Nutritional support in renal disease and dialysis

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Old and new
Acute and chronic

Malnutrition in CKD

- Prevalence of malnutrition high: ~35% in patients beginning haemodialysis
- Mostly in patients with moderate and severe CKD (stage 4 and 5, GFR <30)
- Characterized by loss of muscle mass, loss of visceral protein and then of fat mass
- Adverse effects on natural course of CKD, quality of life, morbidity and mortality

Malnutrition in AKI

- Inadequate supply of nutrients
- Cytokines and toxins of critical illness
- Endocrine factors (especially insulin resistance)
- Metabolic acidosis
- Loss of nutrients in RRT

Fiaccadori E et al., NDT Plus 2010; 3:1-7

Fiaccadori E et al., JASN 1999; 10:581-93

Parenteral Nutrition in Adult Renal Failure
NIM Cano, M Aparicio, G Brunori, JJ Carrerro, B Cianciaruso, E Fiaccadori, B Lindholm, V Teplan, D Fouque, G Guarnieri
Clinical Nutrition 2009; 28:401-414
Protein catabolic rate in critically ill patients with AKI on RRT

Protein catabolic rate (pPCR), g/kg/day

Resting energy expenditure in AKI similar to that in other ICU patients

Faisy C et al., Am J Clin Nutr 2003; 78:241-9

No advantage to N balance in increasing calories in AKI

Nutrition prescribing in AKI patients on RRT

• Protein/amino acids:
  −~1.5 g/kg/day
  −Plus 0.2 g/kg/day to compensate for RRT

• Energy:
  −~25 kcal/kg/day as glucose
  −~10 kcal/kg/day as lipid

Discussion on “correct” weight

Nutrition prescribing in AKI patients on RRT

• Standard multivitamin and trace element preparations usually sufficient
• Particular attention to:
  − selenium, thiamine, vitamin C, folate and copper
• Routinely supplement with 100mg vitamin C

Micronutrients in AKI patients on RRT

Enteral nutrition is the preferred modality in nutrition in AKI

• Enteral nutrition is safe in AKI
• No clinically relevant increase in complications
• Increased gastric residual volumes common however
• Combination with parenteral support may be needed to reach nitrogen target


ESSEN Guidelines 2009

ESSEN Guidelines 2009
**Nutritional support for acute kidney injury**

**Algorithm for nutrition in AKI patients**

**Implications for practice**

There is no strong evidence to conclude that EALH, high calorie-TPN, high-dose amino acids or nitrogen and fat improves the survival and recovery from AKI in critically ill patients.

**Chronic kidney disease**

**Malnutrition in CKD**

- Reduced oral intake because of (excessively?) restrictive diet
- Anorexia of uraemia
- Loss of nutrients (heavy proteinuria)
- MIA syndrome (malnutrition-inflammation-atherosclerosis)
- Hormonal/metabolic abnormalities
- Gastrointestinal symptoms
- Other (low social status, poverty, dentition)

**Nutrition in CKD before dialysis**

- Prevention of muscle loss
- Prevention or treatment of malnutrition
- Reduction of metabolic disorders
- Positive impact on overall prognosis
- Should not worsen CKD progression

**Spontaneous decline in protein intake as GFR declines**

Ikizler A et al. JASN 1995; 6: 1386-1391
Low protein diets in CKD

- Alleviation of the uraemic syndrome
- Reduction of proteinuria
- Reduction of complications of the uraemic syndrome
  - hyperparathyroidism
  - bone disease
  - hyperphosphataemia (1 g of protein = 15 mg P)


Effect of low protein diet (LPD) on GFR

<table>
<thead>
<tr>
<th>(0.6 g prot/kg/day)</th>
<th>Favor Excess Protein</th>
<th>Favor Low Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jungers et al.</td>
<td>14</td>
<td></td>
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<tr>
<td>Bouchard and LaGrene</td>
<td>15</td>
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<tr>
<td>Bergman et al.</td>
<td>15</td>
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<tr>
<td>Ruml et al.</td>
<td>22</td>
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<tr>
<td>Duhamel et al.</td>
<td>30</td>
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<tr>
<td>Zeller et al.</td>
<td>35</td>
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<tr>
<td>Williams et al.</td>
<td>60</td>
<td></td>
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<tr>
<td>Irie et al.</td>
<td>64</td>
<td></td>
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<tr>
<td>D'Amico et al.</td>
<td>128</td>
<td></td>
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<tr>
<td>Rosenman et al.</td>
<td>229</td>
<td></td>
</tr>
<tr>
<td>Klahr et al.</td>
<td>265</td>
<td></td>
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<tr>
<td>Locatelli et al.</td>
<td>438</td>
<td></td>
</tr>
<tr>
<td>Klahr et al.</td>
<td>585</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1919</td>
<td></td>
</tr>
</tbody>
</table>

Gain of GFR of 0.53 ml/min/year


Low protein diet - cautions

- Safe only if no malnutrition at baseline
- Must be monitored for development of malnutrition during follow-up +/- adaptation of regimen
- Must not increase risk of calorie restriction
- Important role for skilled renal dietician

