Peritoneal dialysis

D. Teta (CH)
Nutrition Support in Patients undergoing Peritoneal Dialysis (PD)

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LLL Renal

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Learning objectives

1. To identify nutritional differences between PD and HD patients

2. To learn how to detect and prevent protein energy wasting (PEW) in PD patients

3. To learn how to treat PD patients with established PEW
   - Oral nutritional supplements (ONS)
   - Amino-acid intraperitoneal parenteral nutrition (AA-IPN)
PD is a treatment modality used for renal replacement therapy

- Exchanges between blood and dialysate (uraemic toxins)
- Exchanges between dialysate and blood (dialysate components)
Continuous Ambulatory Peritoneal Dialysis (CAPD)

- Continuous method of renal replacement therapy,
- Home therapy

**Procedure:**

- PD fluid (glucose-based) is introduced in the abdominal cavity via a PD catheter
- Dwell time: 4h-8h
- PD effluent is drained (removal of toxins and excess of water)
- 1 PD exchange (out and in) lasts about 30 minutes
- 4 PD exchanges/day
Automated Peritoneal Dialysis (APD)

- PD is performed during the night,
- PD exchanges via a cycler
- Patient is free during the day
PD versus HD patients: Differences in nutritional status

Cross sectional study, n = 224 PD / 263 HD

<table>
<thead>
<tr>
<th></th>
<th>Mean values</th>
<th>* P &lt; 0.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results in men (n = 124 PD / 155 HD)</td>
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<tr>
<td><strong>Body weight (kg)</strong></td>
<td>70.6 / 65.2</td>
<td></td>
</tr>
<tr>
<td><strong>TSF (cm)</strong></td>
<td>11* / 9</td>
<td></td>
</tr>
<tr>
<td><strong>Body fat (%)</strong></td>
<td>22* / 19</td>
<td></td>
</tr>
<tr>
<td><strong>nPNA (g/kg/d)</strong></td>
<td>0.91 / 0.95</td>
<td></td>
</tr>
<tr>
<td><strong>MAMC (cm)</strong></td>
<td>25 / 24</td>
<td></td>
</tr>
<tr>
<td><strong>Albumin (g/l)</strong></td>
<td>37* / 42</td>
<td></td>
</tr>
<tr>
<td><strong>SGA (% malnutrition)</strong></td>
<td>42.3* / 30.8</td>
<td></td>
</tr>
</tbody>
</table>

Nutritional specificities of PD (1)

- **Protein losses through peritoneal membrane:**
  - protein losses: 10 g/day (mainly albumin and IG), up to 100 g/day if peritonitis
  - amino acids losses: 3-4 g/day (30% essential AA)

- **Glucose absorption through peritoneal membrane:**
  - 100-200 g/day; average: 300-450 kcal/day;
  - (about 20% of total energy intake)
Nutritional specificities of PD (2)

- Lower spontaneous food intake and appetite in PD patients than HD patients: 23-24 kcal/kg/day vs 28-29 kcal/kg/day
  Because of:
  - Presence of PD fluids in the peritoneal cavity: osmolality, volume, type of PD fluids may influence intakes
  - Impaired gastric emptying (more than in HD)
  - High prevalence of gastro-intestinal symptoms such as abdominal pain, constipation, diarrhea

- But lower intakes are compensated by energy provided by glucose absorbed from the peritoneal cavity

⇒ *Total energy intake (including from PD solutions) in PD patients: 29-33 kcal/kg/day*
Ultrafiltration (UF) failure

- In a proportion of patients, especially after 2 years, lack of ultrafiltration = lack of fluid removal capacity after a defined dwell.
- This is due to deterioration of the peritoneal membrane

Consequences

- Overhydration
- Use of PD fluids containing colloids (icodextrin) or high glucose concentrations
Consequences in PD patients

1. Protein losses
   ✓ Lower serum albumin in PD patients
   ✓ Muscle mass not different from HD patients

2. Glucose absorption
   ✓ Hyperglycaemia, hyperinsulinaemia, insulin resistance, de novo diabetes, aggravation of diabetes
   ✓ Increased LDL cholesterol and triglyceride.
   ✓ Adipose tissue accumulation, increased body fat content

3. Ultrafiltration failure
   ✓ Hypertension, oedema, fluid overload
## Recommended intakes in PD patients: Macronutrients

<table>
<thead>
<tr>
<th></th>
<th>ESPEN (1)</th>
<th>NKF (2)</th>
<th>EBPG (3)</th>
<th>ISRN (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein g/kg/day</strong></td>
<td>1.2 - 1.5*</td>
<td>1.2 – 1.3*</td>
<td>1.3*</td>
<td>&gt; 1.2*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 1.5* (peritonitis)</td>
</tr>
<tr>
<td><strong>Energy kcal/kg/day</strong></td>
<td>35**</td>
<td>&lt; 60y: 35**</td>
<td>&lt; 60y: 35**</td>
<td>30-35**/***</td>
</tr>
<tr>
<td></td>
<td>&gt; 60y: 30-35**</td>
<td>&gt; 60y: 30-35**</td>
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</tr>
</tbody>
</table>

