Protein and Energy: Are PD Patients Different?

Vicky Ngo  RD
Providence Health Care
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Outline

1. Understand the prevalence of malnutrition in PD populations and why the requirements are important to us
2. Review current guidelines on protein and energy requirements and its limitations
3. Comparison to other renal replacement modalities
4. Challenges of meeting these requirements
5. Strategies to “fill in” the gap
Protein-Energy Malnutrition (PEM)

- PEM - one of the strongest risk factors of adverse outcomes in pts with ESRD who undergo maintenance dialysis treatment.
- Inadequate amount of protein and energy intake is an important determinant of PEM.
- PD pts consistently have been shown to have reduced intake, with most pts not reaching their recommended daily intake of kcal, protein
# Prevalence of Protein-Energy Malnutrition (PEM)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Patients (n)</th>
<th>Mean age (years)</th>
<th>Mean duration of PD (months)</th>
<th>Region</th>
<th>Malnutrition (%)</th>
<th>Mild-to-moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young et al., 1991</td>
<td>224</td>
<td>53.4</td>
<td>32.2</td>
<td>Europe and North America</td>
<td>32.6</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>Ciacciarusso et al.,</td>
<td>224</td>
<td>60.2</td>
<td>28.0</td>
<td>Italy</td>
<td>34.9</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>CANUSA, 1996</td>
<td>680</td>
<td>54.3</td>
<td>—</td>
<td>Canada, U.S.A.</td>
<td>44.6</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Jansen MA et al., 2001</td>
<td>75</td>
<td>56.0</td>
<td>9.5</td>
<td>Netherlands</td>
<td>49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kang et al., 1999</td>
<td>147</td>
<td>46.7</td>
<td>44.7</td>
<td>Korea</td>
<td>28.6</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Chung et al., 1999</td>
<td>98</td>
<td>47.9</td>
<td>22.3</td>
<td>Korea</td>
<td>44.9</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Kumano et al., 2000</td>
<td>259</td>
<td>50</td>
<td>50.4</td>
<td>Japan</td>
<td>26.2</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Wang et al., 2001</td>
<td>247</td>
<td>55</td>
<td>37</td>
<td>Hong Kong</td>
<td>40.1</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Kang et al., 2002</td>
<td>127</td>
<td>50.7</td>
<td>67.3</td>
<td>Korea</td>
<td>34.7</td>
<td>6.3</td>
<td></td>
</tr>
</tbody>
</table>

* Baseline assessment of incident patients.
* These two studies were performed at the same center with a 2-year interval.
* Study used “subjective judgment,” including an assessment of general condition, objective symptoms, and laboratory findings.
Baseline Serum Albumin Concentration and Survival in Patients on Hemodialysis

Albumin Level of PD Patients (BC Province)

Less than 50% of patients achieve >35g/l

Jan 2012  Jun 2012  Dec 2012

Colors: Green - <25, Yellow - 25-29, Purple - 30-35, Blue - >35
Protein Requirement for Healthy Subjects

- DPI= 0.8g/kg/d by DRA Committee in US¹
- 1.01-1.08g/kg/d (Japan Welfare Ministry)

- Minimum: 0.58g/kg/d by FAO (food and Agriculture Organization of UN), WHO (World Health Organization)²

Compared to Different Modalities (Protein Losses)

- PD > HD > CKD – due to protein losses into PD dialysate are higher than hemodialysate
- Peritoneal protein losses – average 5-15g/day \(^1\)
- Total protein ~9-12g, 6-8g albumin daily, and more during episodes of peritonitis \(^2\)
- HD- Amino acids losses ~ 4-9g in fasting state; 8-12g post prandially, protein losses in negligible \(^2\).

\(^1\) Movilli E et al. Nephrol Dial Transplant 1995;10: 514-518
Contribution of Dialysate Protein & Amino Acids Losses


N=5 CAPD Germany
Result: Protein losses in CAPD (~10g/d)

Wystke, M et al, Perit Dial Int 2007; 27:192-195

Netherlands  N=9 (APD) 4-7 exchanges/night

1) Protein losses significantly & independently related to the number of night time exchanges and the duration of dwell.

