Renal Nutrition

FEEDING THE PATIENT ON HAEMODIALYSIS

K. Poulia (GR)
Feeding the patient on haemodialysis

Kalliopi Anna Poulia, RD, MMedSci, PhD
Clinical Nutritionist-Dietitian, Laiko General Hospital of Athens
Vice President of the Hellenic Dietetic Association
Member of the Board of GrESPN
Conflict of interest

None
Stages of CKD and malnutrition

- **Stage 1**: Kidney damage with normal or ↑ Renal function
- **Stage 2**: Mildly decreased GFR
- **Stage 3**: Moderately decreased GFR
- **Stage 4**: Severely decreased GFR
- **Stage 5**: Kidney disease

CKD US prevalence:
- Stage 1: 3.1%
- Stage 2: 4.1%
- Stage 3: 7.6%
- Stage 4: 0.5%

Malnutrition/PEW:
- 28%–48%
- Up to 75%

ESRD

USRDS 2009 Annual Data Report
Stratton JD et al. J Ren Nutr 2003
Prevalence of malnutrition on hemodialysis patients globally

Figure 3. Prevalence of PEW among patients undergoing maintenance dialysis worldwide reported from studies published during 2000-2014. Color gradation reflects PEW prevalence in all included studies from each country (weighted averages within countries). PEW, protein-energy wasting.

A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease


Department of Nephrology, Hopital Edouard Herriot, Université Lyon 1, U870 INSERM, Lyon, France; Division of Nephrology and Hypertension, Los Angeles Biomedical Research Institute at Harbor—UCLA Medical Center, University of California (UCLA), Torrance, California, USA; CRNH Auvergne, 58 rue Montalembert, Clermont-Ferrand, France; Service de Néphrologie, CHU Bordeaux, Place Amélie Raba-Léon, Bordeaux, France; Division of Nephrology, Federal University of São Paulo, São Paulo, Brazil; Renal Division, Emory University School of Medicine, Atlanta, Georgia, USA; Division of Internal Medicine, Department of Clinical, Morphological and Technological Sciences, University of Trieste, Trieste, Italy; Division of Nephrology, Vanderbilt University Medical Center, Nashville, Tennessee, USA; Departments of Medicine and Biochemistry and Molecular Medicine, University of California (UC) Davis, Davis, California, USA; VANCHCS, Mather, California, USA; Division of Baxter Novum and Renal Medicine, Department of Clinical Science, Intervention and Technology, Karolinska Institutet, Stockholm, Sweden; INSERM ERI-12, Amiens, France; Amiens University Hospital, UPJV, Amiens, France; Nephrology Division, Baylor College of Medicine, Houston, Texas, USA; Faculty of Medicine, Autonomous National University of Mexico, Mexico City, Mexico and Department of Medicine, University Hospital, Wuerzburg, Germany
<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serum chemistry</strong></td>
</tr>
<tr>
<td>Serum albumin &lt; 3.8 g per 100 ml (Brom cresol Green)²</td>
</tr>
<tr>
<td>Serum prealbumin (transthyretin) &lt; 30 mg per 100 ml (for maintenance dialysis patients only; levels may vary according to GFR level for patients with CKD stages 2-5)²</td>
</tr>
<tr>
<td>Serum cholesterol &lt; 100 mg per 100 ml²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Body mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI &lt; 23²</td>
</tr>
<tr>
<td>Unintentional weight loss over time: 5% over 3 months or 10% over 6 months</td>
</tr>
<tr>
<td>Total body fat percentage &lt; 10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Muscle mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle wasting: reduced muscle mass 5% over 3 months or 10% over 6 months</td>
</tr>
<tr>
<td>Reduced mid-arm muscle circumference area³ (reduction &gt; 10% in relation to 50th percentile of reference population)</td>
</tr>
<tr>
<td>Creatinine appearance⁴</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dietary intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unintentional low DPI &lt; 0.80 g kg⁻¹ day⁻¹ for at least 2 months⁵ for dialysis patients or &lt; 0.6 g kg⁻¹ day⁻¹ for patients with CKD stages 2-5</td>
</tr>
<tr>
<td>Unintentional low DEI &lt; 25 kcal kg⁻¹ day⁻¹ for at least 2 months⁶</td>
</tr>
</tbody>
</table>

---


---

Diagnostic criteria for Protein energy malnutrition

---

When at least 1 parameter is lower than the recommended in 3 out of 4 categories
Etiology and consequences of PEW in CKD

Figure 1 | The conceptual model for etiology and consequences of protein energy wasting (PEW) in chronic kidney disease. CVD, cardiovascular disease; GH, growth hormone; HPT, hyperparathyroidism; IR, insulin resistance.

Ta Iñizler et al, Kidney International 2013
### Dialysis Malnutrition Score (DMS)

#### Table 1: Dialysis Malnutrition Score

<table>
<thead>
<tr>
<th>A. Patients related medical history:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight change (overall change in past 6 months)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>No weight change or gain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor weight loss (&lt;5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight loss 6 to 10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight loss 10 to 15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight loss &gt;15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Dietary Intake</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-optimal solid diet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full liquid or moderate overall decrease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypo-caloric liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starvation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Gastrointestinal symptoms</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vomiting or moderate GI symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe anorexia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Functional capacity (nutritionally related functional impairment)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (improved)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty with ambulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty with normal activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed-flight ridden with no or little activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Co-morbidity</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDH &lt; 12 months and healthy otherwise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDH: 1-2 years or mild co-morbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDH: 2-4 years or age &gt;75 or moderate co-morbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDH: &gt;4 years or severe co-morbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very severe multiple co-morbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Malnutrition score (sum of all)**

**Abbreviation:** SGA, subjective global assessment; MDH, maximum duration of hemodialysis. *Five scale parameters are employed and the values are summed. A value of 7 is normal, while 35 is the most severe malnutrition.*
MALNUTRITION INFLAMMATION SCORE (M.I.S.)

