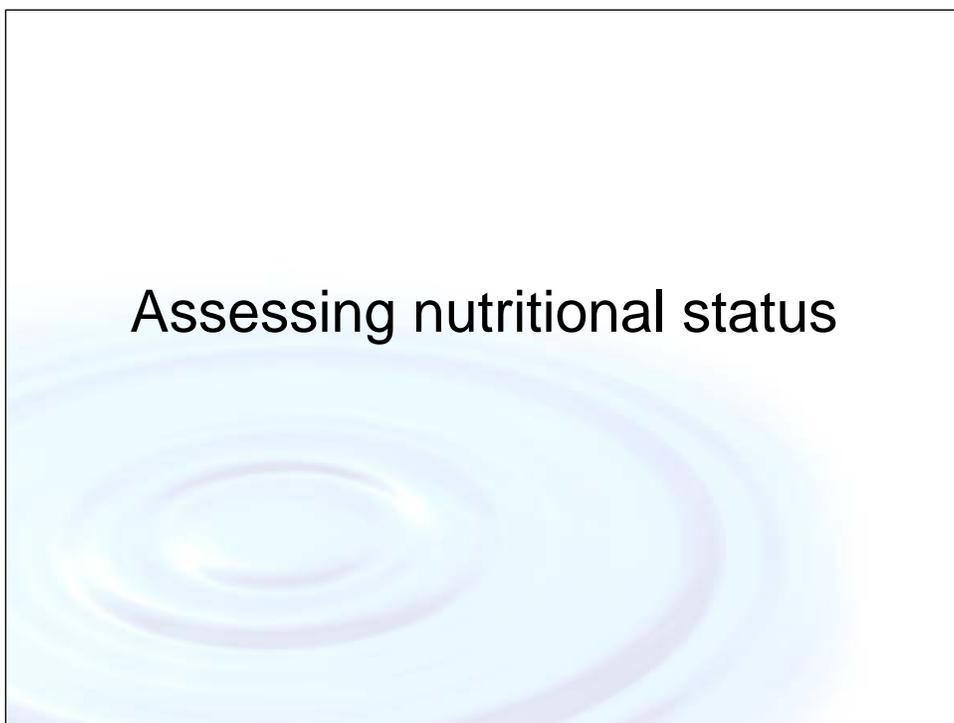
Variable	Relative Mortality Risk	95% Confidence Interval
Age (per year)	1.03	1.01-1.05
IDDM	1.45	0.89-2.36
CVD	2.09	1.33-2.38
Country (USA)	1.93	1.14-3.28
Serum albumin (↑ 1 g/L)	0.94	0.90-0.97
Kt/V (↑ 0.1 units/wk)	0.94	0.90-0.99
SGA (↑ 1 unit)	0.75	0.66-0.85

CANUSA Peritoneal Dialysis Study Group, J Am Soc  
Nephrol 1996; 7-198-207

## Albumin and SGA in the CANUSA Study

- A 1-gram/L lower serum albumin concentration was associated with a 6% increase in relative risk of death.
- A 1-unit lower SGA score was associated with a 25% increase in the relative risk of death.

## Assessing nutritional status



## Subjective Global Assessment (SGA)

- An inexpensive and reproducible instrument for assessing the nutritional status of PD patients
- Gives a global score of protein-energy wasting
- An important parameter in SGA is anorexia
  - Independent predictor of mortality in HD patients

Nephrol Dial Transplant 2005; 20 [Suppl 9]:28-33  
Enia G *et al*, Nephrol Dial Transplant 1993; 8: 1094-1098

## Protein equivalent of total nitrogen appearance (nPNA)

- The rate of urea nitrogen appearance in dialysate and urine is assumed to closely reflect dietary protein intake: the protein equivalent of nitrogen appearance (PNA)
- In PD patients, PNA is estimated from direct measurement of urea nitrogen in dialysate and urine
- PNA is then normalized to a standardized body weight (nPNA) based upon age, sex, body weight and height

Mehrotra R and Kopple JD, Annu Rev Nutr 2001; 21: 343-70

## Limitations of nPNA

- Approximates dietary protein intake only when the patient is in nitrogen equilibrium or steady state
- Will change in anabolic or catabolic situations and in circumstances of marked variation in protein intake
- May overestimate dietary protein intake when the protein intake is  $< 1$  g/kg/day
- Normalizing PNA to body weight can be misleading in obese, malnourished, and edematous patients