2) Protein + amino acids losses =15 % of dietary N intake (avg:0.14g/kg/d dialysate Protein; 0.015g/kg/d dialysate amino acids).

Example: 50 kg PD pt= 7g protein, 0.75g amino acids
### Summary of Individual Studies on Protein Requirement (after year 2000)

<table>
<thead>
<tr>
<th>Study</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aguirre Galindo 2003</td>
<td>Achieved better adherence to high protein diet with use of supplements but no indication of optimal protein intake</td>
</tr>
<tr>
<td>Chen 2008</td>
<td>Improved prealbumin with protein intake 1.2g kg/day compared to 0.8g kg/day</td>
</tr>
<tr>
<td>Chow 2003</td>
<td>Mean protein intake 1.37 (range 0.26–2.92)g/kg associated with mild to moderate malnutrition by SGA in 79% subjects</td>
</tr>
<tr>
<td>Dong 2011</td>
<td>&lt;0.73g/kg – associated with PEW, worst outcome; 0.73-0.93g/kg: negative nitrogen balance and risk of peritonitis; &gt;0.93g/kg favourable long term outcomes</td>
</tr>
<tr>
<td>Gonzalez Espinoza 2005</td>
<td>Trend to improved SGA with protein intake of 1.7 g/kg/day in the intervention group compared to usual (1.0g/Kg/day) intake</td>
</tr>
<tr>
<td>Sutton 2007</td>
<td>Dietary intake 0.93-1.01g/kg/day protein and 23.4–25.7Kcal/kg/day associated with no significant change in nutritional status</td>
</tr>
<tr>
<td>Wang 2007</td>
<td>Protein intake ≥1.17g /Kg/day and total energy intake 29.6 Kcal/kg/day associated with optimal SGA scores. Malnutrition associated with protein intake 0.92 to 1.06 g/kg/day</td>
</tr>
</tbody>
</table>

**References on the last page of presentation**
Dietary Protein Intake (DPI)  
NKF K/DOQI - 2000

PD (clinically stable)
- 1.2-1.3 g/kg/d (no less than 1.2 g/kg/d)
- At least 50% of DPI should be of high BV protein

Unless DPI of 1.2 g/kg/d demonstrated adequate, 1.3g/kg/d should be prescribed

2000 Update National Kidney Foundation KDOQI
DPI European Best Practice Guidelines (EBPG) 2005

- DPI > 1.2 g/kg/d: Not achieved by most PD; no impact on malnutrition or preserve status
- DPI of 1-1.2 associated with neutral or +N balance,
- DPI > 1.0 g/kg/d: Sufficient in most CAPD pts (based on N-balance study)
- Warned against <0.8g/kg/d

# Recommended Dietary Protein Intake by Different Expert Groups

<table>
<thead>
<tr>
<th>Expert Group</th>
<th>Recommended Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Best Practice Guidelines (ENPG) 2005 (^1)</td>
<td>(\geq 1.0)g/kg/d</td>
</tr>
<tr>
<td>NKF K/DOQI (2000)</td>
<td>1.2-1.3g/kg/d</td>
</tr>
<tr>
<td></td>
<td>(&gt;50%) HBV protein</td>
</tr>
<tr>
<td>Australian Evidence Based Practice Guidelines for the Nutritional Management of CKD, 2006 (^2)</td>
<td>1.2 (1.4)g/kg IBW</td>
</tr>
<tr>
<td></td>
<td>(&gt;50%) HBV protein</td>
</tr>
<tr>
<td></td>
<td>(Peritonitis: at least 1.5g/kg/d)</td>
</tr>
<tr>
<td>European Society of Parenteral and Enteral Nutrition (ESPEN)</td>
<td>1.2-1.5g/kg/IBW</td>
</tr>
<tr>
<td></td>
<td>(additional 0.1-0.2g/kg/d if peritoneal inflammation occurs) (50%) HBV protein</td>
</tr>
</tbody>
</table>