1. Change in end dialysis dry weight (overall change in past 3-6 months):

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No decrease in dry weight or weight loss &lt;0.5 kg</td>
</tr>
<tr>
<td>1</td>
<td>Minor weight loss (&gt;0.5 kg but &lt;1 kg)</td>
</tr>
<tr>
<td>2</td>
<td>Weight loss more than one kg but &lt;5%</td>
</tr>
<tr>
<td>3</td>
<td>Weight loss &gt;5%</td>
</tr>
</tbody>
</table>

2. Dietary Intake:

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Good appetite and no deterioration of the dietary intake pattern</td>
</tr>
<tr>
<td>1</td>
<td>Somewhat sub-optimal solid diet intake</td>
</tr>
<tr>
<td>2</td>
<td>Moderate overall decrease to full liquid diet</td>
</tr>
<tr>
<td>3</td>
<td>Hypo-caloric liquid to starvation</td>
</tr>
</tbody>
</table>

3. Gastrointestinal (GI) symptoms:

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No symptoms with good appetite</td>
</tr>
<tr>
<td>1</td>
<td>Mild symptoms, poor appetite or nauseaed occasionally</td>
</tr>
<tr>
<td>2</td>
<td>Occasional vomiting or moderate GI symptoms</td>
</tr>
<tr>
<td>3</td>
<td>Frequent diarrhea or vomiting or severe anorexia</td>
</tr>
</tbody>
</table>

4. Functional capacity (nutritionally related functional impairment):

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal to improved functional capacity, feeling fine</td>
</tr>
<tr>
<td>1</td>
<td>Occasional difficulty with baseline ambulation, or feeling tired frequently</td>
</tr>
<tr>
<td>2</td>
<td>Difficulty with otherwise independent activities (e.g. going to bathroom)</td>
</tr>
<tr>
<td>3</td>
<td>Bedchair-ridden, or little to no physical activity</td>
</tr>
</tbody>
</table>

5. Co-morbidity including number of years on Dialysis:

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>On dialysis less than one year and healthy otherwise</td>
</tr>
<tr>
<td>1</td>
<td>Dialyzed for 1-4 years, or mild co-morbidity (excluding MOC)</td>
</tr>
<tr>
<td>2</td>
<td>Dialyzed &gt;4 years, or moderate co-morbidity (including one MOC)</td>
</tr>
<tr>
<td>3</td>
<td>Any severe, multiple co-morbidity (2 or more MOC)</td>
</tr>
</tbody>
</table>

6. Decreased fat stores or loss of subcutaneous fat (below eyes, triceps, biceps, chest):

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal (no change)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
</tr>
</tbody>
</table>

7. Signs of muscle wasting (temple, clavicle, scapula, ribs, quadriceps, knee, intersseccus):

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal (no change)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
</tr>
</tbody>
</table>

8. Body mass index: BMI = Wt(kg) / Ht(m)^2

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>BMI&lt;16 kg/m^2</td>
</tr>
<tr>
<td>2</td>
<td>BMI 16-17.9 kg/m^2</td>
</tr>
<tr>
<td>3</td>
<td>BMI 18-19.9 kg/m^2</td>
</tr>
</tbody>
</table>

9. Laboratory Parameters:

   9a. Serum albumin:

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Albumin: &lt;3.5 g/dL</td>
</tr>
<tr>
<td>1</td>
<td>Albumin: 3.6-3.9 g/dL</td>
</tr>
<tr>
<td>2</td>
<td>Albumin: 4.0-4.4 g/dL</td>
</tr>
<tr>
<td>3</td>
<td>Albumin: &gt;4.5 g/dL</td>
</tr>
</tbody>
</table>

10. Serum TIBC (total iron binding capacity):

    | Score | Description |
    |-------|-------------|
    | 0     | TIBC<100 mg/dL |
    | 1     | TIBC 100-200 mg/dL |
    | 2     | TIBC 200-249 mg/dL |
    | 3     | TIBC >250 mg/dL |

Total Score = sum of above 10 components (0-30):

Figure 5. MIS. *Major comorbid conditions include congestive heart failure class III or IV, full-blown AIDS, severe coronary artery disease, moderate to severe chronic obstructive pulmonary disease, major neurologic sequelae, and metastatic malignancies or S/P recent chemotherapy. **Suggested equivalent increments for serum transferrin are >200 (0), 170 to 200 (1), 140 to 170 (2), and <140 mg/dL.
Relative mortality risk and malnutrition (DOPPS)

Malnutrition: RR 1.33 *
At risk of malnutrition: RR 1.05
Well nourished: RR 1

* p<0.05

Pifer TB et al. Kidney Int 2002
Relative mortality risk and albumin (DOPPS)

Baseline albumin levels

% Δ Albumin in 6 months

* p<0.001 vs 4<sup>th</sup> Quartile
** p<0.05 vs 4<sup>th</sup> Quartile

Pifer TB et al. Kidney Int 2002
Relative mortality risk and BMI

**BMI at baseline**

- RR for BMI <21.1: 1.6*
- RR for BMI 21.1-24.1: 1.28*
- RR for BMI 24.1-28.1: 1.05
- RR for BMI >28.1: 1