* > 50% of proteins of high biological value
** Including energy supply (glucose) from PD fluids
***Based on physical activity

1 - ESPEN. Clinical Nutrition 2006; 25: 295-310
3 - EBPG. Nephrol Dial Transplant 2005; 20 [Suppl 9]: ix28–ix33
4 - ISRN. Kidney Int 2013
# Recommended intakes in PD patients: Micronutrients

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>Recommended Intake</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESPEN 2000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ESPEN 2006</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Common sense</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Folic Acid, mg</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>accord. to plasma Ca++ &amp; PTH</td>
<td></td>
</tr>
<tr>
<td>Zinc, mg</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Selenium, µg</td>
<td>50-70</td>
<td></td>
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</tbody>
</table>
PD patients and high risk of PEW

• All PD patients and HD patients are at risk of PEW

Further increased risk of PEW in PD patients if:
• Anuria: higher resting energy expenditure (REE), lower intakes
• Inflammation: higher REE
• Congestive heart disease: higher REE and lower intakes
• Severe hyperparathyroidism: higher REE
## Recommendations for monitoring of nutrition status in PD patients

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary interview (3 d)</td>
<td>6 - 12 mo</td>
</tr>
<tr>
<td>nPNA (according to urea in blood and dialysates)</td>
<td>1 mo</td>
</tr>
<tr>
<td>Body weight</td>
<td>1 mo</td>
</tr>
<tr>
<td>BMI</td>
<td>1 mo</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>1-3 mo</td>
</tr>
<tr>
<td>Subjective global assessment (SGA)</td>
<td>6 mo</td>
</tr>
<tr>
<td>DEXA, handgrip</td>
<td>useful</td>
</tr>
</tbody>
</table>

Nutritional support in PD patients

- Dietary counselling
- Oral nutritional supplements (ONS)
- Amino acid-based intraperitoneal parenteral nutrition
- Intravenous parenteral nutrition
- Tube feeding

- Degree of PEW
- Spontaneous intakes
- Patient compliance
Dietary counselling

- In patients treated by HD, nutritional counselling improves compliance with nutritional recommendations.

- In PD patients, no studies have explored this issue. It is assumed that nutritional counselling also improves compliance with nutritional recommendations.
ONS in PD patients: general findings

Mixed results

- Only 4 RCT and many (at least 10) non randomized trials
- Many studies underpowered to detect effects on nutrition status due to high rate of drop-out of 50-60% (compliance)
- Compliant patients (40-50% only): improvements (sometimes marked) of nutritional markers
- Non compliant patients: no effect, as expected
- Patients not compliant because of symptoms (lack of eating drive, nausea)
- Supplements with high biological value (e.g. egg-albumin based) appear to have a greater effect than standard ONS
Randomized clinical trial (US)

Serum albumin < 3.8 g/dL

- **Supplement group:**
  3.6 g EAA 3x/day

- **Control group:** placebo

- **3-month supplementation**

- N = 47 (29 HD / 18 PD)

Oral nutritional supplements

Randomized, open label, controlled clinical trial

28 PD patients, mean age 47 y, 6-month treatment

• treated patients (n = 13):
  oral egg albumin-based supplement 15 g (equivalent to 11 g of HBV protein) twice daily + counselling

• control patients (n = 15): counselling

Results

Good tolerance, no side-effect reported

## Oral nutritional supplements: RCT

<table>
<thead>
<tr>
<th>Authors</th>
<th>N</th>
<th>Type of patients</th>
<th>Design</th>
<th>Months</th>
<th>Nutritional significant effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eustace et al. (2000) (57)</td>
<td>47</td>
<td>HD/PD</td>
<td>RCT: Essential amino acids (3.6 g with meals 3 times daily) vs placebo</td>
<td>3</td>
<td>↑albumin only in HD, not in PD</td>
</tr>
<tr>
<td>Aguirre Galindo et al. (2003) (58)</td>
<td>100</td>
<td>PD</td>
<td>RCT: 100% natural protein vs 50% calcium caseinate + 50% natural protein. All patients receiving 3.5 kcal/kg/d and 1.4 g prot/kg/d</td>
<td>4</td>
<td>↑albumin in both groups, more pronounced with calcium caseinate</td>
</tr>
<tr>
<td>Gonzalez-Espinoza et al. (2005) (59)</td>
<td>28</td>
<td>PD</td>
<td>RCT: egg albumin-based ONS vs control group</td>
<td>6</td>
<td>↑albumin in interventional group, DPI, DEI and nPNA in interventional group</td>
</tr>
<tr>
<td>Moretti et al. (2000) (60)</td>
<td>49</td>
<td>HD/PD</td>
<td>Crossover controlled trial: standard ONS vs control group</td>
<td>12</td>
<td>↑albumin and nPNA in interventional group, ↓albumin and nPNA in control group</td>
</tr>
</tbody>
</table>
Amino acid-based intraperitoneal parenteral nutrition (AA-IPPN)