Clinically stable PD patients

\(^1\) Dombros N et al, Nephrol Dial Transplant. 2005 Dec 20 suppl 9:ix28-ix33
\(^2\) Ash S. Nutrition and Dietetics 2006; 63 (Suppl s2): s33-s45
Protein Requirement Limitations

- Small sample size, not randomized control trial, short duration, dissimilar in design
- Diverse range of population and different ethnicity/age/BMI/muscle mass
- Lack of detail on factors required to examine protein requirements (body weight-IBW, edema-free, DPI, physical activity)
Energy Requirements

- Assessment of energy expenditure (REE) is important for determination of energy recommendation.
- Identify factors associated with a disease that could modify the requirement.
- Calories absorbed from PD dialysates (CAPD, CCPD)
REE predicted by the equations against the reference indirect calorimetry. *P < 0.001 Harris and Benedict > indirect calorimetry; **P < 0.001 Schofield > Harris and Benedict and indirect calorimetry.

### Guidelines for Energy Requirements

<table>
<thead>
<tr>
<th>Source</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBPG 2005 and European Consensus¹</td>
<td>35 kcal/kg* (&lt; 60 yrs)</td>
</tr>
<tr>
<td></td>
<td>30 kcal/kg* (&gt; 60 yrs)</td>
</tr>
<tr>
<td></td>
<td>*standard body weight</td>
</tr>
<tr>
<td>NKF/KDOQI 2000²</td>
<td>35 kcal/kg/d &lt; 60 yrs</td>
</tr>
<tr>
<td></td>
<td>30-35 kcal/kg/d &gt; 60 yrs</td>
</tr>
<tr>
<td>Australian Evidence Based Practice Guidelines for the Nutritional Management of CKD, 2006³</td>
<td>30 35 kcal/kg IBW</td>
</tr>
<tr>
<td>European Society of Parenteral and Enteral Nutrition (ESPEN)</td>
<td>35 kcal/kg/d</td>
</tr>
</tbody>
</table>

Includes energy intake from nutrients absorbed from dialysate

¹ Francesco L et al, Nephrol Dial Transplant 2002; 17:563-572  
² 2000 Update National Kidney Foundation KDOQI  
³ Ash S. Nutrition and Dietetics 2006; 63 (Suppl s2): s33-s45
Calories from PD Dialysate

- Depends on dextrose concentration, dwell time, number/volume of exchanges, types of PD
- Estimation dextrose absorption: 60-70% with CAPD; ~50% CCPD.
- Pts with normal peritoneal transport capacity, ~60% of dialysate glucose load is absorbed / ~ 100-200g glucose/d (~ 340-680 kcal/d)
- Calories could account for more than 1/3 of daily needs.

1 Burkhart J. Semin Dial. 2004; 17:498-504
Resting Energy Expenditure (REE) of PD = Healthy Population?

- REE are similar to those of normal adults 35kcal/kg – positive nitrogen balance could only be attained with EI > 30 kcal/kg/d \(^1\)

- Cross-sectional study of 37 PD pts (Brazil) and controls’ EE by indirect calorimetry found REE was similar between groups\(^2\)

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\(^1\) Bergstrom J et al, Kidney Int 1993; 44: 1048-1057
\(^2\) Bazanelli AP et al. Perit Dial Int 2006 Nov-Dec 26(6) 697-704
REE (Higher in PD)

Wang A et al. Hong Kong

- Loss of RRF (far outweighing that of other factors, including DM, CVD, C-reactive protein, S-alb) is associated with increased REE

- Rationale – Loss of RFF: increases uremia, inflammation, with increased risk CVD

Energy Requirement Limitations

- Age difference but not race – How about those with PEW, obesity, elderly?
- No simple biomarker exists to determine the energy intake (EI) of an individual
- Dietary self-reporting methods are largely used to assess EI in epidemiological surveys and in clinical studies (accuracy?)
## Summary of Guidelines of PI & EI