* p<0.001 vs 4rd Quartile
** p<0.05 vs 4rd Quartile

**% Δ BMI in 6 months**

- RR for Weight Change < -3.5: 1.35**
- RR for Weight Change -3.5-0: 1.03
- RR for Weight Change 0-1.2: 1
- RR for Weight Change >1.2: 1

Pifer TB et al. Kidney Int 2002
PEW and survival – the reverse epidemiology BMI

![Graph showing the relationship between BMI and relative risk of death for general population and hemodialysis patients](graph.png)
The theory of reverse epidemiology

5-year survival according to BMI

Causes of PEW in CKD

Anorexia

• Dietary restrictions (Na, K, P, water)
• Retention of low molecular weight products
• Abnormal plasma aminoacids
• Socio-economic status
• Depression multiple medication, hospitalization
• Co-morbidities

Endocrine and metabolic alterations

• Diabetes
• Acidosis
• Hyperparathyrodism
• Loss of nutrients during HD and PD
Aims of nutritional management of patients on hemodialysis

- Muscle mass maintenance
- Prevention of malnutrition
- Management of metabolic dearengements
- Better quality of life of patients
# Nutritional Management of Chronic Kidney Disease

Kamyar Kalantar-Zadeh, M.D., M.P.H., Ph.D., and Denis Fouque, M.D., Ph.D.

## Table 2. Recommended Dietary and Nutrient Intake in Adults, According to the CKD Stage.\(^a\)

<table>
<thead>
<tr>
<th>Dietary Constituent</th>
<th>Normal Kidney Function with Increased CKD Risk</th>
<th>Mild-to-Moderate CKD(^b)</th>
<th>Advanced CKD(^b)</th>
<th>Transition to Dialysis(^b)</th>
<th>Ongoing Dialysis or Any Stage with Existing or Imminent PEW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein (g/kg/day)</strong></td>
<td>&lt;1.0, increase proportion of plant-based proteins</td>
<td>&lt;1.0 (consider 0.6–0.8 if eGFR &lt;45 ml/min/1.73 m² or rapid progression)</td>
<td>0.6–0.8, including 50% HBV protein, or &lt;0.6 with addition of EAA or KA</td>
<td>0.6–0.8 on nondialysis days and &gt;1.0 on dialysis days</td>
<td>1.2–1.4; may require &gt;1.5 if hypercatabolic state develops</td>
</tr>
<tr>
<td><strong>Sodium (g/day)</strong></td>
<td>&lt;4 (&lt;3 in patients with hypertension)(^f)</td>
<td>&lt;4; avoid intake of &lt;1.5 if hyponatremia likely</td>
<td>&lt;3; avoid intake of &lt;1.5 if hyponatremia likely</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td><strong>Potassium (g/day)</strong></td>
<td>4.7 (same as recommended for general population)</td>
<td>4.7 unless frequent or severe hyperkalemia excursions likely</td>
<td>&lt;3 if hyperkalemia occurs frequently during high-fiber intake</td>
<td>&lt;3 if hyperkalemia occurs frequently during high-fiber intake</td>
<td>&lt;3; target high-fiber intake</td>
</tr>
<tr>
<td><strong>Phosphorus (mg/day)</strong></td>
<td>&lt;1000; minimize added inorganic phosphorus in preservatives and processed foods</td>
<td>&lt;800; minimize added inorganic phosphorus and encourage consumption of more plant-based foods</td>
<td>&lt;800; minimize added inorganic phosphorus and encourage consumption of more plant-based foods</td>
<td>&lt;800; minimize added inorganic phosphorus, consider phosphorus binder as needed</td>
<td>&lt;800; minimize added inorganic phosphorus; add phosphorus binder as needed</td>
</tr>
<tr>
<td><strong>Calcium (mg/day)</strong></td>
<td>1000–1300 (adjusted for age)</td>
<td>800–1000</td>
<td>800–1000</td>
<td>800–1000 or less</td>
<td>&lt;800</td>
</tr>
<tr>
<td><strong>Fibers, allulose, and plant-based foods (g/day)</strong></td>
<td>25–30; target higher proportion (&gt;50%) of plant-based foods (e.g., DASH diet)</td>
<td>25–30 or more; higher proportion (&gt;50%) of plant-based foods</td>
<td>25–30 or more; consider &gt;70% plant-based foods</td>
<td>25–30 or more</td>
<td>25–30 or more; suggest avoiding strict vegan diet</td>
</tr>
<tr>
<td><strong>Energy (kcal/kg/day)</strong></td>
<td>30–35; adjust to target weight reduction if BMI &gt;30(^b)</td>
<td>30–35; increase proportion with LPD</td>
<td>30–35; increase proportion with LPD</td>
<td>30–35</td>
<td>30–35; target higher intake if PEW present or imminent</td>
</tr>
<tr>
<td><strong>Fats</strong></td>
<td>Mostly monounsaturated and polyunsaturated lipids, including n-3 fatty acids</td>
<td>Mostly monounsaturated and polyunsaturated lipids, including n-3 fatty acids, increase proportion with low-protein intake</td>
<td>Mostly monounsaturated and polyunsaturated lipids, including n-3 fatty acids; increase proportion with low-protein intake</td>
<td>Mostly monounsaturated and polyunsaturated lipids, including n-3 fatty acids</td>
<td>Mostly monounsaturated and polyunsaturated lipids, including n-3 fatty acids</td>
</tr>
</tbody>
</table>

---

\(^a\) See text for details.