- Administration of intraperitoneal 1.1% AA solution (commercialized in a PD solution)
- Incorporation in protein synthesis (metabolic studies using intraperitoneal leucine ($^{13}$C)

Analysis of 11 studies of intraperitoneal AA infusions

- 4 RCTs
- 4 cohort series
- Improvement of nitrogen balance in all studies
- Improvement of nutrition parameters in 4 cohort studies, but not in other studies

Mehrotra R, Kopple JD. Adv Ren Replace Ther 2003
AA-IPPN in PD patients

- One long term RCT (3 years)

- Control group: n = 30
  4 out of 4 glucose-based PD fluids

- Study patients: n = 30.
  replacement of 1 out of 4 PD fluids with a PD AA-based solution (Nutrineal). 3 glucose-based PD fluids

<table>
<thead>
<tr>
<th>Table 4. Serial Changes in Nutritional Parameters in Patients on DAA or DD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
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<tr>
<td>---</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
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<tr>
<td>Prealbumin (mg/dL)</td>
</tr>
<tr>
<td>Transferrin (mg/dL)</td>
</tr>
<tr>
<td>Cholesterol (mg/dL)</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
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<tr>
<td>Triceps skin fold (mm)</td>
</tr>
<tr>
<td>Mid-arm muscle circumference (cm)</td>
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<tr>
<td>Fat mass (kg)</td>
</tr>
<tr>
<td>nPNA</td>
</tr>
<tr>
<td>Dietary intake</td>
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<tr>
<td>Protein intake (g/kg/d)</td>
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<tr>
<td>Caloric intake (kcal/kg/d)</td>
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<tr>
<td>Total</td>
</tr>
<tr>
<td>Oral</td>
</tr>
<tr>
<td>Peritoneal</td>
</tr>
</tbody>
</table>

AA-IPPN: gender effect in favour of females

Nutritional support in PD patients

**ONS**
- 500 kcal/day (standard formulas)
  - 5 - 10 kcal/kg/d
  - 0.4 - 0.6 g prot/kg/d

**AA-IPPN**
- 87 mmol/L = 11 g/L
- 70-80% AA absorbed in 6 hours

- ONS can be poorly tolerated in PD patients
- AA-IPPN should be prescribed in patients not tolerating ONS
Enteral nutrition (Tube feeding)

- Indicated in severe PEW, particularly when spontaneous intakes are < 20 kcal/kg/day, and if AA-IPPN or ONS insufficient to cover nutrition needs.
- Polymeric EN, administered via naso-gastric tube.
- Some experience in small infants on PD.
- Not investigated sufficiently in adult PD patients.
- Percutaneous endoscopic gastrostomy or jejunostomy (PEG/PEJ) not recommended in adult PD patients because of the risk of peritonitis (although used in children treated by PD).

Decision tree in PD patients

All PD patients: monitor body weight, intakes regularly

Patients: ↑risk of PEW
Spontaneous intakes
Energy: < 30 kcal/kg/d
Protein: < 1.1 g/kg/d

PEW
BMI < 20 kg/m²
Body weight loss > 10% in 6 months
Prealbumin < 300 mg/l

Spontaneous intakes
> 20 kcal/kg/d

Dietary counselling

Spontaneous intakes
< 20 kcal/kg/d
And/or stress conditions

ONS (or AA-IPPN)

Enteral nutrition (EN)
Or IVPN
(if EN not possible or if encapsulating peritonitis)

No improvement
No improvement

Teta D. e- pen 2013
How to improve the efficacy of nutritional support in PD patients?

• Pre-requisites:
  • look for a treatable cause of undernutrition/PEW
  • correct metabolic acidosis (MW predialysis bicarbonate ≥ 20 mM)
• Early intervention

Other treatments to be tested:
• Specific nutritional supplements: EAA, BCAA
• Exercise + Nutrition support
• Anabolizing agents: male hormone
How to improve Metabolic Profile in PD patients?

• Glucose-based PD solutions can be partially replaced by glucose-free PD fluids (AA-based, icodextrin-based) to reduce glucose load

• This strategy leads to improvements in hyperinsulinemia, insulin resistance, hyperleptinaemia, and lipid abnormalities in these patients

• A recently published RCT showed that diabetic PD patients with a lower glucose load (use of glucose-free PD solutions) had a decreased in HbA1C of 0.6 % vs 0% in the standard group (J Am Soc Nephrol 2013, on line)

• Effect on PD patient’s body composition is unknown

• Favorable effect on long term is likely
Conclusions

• PD patients are characterized by important protein losses and addition of extra calories from glucose-based PD fluids.

• Although data are insufficient, ONS and AA-IPPN may improve nutritional status in PD patients with PEW.

• In patients not tolerating ONS, AA-IPPN should be proposed.

• The impact of glucose-reduced PD regimen on metabolic derangements is promising.
I thank you for your attention