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Protein</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Best Practice Guidelines (ENPG) 2005</td>
<td>&gt; 1.0g/kg/d</td>
<td>35 kcal/kg* (&lt;60 yrs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 kcal/kg* (&gt;60 yrs)</td>
</tr>
<tr>
<td></td>
<td>30 kcal/kg* (&gt;60 yrs)</td>
<td>*standard body weight</td>
</tr>
<tr>
<td>NKF K/DOQI (2000)</td>
<td>1.2-1.3g/kg/d &gt; 50% HBV protein</td>
<td>35 kcal/kg/d &lt;60 yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-35 kcal/kg/d &gt;60 yrs</td>
</tr>
<tr>
<td>Australian Evidence Based Practice Guidelines for the Nutritional Management of CKD, 2006 (4)</td>
<td>1.2 1.4g/Kg IBW &gt;50% HBV protein</td>
<td>30 35 Kcal/Kg IBW</td>
</tr>
<tr>
<td>European Society of Parenteral and Enteral Nutrition (ESPEN)</td>
<td>1.2-1.5g/kg/IBW (additional 0.1-0.2g/kg/d if peritoneal inflammation occurs) &gt;50% HBV protein</td>
<td>35 kcal/kg/d</td>
</tr>
</tbody>
</table>
## Comparison to Other Modalities

<table>
<thead>
<tr>
<th></th>
<th>Pre-Dialysis</th>
<th>HD</th>
<th>PD</th>
<th>Transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein</strong></td>
<td>0.8-1.0</td>
<td>1.2</td>
<td>1.2-1.3</td>
<td>1.3-1.5 (1st 6-8 wk)</td>
</tr>
<tr>
<td>(g/kg/d)</td>
<td>&gt;50% HBV</td>
<td>&gt;50% HBV</td>
<td>&gt;50% HBV</td>
<td>Long term: 1.0</td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>35 &lt;60yr</td>
<td>35 &lt;60yr</td>
<td>35 &lt;60yr</td>
<td>Sufficient to maintain optimal weight</td>
</tr>
<tr>
<td>(kcal/kg/d)</td>
<td>30-35 &gt;60yr</td>
<td>30-35 &gt;60yr</td>
<td>30-35 &gt;60yr</td>
<td></td>
</tr>
</tbody>
</table>
Points to consider

- No studies exist to determine whether provision of additional protein and calories to reach target recommendations will change the outcomes of mortality and morbidity.

- No randomized, prospective, controlled trials have been carried out to examine this question.

- Main risk of increasing protein/calorie intake = need to increase in dialysis dose, of PO4 binder therapy
Challenges

• Typical patient intake compared to healthy individual.

  (Example of 70kg male)

• PD dialysate volume – gastric fullness, satiety

• Glucose absorbed from dialysate and dwell time – anorexia.

• Multiple comorbidities and dietary restrictions.
Challenges

- Actual protein intake: ~ 0.95-1.0g/kg/d;

- Energy intake: ~ 23-28 kcal/kg/d\(^1\)

- Japanese study by Yoshihiko\(^2\): Compliance to protein recommendation is low ~77.3%; EI~85%

Strategies to “Fill In” the Gap

- EI
- REE
- EEPA

Nutrient loss during dialysis
Inflammation
Hypercatabolic illness
Endocrine disorders

Requirement

Actual intake

~60-70%

Anorexia
PD dialysis
Catabolism
Acidosis
Inflammation
1. Oral Nutritional Supplementation

- Boudville et al 2003: Australia n=13
- Substitution of food supplements for regular food with no net gain in calories or protein intake
- Meta-analysis of all oral supplement trials suggested that oral supplement improved serum albumin levels in patients with severe energy wasting