\(^b\) Values given are general guidelines; individual patient needs may vary.

\(^c\) Based on 2017-2018 guidelines by the American Society for Nutrition and Dietetics.

\(^d\) For patients with diabetes.

\(^e\) For patients with heart disease.

\(^f\) For patients with hypertension.

\(^g\) For patients with hyperkalemia.

\(^h\) For patients with hyperphosphatemia.

\(^i\) For patients with hypercalcemia.

\(^j\) For patients with hypercholesterolemia.

\(^k\) For patients with hypothyroidism.

\(^l\) For patients with diabetes.

\(^m\) For patients with heart disease.

\(^n\) For patients with hyperkalemia.

\(^o\) For patients with hyperphosphatemia.

\(^p\) For patients with hypercalcemia.

\(^q\) For patients with hypercholesterolemia.

\(^r\) For patients with hypothyroidism.

\(^s\) For patients with diabetes.

\(^t\) For patients with heart disease.

\(^u\) For patients with hyperkalemia.

\(^v\) For patients with hyperphosphatemia.

\(^w\) For patients with hypercalcemia.

\(^x\) For patients with hypercholesterolemia.

\(^y\) For patients with hypothyroidism.
Nutrition intake in hemodialysis

- **Energy**
  - 30-35Kcal/kg BW
  - Obese: 25-30 Kcal/kg

- **Protein protein intake**
  - HD 1.2-1.5 g/kg

- **Non protein calories**
  - ≥30% Fat
  - CHO up to 60%
  - MUFA
  - Ω-3 fatty acids
    - 1.6 g/day for men
    - 1.1 g/day for women

- **Sodium**
  - HD: <3 g/day

- **Phosphorus**
  - Stage 5: < 800 mg
    - Phosphate binders

- **Potassium**
  - Stage 5: <2.4 g/day

- **Fluids**
  - HD: 500 – 700 ml + urine output

- **Dietary Fiber**
  - 25-30 g or more

Non-adherence to salt restriction

“advising dialysis patients to restrict fluid intake when they have not had advice on how to limit their salt intake is inhumane... and a waste of time”
# Achieving Salt Restriction in Chronic Kidney Disease

<table>
<thead>
<tr>
<th>Study country</th>
<th>Population</th>
<th>Barriers to sodium-restricted diet</th>
</tr>
</thead>
</table>
| Welch et al. (2006) [20] USA | 229 hemodialysis pts, aged 55 ± 14 years, 58% male, 79% African American | (i) Taste (58%)  
(ii) Difficulty when eating out (30%)  
(iii) Cost (23%)  
(iv) Difficulty to understand (21%)  
(v) Too time-consuming (17%) |
| De Brito-Ashurst et al. (2011) [72] UK | 20 female CKD pts, 1st generation immigrants from Bangladesh to the UK, aged 60 ± 8 years; unemployed | (i) Lack of family acceptance (50%, n = 10/20)  
(ii) Fear that friends will gossip/think the family has no money (40%, 8/20)  
(iii) No perceived benefit (25%, n = 5/20) |
| Gordon et al. (2009) [77] USA | 82 transplant recipients aged 47 ± 57 years, 57% male, 56% white | (i) Preferences for salty foods and enjoying taste of salt (n = 9)  
(ii) Lack of available low-salt dishes at restaurants (n = 10) or low-salt foods in markets (n = 3) and when other people cook using salt (n = 3)  
(iii) Lifestyle factors (n = 5) for example, having no time to cook |
| Ireland et al. (2010) [65] Australia | 43 healthy pts from volunteer database, 23% male, aged 55 ± 11 in “tick group” 57 ± 13 y in “FSANZ group” | (i) Limited variety of appropriate foods  
(ii) Difficulty eating out  
(iii) Increased time for shopping |
| Chung et al. (2006) [78] Australia and United States | 68 heart failure patients, aged 63 ± 14 years, 60% male, 63% Caucasian | (i) Trouble choosing foods in restaurants (75%)  
(ii) Favorite foods aren’t low-salt (72%)  
(iii) Taste (69%)  
(iv) Favorite restaurants don’t serve low-salt foods (64%)  
(v) Insufficient will power to change diet (59%)  
(vi) Peers don’t eat low-salt foods (54%)  
(vii) Trouble choosing foods at supermarket (52%)  
(viii) Poor knowledge/understanding (49%)  
(ix) Cost (47%)  
(x) Does not cook (40%)  
(xi) Time to prepare food (38%)  
(xii) Person who cooks doesn’t prepare low-salt foods (30%) |
| Bentley et al. (2005) [79] USA | 20 heart failure patients (recruited from 1 clinic) who had received a healthcare provider’s recommendation to follow a low sodium diet, aged 60 ± 11 years 60% male, 80% non-Hispanic White | (i) Lack of knowledge (need for more detailed dietary information, confusion for pts with additional dietary restrictions)  
(ii) Lack of perceived benefit  
(iii) Interference with socialization (family conflict, difficulty eating out)  
(iv) Limited food choices/lack of palatability |

Figures as mean ± standard deviation. Abbreviations: CKD: chronic kidney disease  
FSANZ: Food Standards Australia New Zealand  
Pts: participants.
Serum potassium increases as eGFR decreases

NHANES 1999–2006

Reference: Adapted from USRDS 2009 Annual Data Report
...and this dish is totally potassium-free!
Numerous sources contribute to potassium levels in CKD