Very low protein diet (VLPD) of 0.3 g/kg/day: effect on proteinuria

Aparicio et al, Nephron 1988

Very low-protein (VLPD) diet

In advanced CKD (stages 4-5)
VLPD with keto-amino acids (KA) may be considered

0.28-0.30 g protein/kg iBW/day
100 mg KA/kg iBW/day
Very low-protein (VLPD) diet

Proved advantages of VLPD + KA versus LPD
• Better nitrogen balance in steady state patients
• Greater decrease in blood urea
• Better overall nutritional status, provided adequate energy intake of 30-35 kcal/kg/day
• Reduced proteinuria
• Probably reduced rate of decline in GFR

Chauveau P et al, J Ren Nutr 2007

Prevalence of malnutrition in haemodialysis

n = 7,123

BMI < 20 kg/m² 24%
Lean body mass < 90% centile 62%
Albumin < 35 g/l 20%
Transthyretin < 300 mg/l 36%
nPNA < 1 g/kg/d 35%

Normalised Protein Nitrogen Appearance
= protein catabolic rate normalised for weight
= urinary nitrogen excretion

Aparicio M et al. Nephrol Dial Transplant 1999

Malnutrition and survival

Reverse epidemiology

Kalantar-Zadeh K. Kidney Int 2003

Haemodialysis and nutrition

Malnutrition in HD

Associated with:
• Infection
• Cardiac failure
• Acute cardiovascular events
• Decreased physical capacity
• Decreased quality of life
• Increased hospitalisation rates
• Decreased survival*

Kalantar-Zadeh K. Kidney Int 2003

Recommended macronutrients

<table>
<thead>
<tr>
<th></th>
<th>ESPEN ¹</th>
<th>NKF ²</th>
<th>EBPG ³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein g/kg/day</td>
<td>1.2-1.4</td>
<td>1.2</td>
<td>&gt;1.1</td>
</tr>
<tr>
<td>Energy kcal/kg/day</td>
<td>35</td>
<td>&lt; 60 y: 35</td>
<td>30-40</td>
</tr>
<tr>
<td>&gt; 60 y: 30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ - Toigo G et al. Clin Nutr, 2000
³ - Fouque D et al. EBPG. Nephrol Dial Transplant 2007
**Recommended micronutrients**

**ESSEN 2000**
- Pyridoxine, mg: 10-15
- Vitamin C, mg: 30-60
- Folic Acid, mg: 1
- Vitamin D: determined by Ca/PTH
- Zinc, mg: 15
- Selenium, µg: 50-70

*Toigo G et al. Clin Nutr, 2000*

**Nutritional support in HD**

- Dietary counselling
- Oral supplements
- Intradialytic parenteral nutrition
- Enteral tube feeding

Severity of malnutrition
- Spontaneous alimentation
- Patient compliance

**Dietary counselling**

Albumin in 6 month RCT

*Leon JB et al. J Ren Nutr 2001*

**Oral nutritional supplements**

*Sharma M, J Renal Nutr 2003*

**Intradialytic parenteral nutrition**

*Chartow GM et al. Am J Kidney Dis 1994*

**Nutritional support**

- Oral supplements or IDPN?

  - Both oral supplements and IDPN can improve nutritional status
  - Oral supplements are simpler and cheaper

Is there any advantage to IDPN?
- nutritionally?
- in terms of morbidity and mortality?
### Enteral nutrition

- Polymeric EN via naso-gastric tube or gastrostomy
- Necessary during severe undernutrition, particularly when spontaneous intake < 20 kcal/kg/day and/or when IDPN is insufficient
- Enteral nutrition should be preferred to full parenteral nutrition*
- Poorly investigated

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### Exercise augments the acute anabolic effects of IDPN in haemodialysis patients

- **Nandrolone decanoate in HD patients**
  - **Nandrolone Decanoate Group**
    - 100 mg/week during 6 mo (n = 14)
  - **Placebo Group**
    - (n = 15)

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*Please note that the asterisk (*) indicates a lack of investigation or insufficient data.*
**Daily dialysis**

- **Protein (g/kg/day)**
  - Standard HD
  - Daily HD (6 mo)
  - Daily HD (12 mo)

- **Energy (kcal/kg/day)**
  - Standard HD
  - Daily HD (6 mo)
  - Daily HD (12 mo)

Galland et al., *Kidney Int* 2001

**Conclusions for HD patients**

- Dietary counselling, ONS and IDPN effective
- Effect independent of CRP
- Increase in transthyretin during nutritional support is associated with increased survival
- IDPN is indicated in malnourished HD patients failing oral supplementation (before enteral tube feeding)
- Exercise improves the efficacy of IDPN
- Consider androgens or daily dialysis if unresponsive