- Oral nutritional supplements, protein powder

### Table 4: Nonrandomized Trials in Patients Undergoing Peritoneal Dialysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention modality, duration and study design</th>
<th>Patients and condition (n)</th>
<th>Results and conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shimomura et al. (1993)</td>
<td>Protein dessert with high biological value (0.1–0.3 g/kg daily) for &gt;6 months</td>
<td>CAPD (18) No control arm</td>
<td>Increased serum levels of total protein, albumin, prealbumin, transferrin, total amino acids, EAA/non-EAA ratio, Kt/V urea, PCR. Albumin levels rose from 32.5 g/l to 33.1 g/l in patients given the dessert, whereas patients in the control group had an albumin level of 38.8 g/l and 37.7 g/l before and after the study period, respectively.</td>
</tr>
<tr>
<td>Patel &amp; Raftery (1997)</td>
<td>Standard ONS (Protein Forte [Fresenius Kabi, Bad Homburg, Germany] and Ensure® Plus [Abbott Nutrition, Columbus, OH, USA]) vs routine care for 8 weeks</td>
<td>PD (22) Case (10) Control (12)</td>
<td>Increased serum albumin levels, nPCR, DPI and DEI in the group taking supplements. Significant difference in BMI and protein intake between the groups.</td>
</tr>
<tr>
<td>Heaf et al. (1999)</td>
<td>Standard ONS (Fortimel [Nutricia, Schiphol, The Netherlands]) vs usual diet for 10 weeks</td>
<td>PD (42) Case (12) Control (30) Albumin concentration &lt;36 g/l</td>
<td>No improvement in nutritional status; albumin levels decreased in both groups. Condition worsened in half of patients because of nausea.</td>
</tr>
<tr>
<td>Boudville et al. (2003)</td>
<td>CKD-specific ONS (Nepro®, Abbott Nutrition) vs calorie-free placebo; crossover design</td>
<td>PD (13) Baseline albumin concentration 34.8 g/l</td>
<td>Drinking the supplement 2 h before lunch resulted in a significant increase in total caloric intake as compared with during the placebo visit (843 kcal vs 430 kcal, respectively; P&lt;0.001) and protein intake (41.3 g vs 27.6 g, respectively; P=0.006).</td>
</tr>
<tr>
<td>Teixidó-Planas et al. (2005)</td>
<td>Non-CKD-specific ONS (Protenplus®, Fresenius); multicenter, randomized study for 6–12 months</td>
<td>PD (70) Case (35) Control (35)</td>
<td>Increased total lymphocyte count in the 'intention to treat' analysis. In the 'as treated' analysis (9 cases, 20 controls): increased body weight (P&lt;0.03), triceps skinfold thickness (P&lt;0.01), mid-arm-muscle circumference (P&lt;0.03), lean body mass (P&lt;0.002), creatinine generation rate (P&lt;0.002) in the group taking the supplement. High noncompliance rate: 15 patients stopped ONS.</td>
</tr>
</tbody>
</table>

Abbreviations: CAPD, continuous ambulatory peritoneal dialysis; CKD, chronic kidney disease; DEI, dietary energy intake; DPI, dietary protein intake; EAA, essential amino acid; nPCR, normalized protein catabolic rate; ONS, oral nutritional supplement; PD, peritoneal dialysis.

