Chapter 29: Nutrition and the Kidney in the Elderly Patient

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Both older persons and persons with kidney failure are highly prone to develop nutritional deficiencies (Table 1). The major nutritional problem experienced by both groups is weight loss associated with protein energy malnutrition. Renal failure patients with low body mass index, weight loss, low albumin, and low cholesterol all have increased morbidity and mortality.[1] These are classical components of the malnutrition, inflammation, and atherosclerosis (MIA) syndrome in ESRD. Similarly, in older persons, weight loss is associated with increased mortality.

WEIGHT LOSS

The causes of weight loss in older persons are as follows[2]: cachexia, anorexia, sarcopenia, and dehydration.

Sarcopenia is the loss of muscle mass that occurs with aging. It is associated with varying degrees of muscle power (dynapenia). Severe sarcopenia (defined as appendicular skeleton lean mass corrected for height that is 2 SD below the normal value for young persons) occurs in 5 to 13% of persons over the age of 70 yr. Sarcopenia is associated with increased disability, and its medical costs have been calculated to be $18.4 billion per year in the United States. On the whole, fat older persons who maintain muscle mass do fairly well, but those who are fat but have lost muscle mass (the "fat frail" or sarcopenic obese) have worse outcomes as far as disability and mortality than do the thin sarcopenic.

There are many causes of sarcopenia (Table 2). These include genetic factors, weight at birth, poor energy and protein intake, low levels of activity, decreased motor units, insulin resistance, decreased anabolic hormones, low vitamin D, increased cytokines, and peripheral vascular disease. The potential treatments for sarcopenia are outlined in Table 3. Overall, the best treatments are exercise (especially resistance exercise), anabolic hormones (*e.g.*, testosterone and selective androgen receptor molecules), and vitamin D replacement. Creatine together with exercise improves muscle strength in older persons. It also reduces cramps. There are no data in renal failure.

The decreased testosterone and vitamin D associated with kidney disease make sarcopenia more likely to occur in renal failure. Insulin resistance in renal failure further decreases muscle anabolism and increases fat accumulation in muscle. With aging, there is a physiologic anorexia of aging with older males reducing their caloric intake by a third and females by a quarter over their lifespan.[3] There are multiple causes of this physiologic anorexia. Aging is associated with a decline in taste and olfaction. With aging there is a decrease in adaptive relaxation of the fundus of the stomach, resulting of a quicker filling of the antrum and early satiation. This is associated with slower gastric emptying that occurs with large gastric volumes in older persons. The satiation hormone, cholecystokinin, is increased with aging, and it is more effective at reducing food intake in older persons. The reduction in testosterone in older males leads to an increase in leptin that can reduce food intake and increase energy metabolism.

Renal failure is classically associated with anorexia because of circulating uremic toxins. In addition, urea in the mouth produces gingivitis, decreasing the enjoyment of eating. Male kidney failure patients have low testosterone, increasing the potential of higher leptin levels increasing anorexia.

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Table 1. Nutritional alterations in kidney disease

1. Weight Loss
—Sarcopenia
—Protein energy malnutrition
Anorexia
Malabsorption
Hypermetabolism
Cachexia
—Dehydration
2. Vitamin abnormalities
—Decreased folate
—Decreased pyridoxine
—Increased homocysteine
—Decreased niacin
—Decreased vitamin C
—Decreased 25(OH) vitamin D
—Increased vitamin A
3. Trace mineral abnormalities
—Decreased zinc
—Decreased selenium
—Decreased iron or its bioavailability
—Increased copper
—Increased magnesium
4. Electrolytes
—Hyperkalemia
—Hyponatremia
5. Carnitine deficiency and/or functional impairment
6. Lipids
—Hypertriglyceridemia
—Hypercholesterolemia
7. Carbohydrates
—Insulin resistance
—Hyperglycemia