Enia G *et al*, *Nephrol Dial Transplant* 1993; 8: 1094-10

## Anthropometry

- Anthropometry quantifies body mass and provides a semiquantitative estimate of the components of body mass, particularly bone, muscle, and fat compartments
- Inexpensive and easily performed
- Can be used as an adjunct to clinical assessment of nutritional status
- Estimates of lean body mass and fat mass agree reasonably well with DEXA

# Anthropometry

- Parameters assessed:
  - Body weight
  - Height
  - Skeletal Frame Size
  - Skin-fold thickness
  - Percentage of body mass that is fat
  - Percentage of usual body weight
  - Percentage of standard body weight
  - Body mass index

# Hand strength

- Functional test of nutritional status
- Inexpensive and simple to perform
- Correlates well with other tests of nutritional status
- Demonstrated to predict outcomes in PD patients

Wang AYM *et al*, Am J Clin Nutr 2005; 81: 79-86

Heimbürger O *et al*, Am J Kidney Dis 2000; 36: 1213-1225

## Dual Energy X-Ray Absorptiometry (DEXA)

- Reliable, noninvasive method to assess the three main components of body composition
  - Fat mass
  - Fat-free mass
  - Bone mineral mass and density
- Less influenced by hydration
- Superior precision and accuracy compared to anthropometry
- More expensive to perform

# NKF/K/DOQI Assessment and Monitoring Recommendations

Measure	Minimum Frequency of Measurement
Serum albumin	Monthly
% of usual post-drain body weight	Monthly
% of standard (NHANES II) body weight	Monthly
Subjective Global Assessment	Monthly
Dietary interview and/or diary	Every 6 months
nPNA	Every 3-4 months
Anthropometrics	As needed
DEXA	As needed

Am J Kidney Dis 2000; 35 (6) Suppl 2: S17-S104

## Dietary protein intake (DPI)

- The recommended dietary protein intake for peritoneal dialysis patients is 1.2-1.3 g/kg body weight/day (K/DOQI).
- Nitrogen balance studies have shown that DPI of 1.2 g/kg/day or greater is almost always associated with neutral or positive nitrogen balance.
- CAPD patients average about 8 g/day of peritoneal protein loss
  - Higher during episodes of peritonitis

Kopple JD, Am J Kidney Dis 2001; 38 (4) Suppl 1: S68-S73

## Dietary Protein Intake: A Dissenting View

- There is a linear relationship between protein and phosphorous intake.
- High protein diets are frequently associated with hyperphosphatemia.
- Phosphate clearance is similar to creatinine clearance
  - In anuric patients, maintaining normal phosphorous levels will be difficult with the recommended DPI

Uribarri J, Am J Kidney Dis 2001; 37: 1313-1318

## Dietary energy intake

- Energy intake of patients on PD represents the sum of dietary intake and glucose absorption from dialysate (See slides 26-27).
  - In CAPD patients with normal peritoneal transport capacity, about 60% of the daily dialysate glucose load is absorbed: about 100-200 grams/24 hours
- K/DOQI recommendations:
  - 35 kcal/kg/day for patients younger than 65
  - 30-35 kcal/kg/day for patients older than 65

Nephrol Dial Transplant 2005; 20 [Suppl 9]:28-33  
Heimberger O *et al*, Kidney Int 1992; 41: 1320-1332

## Glucose absorption from dialysate

- Glucose absorbed from dialysate can be estimated using the following equation:
  - Glucose absorbed (g/day) =  $0.89x$  (g/day) -43
  - $x$  = the total amount of dialysate glucose instilled each day
- Glucose absorption from dialysate may contribute to excess caloric intake, weight gain, and the metabolic syndrome.

## Glucose absorption from dialysate

- Grodstein *et al* performed metabolic studies in 7 stable male CAPD patients
- All exchanges were with 1.5% or 4.25% dextrose solutions
- Daily glucose absorption was calculated as the difference between the quantity instilled into the peritoneal cavity and the amount drained each day.
- An average of 182 + 62 g of glucose was absorbed each day.
- Glucose absorbed from dialysate accounted for 20.3% of total energy intake.