### Effects of Oral Supplements on Nutritional Status in Patients on Peritoneal Dialysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Study type</th>
<th>Population</th>
<th>Interventions</th>
<th>Follow-up</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shimomura et al. (1993)¹⁰⁹</td>
<td>Nonrandomized controlled</td>
<td>36</td>
<td>Supplement of 0.1–0.3g protein per kg per day ($n=18$); controls had no supplement ($n=18$)</td>
<td>6 months</td>
<td>↑ serum albumin, prealbumin, transferrin, plasma total amino acids, and the ratio of essential amino acids to nonessential amino acids</td>
</tr>
<tr>
<td>Heaf et al. (1999)¹¹⁰</td>
<td>No control group</td>
<td>14</td>
<td>Commercial supplement with 40g protein per day</td>
<td>10 weeks</td>
<td>No change in serum albumin, DPI, calorie intake and nPNA</td>
</tr>
<tr>
<td>Eustace et al. (2000)¹¹¹</td>
<td>Randomized double blind placebo-controlled</td>
<td>47 (18 on PD and 29 on HD)</td>
<td>Oral essential amino acid tablets vs placebo</td>
<td>3 months</td>
<td>No change in serum albumin level or grip strength; ↑ skinfold thickness</td>
</tr>
<tr>
<td>Aguirre Galindo et al. (2003)¹¹²</td>
<td>Randomized</td>
<td>100</td>
<td>High protein diet (1.4g/kg per day ($n=50$) vs calcium caseinate diet ($n=50$)</td>
<td>4 months</td>
<td>↑ serum albumin level and total protein in both groups</td>
</tr>
<tr>
<td>Boudville et al. (2003)¹¹³</td>
<td>Single blind crossover</td>
<td>13 on PD</td>
<td>Commercial supplement with 475kcal and 16.6g protein</td>
<td>ND</td>
<td>↑ serum albumin level, total calorie and protein intake</td>
</tr>
<tr>
<td>Telixidó-Planas et al. (2005)¹¹⁴</td>
<td>Randomized controlled</td>
<td>75</td>
<td>Commercial supplement with 20g of protein per day</td>
<td>12 months</td>
<td>No change in serum albumin level; high rate of noncompliance and intolerance to commercial protein supplement</td>
</tr>
<tr>
<td>González-Espinoza et al. (2005)¹¹⁵</td>
<td>Randomized controlled</td>
<td>30</td>
<td>Egg albumin supplement with 30g protein per day ($n=13$); control ($n=15$)</td>
<td>6 months</td>
<td>↑ serum albumin, total calorie and protein intake, and nPNA</td>
</tr>
<tr>
<td>Poole and Hamad (2008)¹¹⁶</td>
<td>No control group</td>
<td>190 (157 on HD and 33 on PD)</td>
<td>20–30g protein and 500kcal per day for nondiabetics; 13.8g protein and 250 kcal per day for diabetics</td>
<td>3 months</td>
<td>↑ serum albumin (HD only); no significant improvement in PD</td>
</tr>
<tr>
<td>Moretti et al. (2009)¹¹⁷</td>
<td>Randomized crossover</td>
<td>49 (6 on PD and 43 on HD)</td>
<td>PD: 105g protein per week; HD: 45g protein per week</td>
<td>12 months</td>
<td>No change nPCR and ↑ serum albumin level in protein supplemented group; ↓ nPCR and serum albumin level in controls</td>
</tr>
</tbody>
</table>

Abbreviations: DPI, dietary protein intake; HD, hemodialysis; ND, not determined; nPNA, normalized protein nitrogen appearance; nPCR, normalized protein catabolic rate; PD, peritoneal dialysis.
Oral Nutritional Supplement Use Across BC

Total N=477 / 1089 (44%)
Intraperitoneal Amino Acids

- Amino Acid 1.1% (Nutrineal)
- 1 bag/day – with lunch/supper to enhance absorption
- Provides 17-18g amino acids
- Expensive
Low Phosphorus to Protein Ratio Food

- Food with high amount of protein and small amount of phosphorus

- Lower PO4 level without risking malnutrition

- Example: egg white

Taylor LM. J Ren Care 2011 Mar;37(1):16-24
Caloric-Dense Food

- Replace current food/snack with higher energy and protein content.
- Specialty high protein/energy bars, cookies, pudding
- Know what is available in the market and be creative.
Liberalize Diet Restrictions

- Set priorities
- Diabetes, low salt, lipids, PD (potassium, phosphorus)…..vegetarian…..gluten free.
- Eats while “empty”
Minimize Protein Loss

- Adequate dialysis
- Preserve peritoneal membranes
- Watch for and treat infection/inflammation/wounds to preserve protein (albumin) in the body
Conclusion

- PD populations: Dialysate, anorexia, inflammation, dialysis prescription affects protein/energy requirement and po intake.
- Understand current evidences, guidelines and limitations.
- Protein intake should not be considered in isolation from energy intake.
- Development of valid prediction equations for estimating energy expenditure.
- Ongoing nutrition assessment and counselling to “fill in” the gap.
References

(Studies on protein requirement)

Aguirre Galindo BA et al. Perit Dial Int 2003; 23: 434 9
Chen WG Journal of Chinese Integrative Medicine 2008; (5): 473 7
Chow VCY Perit Dial Int 2003; (SUPPL. 2): S52 S54
Questions