The most common cause of pathologic anorexia with aging is depression. Therapeutic diets are bland and further aggravate anorexia. Chronic pain often limits the desire to eat. A variety of medicines interfere with taste and produce anorexia. The common reversible causes of weight loss in older persons are given in Table 4. Nutritional deficiencies may be related to (1) the inability to access groceries—decline in mobility, poor vision, and loss of driving privileges and (2) lack of an enthusiasm to cook and a loss of ability to prepare food. Food preparation requires cognitive styles, dexterity, and ability to stand for long periods, all of which are often lacking in elderly dialysis patients.[4]

Table 2. Causes of sarcopenia*

Lack of physical activity
Lack of adequate protein ingestion
Anabolic hormone deficiency
Testosterone
Dehydroepiandrosterone insulin growth factor-1 (DHEA)
Growth hormone, including its muscle isoform
Vitamin D deficiency
Cytokine excess (interleukin-6, tumor necrosis factor-α)
Motor neuron loss
Insulin resistance
Low birth weight
Genetics
Myostatin
Ciliary neurotrophic factor (CNTF) and its receptor
Vitamin D receptor (VDR *Bsm*1)
Angiotensin converting enzyme
Androgen receptor gene (CAG-repeats)
Cyclin-dependent kinase inhibitor 1A

*For those wishing more details regarding the genetic factors, please see reference 2.

Table 3. Treatment of sarcopenia

Exercise
Aerobic
Resistance
Vibration platform exercises
Nutrients
Essential amino acids
Creatine
Anabolics
Testosterone
Selective androgen receptor molecules
Ghrelin analogs
Proteolysis Inhibitor
Angiotensin converting enzyme (ACE) inhibitors
Orexigenics
Megestrol
Dronabinol

In renal failure, nausea, vomiting, and diarrhea can lead to weight loss. Confusion, depression, and anxiety can lead to decreased food intake. Generalized bone pain may limit food intake.

Approximately 8% of renal failure patients on dialysis have cachexia. Cachexia or wasting disease consists of loss of both muscle and fat, anorexia, hypermetabolism, decreased intestinal mobility, low albumin, low cholesterol, and elevated acute phase proteins.[5] In general, in renal failure patients, it is caused by elevated inflammatory cytokine levels. Cytokines decrease cholesterol and cause third spacing of albumin and prealbumin, explaining the very low levels of these circulating substances often seen in renal failure. In renal failure, superimposed acute and chronic illnesses can further aggravate the

Table 4. MEALS-ON-WHEELS mnemonic for treatable causes of weight loss in older persons

Medications (*e.g.*, digoxin, theophylline, cimetidine)
Emotional (*e.g.*, depression)
Alcoholism, elder abuse, anorexia tardive
Late life paranoia
Swallowing problems
Oral factors
Nosocomial infections (*e.g.*, tuberculosis)
Wandering and other dementia-related factors
Hyperthyroidism, hypercalcemia, hypoadrenalism
Enteral problems (*e.g.*, gluten enteropathy)
Eating problems
Low salt, low cholesterol, and other therapeutic diets
Stones (cholecystitis)

cachexia. Peritoneal dialysis is associated with potentially large losses of protein and albumin. Blood loss that is common in older persons with renal failure further contributes to protein energy malnutrition. The role of toxins, retained during renal failure, at producing catabolism is uncertain. Acidemia suppresses albumin synthesis and promotes negative nitrogen balance.

Recent studies have suggested that optimal survival in patients with renal failure requires a protein intake of between 1.1 to 1.4 g/kg protein per day.[6] In end-stage renal failure patients, an energy intake of 35 to 40 kcal/kg per day seems to be necessary to maintain weight and nitrogen balance. In persons with a lower caloric intake, amino acid supplementation may be helpful.