Grodstein *et al*, *Kidney Int* 1981; 19: 564-567

## Metabolic acidosis

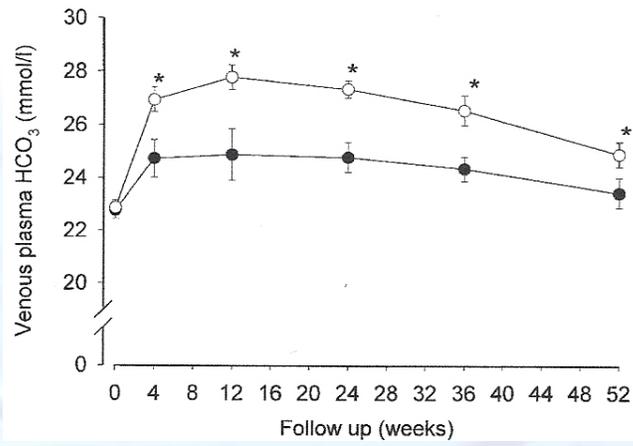
- Metabolic acidosis is a stimulus for net protein catabolism.
- Metabolic acidosis elicits the transcription of genes for proteolytic enzymes in muscle.
- CAPD patients with metabolic acidosis are more malnourished compared to those without acidosis.
- Correction of acidosis may lead to an improvement in protein turnover with decreased protein degradation.

Is there clinical improvement in nutritional status by correction of acidosis?

- Szeto and colleagues studied 60 PD patients with acidosis and  $Kt/V < 2.1$ 
  - Randomized to oral sodium bicarbonate 0.9 g three times daily or placebo
- Treatment with oral bicarbonate resulted in improved nutritional status

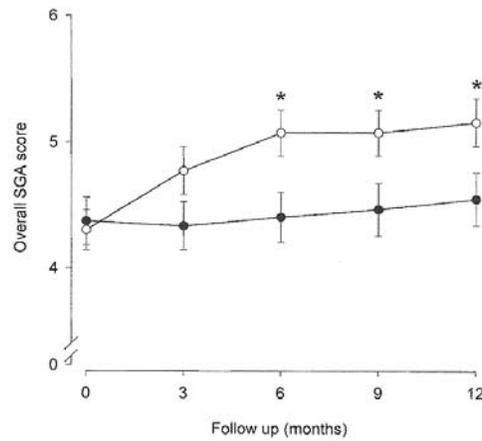
Szeto et al, J Am Soc Nephrol 2003; 14: 2119-2126

### Change in bicarbonate level (open circles treated with NaHCO<sub>3</sub>)



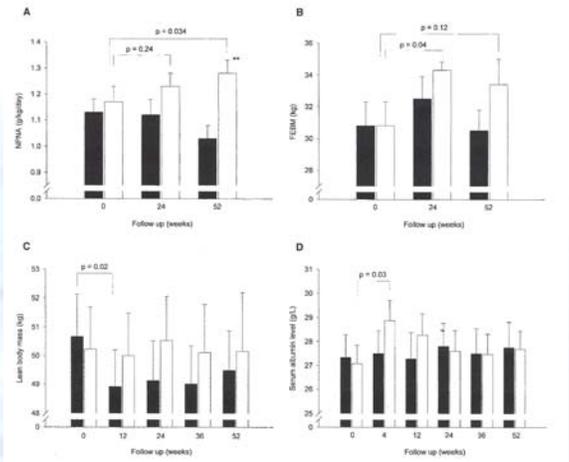
Szeto et al, J Am Soc Nephrol 2003; 14: 2119-2126

## Improvement in SGA in NaHCO<sub>3</sub> treated group



Szeto et al, J Am Soc Nephrol 2003; 14: 2119-2126

# Other nutritional parameters



Szeto et al, J Am Soc Nephrol 2003; 14: 2119-2126

## K/DOQI Recommendations

- Serum bicarbonate should be measured in maintenance dialysis patients once monthly.
- Predialysis or stabilized serum bicarbonate levels should be maintained at or above 22 mmol/L.

Am J Kidney Dis 2000; 35 (6) Suppl 2: S17-S104

The image features a square frame containing a background of light blue water ripples. The ripples are concentric circles that fade out from the center towards the edges. Overlaid on this background is the word "Interventions" in a bold, black, sans-serif font, centered horizontally and vertically within the frame.

# Interventions

## Evaluate for reversible causes of malnutrition

- **Psychiatric**
  - Depression: Consider anti-depressant
- **Socioeconomic**
  - Poverty
  - Inability to buy nutritious foods
  - Inability to prepare nutritious foods
- **Medical**
  - Gastroparesis
  - Malabsorption
  - Early satiety
  - Inflammation/infection

## Evaluate for reversible causes of malnutrition

- Inadequate dialysis
  - Assess dialysis adequacy. If dialysis dose is inadequate, modify prescription.
  - Consider modality switch to HD if protein-energy wasting is severe and difficult to increase dose of PD
- Metabolic acidosis
  - Add sodium bicarbonate

## K/DOQI Guidelines for nutritional support

- Before considering nutrition support, the patient should receive a complete nutritional assessment.
- Any potentially reversible or treatable condition or medication that might interfere with appetite or cause malnutrition should be eliminated or treated.
- For nutrition support, the oral diet may be fortified with energy and protein supplements.

