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Educational Paper

Basics in Clinical Nutrition: Nutritional support in renal disease

Wilfred Druml

University of Vienna and Vienna General Hospital, Vienna, Austria

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Learning objectives

- To understand the metabolic abnormalities in patients with renal disease
- To know the determinants of nutritional state and the causes of malnutrition in uraemia
- To be aware of the aims of nutritional support and the type and composition of diets in renal disease

1. Pathophysiology

Patients with renal failure comprise an extremely heterogeneous group of subjects with differing – and sometimes contradictory – aims of nutritional support, nutritional requirements and composition of nutritional regimes.

Renal failure is a pan-metabolic and pan-endocrine abnormality affecting more or less every metabolic pathway of the body. Despite differences in metabolic presentation (and nutritional needs) in various forms of renal failure and during the course of disease in the individual patient, there are some common features in their metabolic changes (Table 1). Energy metabolism is not grossly affected by renal dysfunction (which rather decreases than increases oxygen consumption) and is more determined by associated complications.

2. Metabolic and nutritional consequences of renal replacement therapies

Renal replacements therapies are associated with multiple metabolic side effects. Among those are the loss of nutritional substrates, such as amino acids and water soluble vitamins, but also systemic effects, such as activation of protein catabolism and increase in lipid peroxidation as a consequence of bioincompatibility. In patients with acute renal failure (ARF) continuous renal replacement therapies (CRRT) have become the standard treatment modalities, the metabolic side effects of which are clinically relevant because of the continuous mode of therapy and the high fluid turnover. These effects have to be considered in designing a nutritional program for a patient with ARF (see below).

Nutritional treatment can be considered under 3 main headings:
- The patient with stable chronic renal failure
- The patient on renal replacement therapy
- The patient with acute renal failure

3. Nutritional therapy of patients with renal disease

3.1. Non-catabolic patients with stable chronic renal failure (CRF)

3.1.1. Additional metabolic aspects

In the absence of concurrent disease and compensation for metabolic acidosis the patients are usually not (grossly) catabolic.

3.1.2. Nutritional state

The patients however, are at a high risk of malnutrition, because of uraemia associated factors, metabolic acidosis and concurrent disease, impaired appetite and oral food intake, gastrointestinal side effect of uraemia, and potentially ill directed dietary regimens.

3.1.3. Aims of nutritional management

The purpose of nutritional management is to prevent malnutrition at an early stage of renal disease and/or to maintain an

E-mail address: espenjournals@espen.org (Editorial Office).

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Table 1
Main metabolic abnormalities in patients with renal failure.

Metabolic abnormalities in patients with renal failure
Peripheral insulin resistance
Impairment of lipolysis
Low grade inflammatory state ± activation of protein catabolism
Augmented catabolic response to intercurrent disease
Metabolic acidosis
Hyperparathyroidisms, uremic bone disease
Impairment of vitamin D_3 activation

optimal nutritional status, to reduce or control accumulation of waste products, to prevent cardiovascular disease by treating hyperlipidemia, bone disease by treating vitamin D deficiencies and hyperparathyreoidismus and to retard progression of renal dysfunction.

Note: In nutrition of patients with CRF there is a delicate balance between induction of toxic effects by giving excess and inducing malnutrition by giving too little.

Nutrient requirements are summarized in Table 2. Special attention must be given to protein, phosphorus, potassium, and bicarbonate and also to active vitamin D_3 analogues.

During dietary treatment the most controversial question is related to protein intake. There is some agreement that there should be (at least) a moderate protein restriction (0.7–1.0 g kg^{-1} day^{-1}). If protein intake is reduced below 0.6 g kg^{-1} day^{-1} a supplement of essential amino acids and/or keto-analogues of amino acids must be provided. The extent of electrolyte restriction is variable in the individual patient. Bicarbonate supplementation must not be forgotten in these patients. Parenteral and enteral nutrition is usually only given in acutely ill patients (see below).