Studies in older persons with ESRD have suggested that very low protein diets may decrease the time to dialysis and days in hospitalization without altering mortality. As this is a quality-of-life issue, older persons should be informed of this possibility to allow them to make informed choices. In severely malnourished anorectic patients on dialysis, intradialytic peripheral parenteral nutrition may be a reasonable approach.[7–9]

MICRONUTRIENTS

In general, because caloric intake is insufficient in persons on dialysis, it may be expected that micronutrient intake may be insufficient. Virtually no patients ingest the recommended folate and pyridoxine intakes.[10] Niacin and selenium intakes are also low in persons on long-term dialysis. Vitamin C levels are reduced by hemodialysis.[11] 25(OH) Vitamin D levels are low in ESRD.

Elevated homocysteine levels in epidemiologic studies have been associated with cardiovascular disease, Alzheimer's disease, and osteoporosis. Renal failure itself causes elevation of homocysteine. Folate has the best effect on reducing homocysteine in the deficiency patients. Addition of vitamin B_{12} may be appropriate to prevent unmasking of latent vitamin B_{12} levels. Elevated methylmalonic acid levels are diagnostic of vitamin B_{12} deficiency.

Older persons with renal failure who are bruising easily will benefit from vitamin C supplementation. Vitamin A levels are elevated in end-stage kidney disease. Elevated vitamin A levels cause increased production of PTH and bone disease. For this reason, multivitamins with vitamin A need to be avoided in renal failure.

As far as trace elements are concerned, zinc, selenium, and iron are the most likely to be deficient in end-stage kidney failure, whereas magnesium and copper are liable to be in excess. Zinc deficiency in kidney failure may lead to dysgeusia, anorexia, and hypogonadism. Zinc deficiency is particularly likely to occur in patients on diuretics.

Iron sulfate causes anorexia and gastrointestinal distress and, as such, iron gluconate is preferred. If oral iron cannot maintain adequate erythropoiesis, as measured by flow cytometry (>10% hypochromic subpopulation), intravenous iron is required. Excess iron replacement should be avoided because of the possibility that it may increase the likelihood of certain infections.

Aluminum excess occurs mainly because of use of $Al(OH)_3$ as a phosphate binder. Aluminum excess has been correlated with cognitive dysfunction and bone disease. Thus, low phosphate diets and use of nonaluminum phosphate binders are preferred for control of hyperphosphatemia.

CARNITINE

Carnitine is a nutrient that is essential for the transport of long chain fatty acids into mitochondria. As such, it plays a key role in mitochondrial energy control. Serum carnitine deficiency occurs during hemodialysis. Carnitine in hemodialysis patients may reduce fatigue, increase exercise capacity, reduce erythropoietin requirement, reduce cramps, and reduce hypotensive events during dialysis.[12,13] Carnitine seems to be safe. Available data consist of small trials and thus its use cannot be recommended routinely. However, in severe muscle weakness, cramps, dialysis hypotension, fatigue, or anemia resistant to erythropoietin, a therapeutic trial may be considered. Carnitine can be given orally as 0.5 g daily or infused intravenously after dialysis (10 to 20 mg/kg, three times per week).

TAKE HOME POINTS

- Protein energy malnutrition is the most common nutritional problem in older persons on dialysis; it is associated with poor outcomes
- Folate and pyridoxine intakes are usually insufficient in older persons with renal failure
- Outcomes, such as less falls and improved function can be obtained by keeping 25(OH) vitamin D levels >100 nmol/L.

DISCLOSURES

None.

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REVIEW QUESTIONS: NUTRITION AND THE KIDNEY IN THE ELDERLY PATIENT

1. Optimal protein intake in older persons with kidney disease are
   a. 0.8 g/kg per day
   b. 0.8–1 g/kg per day
   c. 1.1–1.4 g/kg per day
   d. 1.5–1.8 g/kg per day
   e. 2.0 g/kg per day

2. Which of the following have the worst outcomes as far as mortality and disability are concerned?
   a. Thin sarcopenic
   b. Obese
   c. Obese sarcopenic
   d. BMI 21 to 23 kg/m^2

3. Which of the following should be avoided in kidney disease?
   a. Vitamin A
   b. Folate
   c. Vitamin C
   d. Vitamin D
   e. Zinc