**Peritoneal dialysis and nutrition**

**PD vs HD: Prevalence of malnutrition**

<table>
<thead>
<tr>
<th></th>
<th>PD</th>
<th>HD</th>
<th>p &gt; 0.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 224 PD / 263 HD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Results in men (n = 124 PD / 155 HD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>70.6</td>
<td>65.2</td>
<td></td>
</tr>
<tr>
<td>Albumin (g/l)</td>
<td>37</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>nPNA (g/kg/d)</td>
<td>0.91</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>MAMC (cm)</td>
<td>25</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>TSF (cm)</td>
<td>11</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>22</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>SGA (% malnutrition)</td>
<td>42.3</td>
<td>30.8</td>
<td></td>
</tr>
</tbody>
</table>


**Nutritional status: HD vs PD**

**Patients on PD have:**
- More fluid overload (5-15 g/day)
- Greater protein losses (100-150 g/day)
- Positive energy balance
- More negative protein balance
- Increase in body fat mass and weight over time

**Nutritional aspects specific to PD**

- Lower food intake and appetite than HD patients (role of PD fluids in the peritoneal cavity)
- Impaired gastric emptying
- More gastro-intestinal symptoms
**Nutritional aspects specific to PD**

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

- **Glucose absorption through peritoneal membrane:**
  - >100g/day; average: 300-450 kcal/day
  - about 20% of total energy intake
  - spontaneous energy intake in PD patients: 23-24 kcal/kg/day
  - total energy intake in PD patients: 29-33 kcal/kg/day

**Recommended intakes in PD patients**

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th>Pyridoxine, mg</th>
<th>Vitamin C, mg</th>
<th>Folic Acid, mg</th>
<th>Vitamin D</th>
<th>Zinc, mg</th>
<th>Selenium, µg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>100</td>
<td>1</td>
<td>judge by Ca++ &amp; PTH</td>
<td>15</td>
<td>50-70</td>
</tr>
</tbody>
</table>

*Including energy supply (glucose) from PD fluids*

**Recommended intakes in PD patients (Macronutrients)**

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

1 - ESPEN. Clinical Nutrition 2006; 25: 295-310

**Dietary counselling in PD**

- No studies in PD patients
- Data from HD can perhaps be extrapolated
- Nutritional counselling in PD should improve compliance with nutritional recommendations

**Oral nutritional supplements**

- Randomized clinical trial (US)
  - serum albumin < 3.8 g/dL
  - > 90% compliance during a 2w run-in period
  - Supplement group: 3.6 g EAA 3x/day
  - Control group: placebo
  - 3 months
  - N = 47 (29 HD / 18 PD)

**ONS in PD – Mexican study**

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 (13C))

Analysis of 11 studies of intraperitoneal infusions (4 RCT)

- Improvement in nitrogen balance
- Minor improvement in nutrition parameters

Nutritional support in PD patients

<table>
<thead>
<tr>
<th>ONS</th>
<th>AA-IPPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 kcal/day (standard formulas)</td>
<td>87 mmol/L = 11g/L</td>
</tr>
<tr>
<td>• 5 -10 kcal/kg/d</td>
<td>70-80% AA absorbed in 6 hours</td>
</tr>
<tr>
<td>• 0.4 - 0.6 g prot/kg/d</td>
<td></td>
</tr>
</tbody>
</table>

- AA-IPPN more efficient and better tolerated
- AA-IPPN is the 1st choice nutritional support in PD patients with acceptable spontaneous intake

Enteral nutrition (tube feeding)

- Polymeric EN, administered via naso-gastric tube
- Some experience in small infants on PD
- Not investigated in adult PD patients
- Percutaneous endoscopic gastrostomy or jejunostomy not recommended in adult PD patients (used in children)

- Indicated in severe undernutrition, particularly when spontaneous intakes are < 20 kcal/kg/day, and if AA-IPPN or ONS insufficient to cover nutrition needs

Nutrition in PD patients: algorithm

Undernourished PD patient

<table>
<thead>
<tr>
<th>Mild undernutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy: &lt; 30 kcal/kg/d</td>
</tr>
<tr>
<td>Protein: &lt; 1.1 g/kg/d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severe undernutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight loss &gt; 10% in 6 months</td>
</tr>
<tr>
<td>Prealbumin &lt; 300 mg/l</td>
</tr>
</tbody>
</table>

- Dietary counseling
- No improvement
- Spontaneous intakes > 20 kcal/kg/d
- Spontaneous intakes < 20 kcal/kg/d and/or stress conditions
- Enteral nutrition (EN) or IVPN (if EN not possible or if encapsulating peritonitis)
- AA-IPPN (or ONS) or IDPN
- No improvement

Conclusions

- Malnutrition is common in AKI and CKD
- It has a bad prognosis if untreated
- Identification and early intervention is however helpful
- AKI needs extra nitrogen but little increase in energy
- Protein restriction is valuable in pre-dialytic CKD if no malnutrition
- Dialysis increases nitrogen requirements
- IDPN is valuable in treatment of malnutrition in HD
- AA-IPPN is valuable in malnutrition in PD
- Multimodal strategies are recommended