- Potassium-rich foods
- Salt substitutes
  - Low-sodium products may have added KCl.
- Herbs and dietary supplement (examples)
  - Noni juice (56 mmol/L)
  - Alfalfa
  - Dandelion
  - Horsetail
  - Nettle
- Medications:
  - K supplements
    - KCl, K citrate
  - Impair excretion
    - ACEI
    - ARBs
    - K+-sparing diuretics
    - Nonsteroidal anti-inflammatory drugs
- Potassium food additives

References:
Phosphate metabolism in healthy and HD patients

Positive phosphorus balance with the recommended dietary intake

- KDOQI: Protein intake $\geq 1.2 \text{ g/kg/ for HD/PD patients which is equal to}$
  $1000 \text{ mg P/day}$
- $\sim 60\%$ of the total P is absorbed
  - $600 \text{ mg/day} = +4200 \text{ mg/week}$
- Dialysis puts away $800 \text{ mg/session}$
  - $3 \text{ sessions/week} = -2400 \text{ mg}$
- $4200 \text{ mg absorbed} - 2400 \text{ mg disregarded} = \text{Positive balance of 1600 mg P/week}$
Consequences of hyperphosphataemia
Adjusted Relative Risk of Death in Dialysis Patients

N = 40,538

Risk of Death

Serum Phosphorus (mg/dL)

< 3.0 3.0–4.0 4.0–5.0 5.0–6.0 6.0–7.0 7.0–8.0 8.0–9.0 > 9.0

Block, 2004
Phosphorus absorption varies by source: organic < inorganic

**Organic phosphorus**
- 40–60% absorbed
- Phytates ↓ absorption
  - Dairy products
  - Meat, poultry, fish
  - Soy (soy milk, tofu)
  - Nuts and seeds
  - Dried beans and peas
  - Whole grains

**Inorganic phosphorus**
- > 90% absorbed
  - Food additives
  - Dietary supplements
  - Calcium fortification

Phosphorus is **not** found on the Nutrition Facts Label.

**Energy**

Kilojoules (kJ) are the metric equivalent of kilocalories (kcal)

<table>
<thead>
<tr>
<th></th>
<th>Per 100g</th>
<th>Per 1/2 can</th>
<th>GDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>309kJ</td>
<td>640kJ</td>
<td>2000</td>
</tr>
<tr>
<td>(kcal (Calories)</td>
<td>73kcal</td>
<td>151kcal</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>4.9g</td>
<td>10.0g</td>
<td>45g</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>12.9g</td>
<td>25.7g</td>
<td>230g</td>
</tr>
<tr>
<td>(of which sugars)</td>
<td>9.0g</td>
<td>(10.4g)</td>
<td>90g</td>
</tr>
<tr>
<td>Fat</td>
<td>0.2g</td>
<td>0.4g</td>
<td>70g</td>
</tr>
<tr>
<td>(of which saturates)</td>
<td>Trace</td>
<td>(Trace)</td>
<td></td>
</tr>
<tr>
<td>Fibre</td>
<td>3.8g</td>
<td>7.9g</td>
<td>24g</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.9g</td>
<td>0.7g</td>
<td>2.4g</td>
</tr>
<tr>
<td>Salt equivalent</td>
<td>0.8g</td>
<td>1.7g</td>
<td>6g</td>
</tr>
</tbody>
</table>

**Carbohydrates**

Sugars are carbs, but some companies hide the amount of sugar by not breaking down the figure.

**Fat**

Fat content is not always broken down. Saturated fat is particularly a concern.

**Source:** Heinz
Intestinal microbiota in CKD/ESRD

CKD/ESRD

- Reduced fiber intake
- Slowed GI tract transit
- Medicinals
- Altered intestinal absorption of proteins
- Increased intestinal elimination of waste products (urea, uric acid, oxalate)
- Intradialytic hypotension
- Interdialytic GI congestion
- Intestinal microbleeds as consequence of systemic anticoagulation during HD
- Damage of the intestinal tight junction by ammonium

Increased production of uraemic toxins

DYSBIOSIS

Endotoxemia
Local and systemic inflammation

DERANGED INTESTINAL BARRIER
with bacterial translocation

## Effects of CKD on the intestinal tract

<table>
<thead>
<tr>
<th>Effects</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduced intake of dietary fibers</td>
<td>Prescribed potassium restrictions leads to a reduced consume of fruits and vegetables</td>
</tr>
<tr>
<td>2. Prolonged colonic transit times (constipation)</td>
<td>Multifactorial: dialysis modality, lifestyle, inactivity, phosphate binders, dietary restrictions, low fluid intake, primary renal disease and comorbidities (diabetes, heart failure, malnutrition, cerebrovascular disease)</td>
</tr>
<tr>
<td>3. Increased amounts of protein available for proteolytic bacterial species</td>
<td>Protein assimilation is impaired in uremia. The reduced ratio between carbohydrate and nitrogen available in the colon increase the proliferation of proteolytic species with generation of toxic end-products such as phenols and indoles</td>
</tr>
<tr>
<td>4. Changes on the colonic microbiota</td>
<td>Depletion of the intestinal epithelial tight junction proteins caused by uremia, hemodialysis complications (hypotension, intestinal edema and ischemia), micro-bleeding caused by the systemic coagulation alterations typical of uremia</td>
</tr>
</tbody>
</table>
Dietary fiber and CKD

- Co-morbidities
- Medications
- Dietary (anorexia, low fiber)
- Constipation

↓ Motility
↓ Protein digestion
↓ Absorption (edema)

↑ Proteolytic bacterium flora
↑ Toxin generation (NH₃/NH₄⁺, amines, thiols, indoles, p-cresol)