3.2. Patients on chronic renal replacement therapy

Patients on chronic renal replacement therapy (haemodialysis – HD, chronic ambulatory peritoneal dialysis – CAPD) are frequently malnourished or at extreme risk of developing malnutrition. This is because HD per se is a catabolic event with 10–13 g of amino acids lost per day in the dialysate (see »Impact of renal replacement therapies«). In CAPD 8–9 g of protein are lost daily in the dialysate, although up to 125 g of glucose may be gained. The problem in these patients is not that they eat too much but too little (Table 3).

Note: In HD patients there is a high prevalence of malnutrition (10–30%) and a tight correlation between nutritional state, morbidity and mortality.

Table 2
Daily nutritional requirements in (stable) patients with CRF, on HD or CAPD.

		Conservative therapy	Haemodialysis	Peritoneal dialysis
Energy	(kcal kg^{-1})	>35	>35	>35[a]
Protein	(g kg^{-1})	0.6–1.0	1.1–1.4	1.2–1.5
Phosphorus	(mg)	600–1000	800–1000	800–1000
	(mmol)	19–31	25–32	25–32
Potassium	(mg)	1500–2000[b]	2000–2500	2000–2500
	(mmol)	38–40	40–63	40–63
Sodium	(g)	1.8–2.5[b]	1.8–2.5	1.8–2.5
	(mmol)	77–106	77–106	77–106
Fluid	(ml)	Not restricted	1000 ml + DO	1000 ml + UF + DO

DO = daily (urine) output.
[a] Included energy (glucose) from the dialysate.
[b] Individual requirements can differ considerably.

Table 3
Causes of malnutrition in haemodialysis patients

Malnutrition in haemodialysis patients
Anorexia – reduced oral nutrient intake
Gastrointestinal consequences of uraemia
Restrictive diets
Uremic toxicity – inadequate dialysis prescription
Metabolic acidosis
Endocrine factors (PTH, insulin resistance etc.)
Dialysis-associated factors (loss of nutrients, induction of protein catabolism)
Intercurrent disease (infections, etc.)

3.2.1. Aims of nutritional treatment during renal replacement therapy

The purpose of nutritional management is to prevent or treat malnutrition, to reduce accumulation of fluid, waste products, potassium and phosphorus, and to prevent complications of uraemia (cardiovascular disease, bone disease etc.)

Nutrient requirements are shown in Table 2. Special attention must be paid to potassium, phosphorus, and fluids (but not protein or energy intake).

During dietary treatment patients must be maintained on an adequate energy and protein intake. Vitamins (including active vitamin D_3) must be supplied. Potassium and phosphate intake should be reduced. If necessary, oral phosphate binders must be given to the patients. Parenteral and enteral nutrition are usually given in acutely ill patients (see below).

3.2.2. Intradialytic parenteral nutrition (IDPN)

If alternative strategies for improving nutrient intake or nutritional state (Table 4) have failed, an IDPN should be considered:

Composition:
- A mixture of glucose (50–100 g), amino acids (50–70 g), lipids (20–40 g) and water soluble vitamins should be given instead of a single nutrient.
- The parenteral nutrition solution should be infused during the whole dialysis period into the drip chamber of the venous blood line.

3.3. Patients with acute renal failure (ARF) and HD/CAPD – patients with acute catabolic disease

3.3.1. Aims of nutritional therapy

In ARF the aim of nutritional treatment is not the alleviation of uremic toxicity and retardation of progression of renal disease (as in CRF), but – as in other acute disease – the stimulation of immunocompetence, of wound healing and other reparative functions. In most clinical situations, requirements will exceed the minimal intake recommended for stable CRF patients or the recommended daily allowances (RDA) for normal subjects.

Table 4
Strategies to treat malnutrition in haemodialysis patients

Treatment of malnutrition in haemodialysis patients	
Treatment of potential causes	– inadequate dialysis prescription
	– metabolic acidosis
	– hyperparathyroidisms
	– intercurrent acute illness
Dietetic counselling	– modifications of the diet
	– enteral supplements
	– tube feeding
	– nocturnal
	– nursing homes
Parenteral nutrition	– intradialytic parenteral nutrition (IDPN)
Therapy with growth factors	– anabolic steroids, rHGH, rIGF-1??