Am J Kidney Dis 2000; 35 (6) Suppl 2: S17-S104

## K/DOQI Guidelines for nutritional support

- If oral nutrition, including nutritional supplements, is inadequate, tube feeding should be offered if medically appropriate.
- If the combination of oral intake and tube feeding does not meet protein and energy requirements, daily total or partial parenteral nutrition should be considered.

Am J Kidney Dis 2000; 35 (6) Suppl 2: S17-S104

## Nutritional support

- Enteral tube feeding is considered the first line of nutritional therapy for the hospitalized patient who is unable to eat adequately.
- Enteral tube feedings may also be administered at home.
- IPAA may increase protein balance in malnourished PD patients who have low protein intakes.
- A single 2-L exchange of 1.1% amino acid dialysate for 5-6 hours provides a net uptake of about 17-18 grams of amino acids.
  - Note that amino acid dialysate is not available in the United States. It is available in Canada and in Europe.

## Appetite stimulants

- Appetite stimulants such as megestrol acetate, cannabinoids, and anabolic steroids such as oxandrolone have been used anecdotally to increase protein intake in severely malnourished PD patients.

## Question 1

- All of the following are true about assessment of nutritional status in PD patients *except*:
  - A) Serum albumin should be measured monthly.
  - B) DEXA scanning should be performed annually.
  - C) Serum albumin alone is not a good predictor of nutritional status.
  - D) nPNA may be misleading in edematous patients.

## The correct answer is B.

- The serum albumin should be measured monthly as suggested by NKF/K/DOQI (Slide 22).
- Serum albumin does have several limitations including that it is influenced negatively by inflammation (Slide 10).
- nPNA may be influenced by an edematous state (Slide 17).
- DEXA can be used as an adjunct to less costly assessments of nutritional status, but there is no recommendation for annual DEXA testing (Slide 22).

## Question 2

A 51-year-old woman with ESRD secondary to diabetic nephropathy has been on CAPD (2L x 4 exchanges/day) for 2 years. She feels generally well, but the dietician notes that she has been losing weight. Her serum albumin is 3.5 g/dL. Her most recent weekly Kt/V was 2.1, K<sup>+</sup> 3.8 mEq/L, HCO<sub>3</sub><sup>-</sup> 19 mEq/L. Which of the following would be an appropriate first step in the management of this patient?

- A) Increase fill volume to 2.5 L to increase  $Kt/V$
- B) Make one exchange per day with intraperitoneal amino acids
- C) Add sodium bicarbonate
- D) Increase the number of exchanges per day to 5

## The correct answer is C.

- The patient's Kt/V is 2.1, which suggests adequate small solute clearance. There is therefore no need to increase the fill volume (A) or increase the number of exchanges (D). Furthermore, an increase in fill volume may induce more satiety, adversely affecting protein/calorie intake. Intraperitoneal amino acids may be considered for patients who have failed enteral feeding, but this patient does not meet that criterion. The simplest and least expensive maneuver is to correct her metabolic acidosis (Slide 31).

## Suggested readings

- Mehrotra R and Kopple JD, *Annu Rev Nutr* 2001; 21: 343-70
- Wolfson M, *J Ren Nutr* 1999; 9: 126-128
- Enia G *et al*, *Nephrol Dial Transplant* 1993; 8: 1094-10
- *Am J Kidney Dis* 2000; 35 (6) Suppl 2: S17-S104
- *Nephrol Dial Transplant* 2005; 20 [Suppl 9]:28-33
- Heimberger O *et al*, *Kidney Int* 1992; 41: 1320-1332
- Uribarri J, *Am J Kidney Dis* 2001; 37: 1313-1318
- Szeto *et al*, *J Am Soc Nephrol* 2003; 14: 2119-2126
- Blake *et al*, *J Am Soc Nephrol* 1993; 3: 1501-10
- CANUSA Peritoneal Dialysis Study Group, *J Am Soc Nephrol* 1996; 7-198-207
- Kopple JD, *Am J Kidney Dis* 2001; 38 (4) Suppl 1: S68-S73