↓ Kidney function
↑ Cytokine production, ↑ half-life
↓ Cytokine elimination

↑ Cytokines
↑ Uremic toxins
Endotoxemia

Mucosal injury Translocation (bacteria, toxins)
Inflammation (cytokine release)
Immune suppression

Nutrients 2017, 9, 208; doi:10.3390/nu9030208
Dietary fiber effects in chronic kidney disease: a systematic review and meta-analysis of controlled feeding trials *EJCN* 2014, 1-8

### Serum Urea

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Fibre</th>
<th>Control</th>
<th>Mean Difference Fibre vs Control</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yazidis et al. (30) (T1)</td>
<td>3</td>
<td>3</td>
<td>12.6%</td>
<td>-0.22 (-0.43, -0.01)</td>
</tr>
<tr>
<td>Yazidis et al. (30) (T2)</td>
<td>3</td>
<td>3</td>
<td>5.8%</td>
<td>-0.40 (-0.82, 0.01)</td>
</tr>
<tr>
<td>Miyazaki et al. (32)</td>
<td>15</td>
<td>15</td>
<td>12.7%</td>
<td>0.00 (-0.21, 0.21)</td>
</tr>
<tr>
<td>Burgess et al. (29)</td>
<td>9</td>
<td>9</td>
<td>21.4%</td>
<td>0.16 (0.13, 0.19)</td>
</tr>
<tr>
<td>Paridio et al. (28)</td>
<td>6</td>
<td>6</td>
<td>15.1%</td>
<td>0.22 (0.05, 0.39)</td>
</tr>
<tr>
<td>Mura et al. (31)</td>
<td>10</td>
<td>10</td>
<td>15.5%</td>
<td>-0.03 (-0.19, 0.13)</td>
</tr>
<tr>
<td>Ponder, F. (32)</td>
<td>20</td>
<td>20</td>
<td>16.8%</td>
<td>0.19 (0.06, 0.32)</td>
</tr>
<tr>
<td>Total (65%) C</td>
<td>60</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: <em>I^2</em> = 0.32; <em>H^2</em> = 0.69; <em>P</em> = 0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: <em>Z</em> = 0.73 (<em>P</em> = 0.47)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Creatinine

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Fibre</th>
<th>Control</th>
<th>Mean Difference Fibre vs Control</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yazidis et al. (30) (T1)</td>
<td>3</td>
<td>3</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Yazidis et al. (30) (T2)</td>
<td>3</td>
<td>3</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Miyazaki et al. (32)</td>
<td>15</td>
<td>15</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Burgess et al. (29)</td>
<td>9</td>
<td>9</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Paridio et al. (28)</td>
<td>6</td>
<td>6</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Mura et al. (31)</td>
<td>10</td>
<td>10</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Ponder, F. (32)</td>
<td>20</td>
<td>20</td>
<td>0.5%</td>
<td>-0.04 (-0.07, 0.16)</td>
</tr>
<tr>
<td>Total (65%) C</td>
<td>60</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: <em>I^2</em> = 0.32; <em>H^2</em> = 0.69; <em>P</em> = 0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: <em>Z</em> = 0.73 (<em>P</em> = 0.47)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Phosphorus

- Phosphorus Levels
- Serum Phosphorus
- Phosphate
- Phosphate Binding
- Dietary Fiber

**A systematic review and meta-analysis of controlled feeding trials**

**Serum Urea**

**Creatinine**

**Phosphorus**
Continuous Nutritional Assessment and Monitoring

Monitor any changes in nutritional status

Assess current dietary intake / Assess current nutritional status

Decide on appropriate nutritional intervention / Consider additional nutritional interventions
Algorithm for Nutritional support in CKD

- Monitoring:
  - Assessment of nutritional status
  - Optimization of dialytic treatment
  - Management of comorbidities
  - Nutritional counseling
  - Physical activity and exercise programs

Nutritional intervention if:
- DPI < 1 g/kg/day or DEI < 30 kcal/kg/day
- sAlb < 3.8 g/dl or sPreAlb < 28 mg/dl
- Non-intentional weight-loss > 5% in 3 months or > 10% in 6 months
- Malnutrition identified by SGA or MIS

Start oral supplementation
  (intral or intradialytic)
  Target: DPI > 1.2 g/kg/day

- sAlb > 3.8 g/dl
- sPreAlb > 28 mg/dl
- Increase in BW and muscle mass

Maintain nutritional goals
- sAlb > 4 g/dl
- sPreAlb > 30 mg/dl
- DPI > 1.2 g/kg/day
- DEI > 30-35 Kcal/kg/day

- No change or worsening of nutritional status

- Intensify therapy:
  - Increase oral supplementation
  - Start IDPN
  - Consider EN, PEG
  - NPT in the case of non-functioning GI

A. Sabatino et al. / Clinical Nutrition 36 (2017) 663–671
Nutritional support in hemodialysis

- Nutrition consultation
- Oral nutritional supplements
- Intradialytic Parenteral nutrition (IDPN)
- Enteral nutrition
- Total Parenteral Nutrition

- Depending on
  - Level of malnutrition
  - Compliance
  - Spontaneous nutritional intake
Nutritional interventions

- Encourage nutrient intake
  - Modify and/or liberate diet according to individualized needs
  - Small frequent meals / allowed energy dense snacks
  - Snacking during hemodialysis
- In case or early satiety protein foods should be eaten first
- Energy dense/ low volume dietary choices
- Food fortification
  - Protein
  - CHO
  - Fat
Nutritional supplements

- Protein Powder
  - Food fortification

- Protein syrup
  - Fortification or given as a protein shot

- ONS, hyper caloric

- CKD-specific ONS
  - Low volume, hyper caloric
  - Low in electrolytes
CKD- specific ONS

Daily intake:

- 500 Kcal – energy dense (i.e. 1.5-2.0 Kcal/ml)
- 0.4-0.6 g protein/kg/ day
- 5-10 Kcal/kg/day (CHO – fat)

Can cover the needs of patients with

- Spontaneous nutritional intake
- > 20 Kcal/ kg/ day
- Protein 0.8 g/kg/day
Provision of a high protein (31g) meal during hemodialysis for 6 months vs standard meal lower in protein and electrolytes
Effect of an intradialytic protein-rich meal intake in nutritional and body composition parameters on hemodialysis patients

Cristina Caetano a, b, Ana Valente a, Francisco Jorge Silva b, Jorge Antunes b, Cristina Garagarza a, *

Table 3
Laboratory parameters and body composition: baseline and 6 months comparison within groups.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>IG</th>
<th></th>
<th>p</th>
<th>CG</th>
<th></th>
<th></th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Month 0</td>
<td>Month 6</td>
<td></td>
<td>Month 0</td>
<td>Month 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nPCR (g/kg/d)</td>
<td>1.09 ± 0.27</td>
<td>1.20 ± 0.27</td>
<td>0.001</td>
<td>1.07 ± 0.23</td>
<td>1.06 ± 0.24</td>
<td>0.052</td>
<td></td>
</tr>
<tr>
<td>Dry weight (kg)</td>
<td>65.0 (56.3–71.4)</td>
<td>63.8 (54.6–74.5)</td>
<td>0.428</td>
<td>61.5 (55.0–76.3)</td>
<td>62.0 (55.3–76.2)</td>
<td>0.478</td>
<td></td>
</tr>
<tr>
<td>Phosphorus (mg/dL)</td>
<td>3.91 ± 1.11</td>
<td>3.87 ± 1.19</td>
<td>0.770</td>
<td>4.32 ± 1.29</td>
<td>4.07 ± 1.34</td>
<td>0.231</td>
<td></td>
</tr>
<tr>
<td>Potassium (mEq/L)</td>
<td>4.9 (4.5–5.4)</td>
<td>4.8 (4.5–5.5)</td>
<td>0.582</td>
<td>4.9 (4.5–5.6)</td>
<td>4.8 (4.3–5.3)</td>
<td>0.062</td>
<td></td>
</tr>
<tr>
<td>CRP (mg/dL)</td>
<td>13.3 (4.9–25.3)</td>
<td>15.7 (7.5–24.5)</td>
<td>0.477</td>
<td>9.6 (4.7–21.0)</td>
<td>9.5 (5.2–19.9)</td>
<td>0.744</td>
<td></td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.63 (3.50–3.70)</td>
<td>3.60 (3.44–3.80)</td>
<td>0.592</td>
<td>3.81 (3.52–3.99)</td>
<td>3.74 (3.48–3.90)</td>
<td>0.039</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.0 (21.7–27.8)</td>
<td>24.3 (22.1–28.5)</td>
<td>0.405</td>
<td>24.1 (22.8–29.1)</td>
<td>24.3 (22.5–29.1)</td>
<td>0.476</td>
<td></td>
</tr>
<tr>
<td>FMI (kg/m²)</td>
<td>11.2 (7.5–16.0)</td>
<td>11.8 (8.4–17.0)</td>
<td>&lt;0.001</td>
<td>12.1 (9.1–15.7)</td>
<td>12.0 (8.9–17.5)</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>LTI (kg/m²)</td>
<td>13.3 (11.8–15.4)</td>
<td>12.2 (10.6–14.8)</td>
<td>0.008</td>
<td>12.7 (11.0–14.7)</td>
<td>11.2 (10.1–13.6)</td>
<td>0.003</td>
<td></td>
</tr>
</tbody>
</table>

nPCR: normalized protein catabolic rate; CRP: protein C reactive; BMI: body mass index; FMI: fat tissue index; LTI: lean tissue index. Bold indicates statistical significance of p < 0.05.

* Mean ± SD.

Median (interquartile range).
Results from the randomized controlled IHOP trial suggest no effects of oral protein supplementation and exercise training on physical function in hemodialysis patients.

138 HD patients
5 HD clinics in Illinois

1°
Control (CON) n=44
Protein (PRO) n=45
Protein + Exercise (PRO+EX) n=49

OUTCOMES

12 months
6 months

CONCLUSION:
No change in our primary outcome (shuttle walk test), but modest improvements in secondary measures of physical function from baseline in the PRO and PRO+EX groups. This suggests that more comprehensive lifestyle modifications may be needed in this population.
Compliance?

Intradialytic Parenteral Nutrition

Provide:

- 800 – 1200 Kcal / session of HD
- → 400 – 600 Kcal / ημέρα
- 30-60 g protein/session
- 5-10 Kcal/kg/day

For a patient of 60 kg

- 5-8 kcal/kg/day
- 0.2-0.4 g protein/kg/ day

Cover the needs of patients

- With spontaneous nutritional intake
- > 20 Kcal/ kg/ day
- 0.8 g protein /kg/day
Intradialytic Parenteral nutrition - IDPN

• Cyclic parenteral nutrition during HD
  – 15-20 Kcal/kg/ HD session
  – 0.5-1g/ kg protein/ HD session

• IDPN is administered via an infusion pump that can overcome venous pressure in the dialysis blood lines.

• This fluid is then mixed with the patient’s venous blood and returned to the body through the venous access.
  – 1lt with max rate 250 ml/h
  – 1 lt in 4 hours
  – During the first week we give ½ of the amount
  – Good control of ultrafiltrate
  – Addition of Na: 75 mmol/l to prevent rebound
## Cons and Pros of IDPN

### Advantages
- No need for a dedicated enteral feeding tube or parenteral nutrition vascular access
- Ultrafiltration during dialysis will help minimize the risks for fluid overload
- No demands on patient time or effort

### Disadvantages
- Provides insufficient energy and protein to support long-term daily needs
- Does not address the problem of improving patient’s eating behavior
- Side effects such as metabolic and electrolyte abnormalities
- Medicare reimbursement for IDPN is complex and extremely time-consuming

*Nutr Clin Pract. 2018;33:767–771*
## Practical aspects of IDPN

| **Formula** | • Use the most concentrated all-in-one total admixures for parenteral nutrition  
• Use electrolyte free formulas in case of hyperkalemia (>6 mmol/l) and hyperphosphatemia (>5.5 mg/L) |
|-------------|--------------------------------------------------------------------------------------------------------|
| **Metabolic parameters** | • Do not start IDPN with lipids if triglycerides levels >300 mg/dl  
• Serum glucose should be maintained between 110 and 180 mg/dl.  
• Use subcutaneous insulin administered as rapid action analogs 15 min after the start of dialysis (0.1 UI/kg as first step) if necessary. |
| **Administration** | • Infuse IDPN in the venous drip chamber by a parenteral pump  
• Wait to start IDPN until dialysis machine pressure and patient parameters are stable (nearly 15 min after the beginning of dialysis)  
• Increase IDPN volume weekly for the first 3 weeks to achieve regimen rates |
| **Dialysis procedures** | Adjust the ultrafiltration rate as per patient need to remove IDPN fluids |
| **Nutrient intake** | Calculate the maximum macronutrient amount given by IDPN per dialysis (4 h) as energy 15 kcal/kg/dialysis and amino acids: 0.8-1 g/kg/dialysis |

A. Sabatino et al. / Clinical Nutrition 36 (2017)
Intradialytic parenteral nutrition in maintenance hemodialysis patients suffering from protein-energy wasting. Results of a multicenter, open, prospective, randomized trial

Tobias A. Marsen a, b, Justinus Beer b, Helmut Mann c, for the German IDPN-Trial group

Fig. 3. Change from baseline in mean serum prealbumin (transferrin) over time in the intervention group (STANDARD + IDPN) compared to the control group (STANDARD) (FAS, n = 83). Changes from baseline (V2) in mean serum prealbumin during 3 times weekly IDPN treatment over 16 weeks (V3 = week 4, V4 = week 8, V5 = week 12, V6 = week 16) and in the follow-up period (NV1 = week 22, NV2 = week 28) compared to the untreated control group. The difference between treatment groups was statistically significant in favor of the intervention group (FAS, n = 39) at week 16 (V6). The treatment effect was maintained 6 weeks after stop of IPDN treatment (NV1) and declined in the following 6 weeks (NV2), but mean prealbumin values were still well above those measured in the control group (FAS, n = 44).
Adverse effects of IDPN

• Fluid overload
• The infusion of glucose can cause pain due to its high osmolarity
• Intradialytic hypotension → addition of Na in the parenteral solution
• Cost
*Periodic nutritional screening
SAIb, weight, BMI, MIS, DPI, DEI

Nutritional assessment (as indicated)
SIAlb; SGA; anthropometrics

Continuous preventive measures
- Continuous nutritional counseling
- Optimize RRT-Rx and dietary nutrient intake
- Manage comorbidities (acidosis, DM, inflammation, CHF, depression)

Indications for nutritional interventions despite preventive measures
- Poor appetite and/or poor oral intake
- DPI < 1.2 (CKD 5D) or < 0.7 (CKD 3–4); DEI < 30 kcal/kg/day
- SIAlb < 3.8 g/dl or SIAlb < 28 mg/dl
- Unintentional weight loss > 5% of IBW or EDW over 3 months
- Worsening nutritional markers over time
- SGA in PEW range

Start CKD-specific oral nutritional supplementation
- CKD 3–4: DPI target of > 0.8 g/kg/day (a AV/KA or ONS)
- CKD 5D: DPI target > 1.2 g/kg/day (ONS at home or during dialysis treatment; in-center meals)

SAIb > 3.8; SIAlb > 28 weight or LBM gain

Maintenance nutritional therapy goals
- SAIb > 4.0 g/dl
- SIAlb > 30 mg/dl
- DPI > 1.2 (CKD-5D) and > 0.7 g/kg/day (CKD 3–4)
- DEI 30–35 kcal/kg/day

Intensified therapy
- Dialysis prescription alterations
- Increase quantity of oral therapy
- Tube feeding or PEG if indicated
- Parenteral interventions:
  - IDPN (esp. if SAIb < 3.0 g/dl)
  - TPN

Adjunct therapies
- Anabolic hormones
- Androgens, GH
- Appetite stimulants
- Anti-inflammatory interventions
  - Omega 3; IL-1ra
- Exercise (as tolerated)

No improvement or deterioration
Conclusions

• Malnutrition in HD is common
• Nutritional management in hemodialysis is complex
• Nutritional interventions should be individualized, according to the needs of the patients
• Nutritional screening should be performed and nutritional support should be provided at early stages of PEW, according to the needs and adherence of the patient
Thank You