Kidney disease interferes with the normal capacity of nephrons to filter waste products of body metabolism.

Short-term kidney disease requires basic nutrition support for healing rather than dietary restriction.

3.8 million Americans have some form of kidney disease.

42,000 persons die from such diseases each year.

Dual Role of the Kidneys

Kidneys make urine, through which they excrete most of the waste products of metabolism.

Kidneys control the concentrations of most constituents of body fluids, especially blood.

Basic Structure and Function

Structures

- Basic unit is the nephron
  - Glomerulus
• Tubules

• Function
  — Excretory and regulatory
  — Endocrine

• Basic Structure

• Renal Nephrons
  • Basic functional unit of the kidney

• Major nephron functions
  — Filtration of materials in blood
  — Reabsorption of needed substances
  — Secretion of hydrogen ions to maintain acid-base balance
  — Excretion of waste materials

• Additional functions
  — Renin secretion (for body water balance)
  — Erythropoietin secretion (for red cell production)
  — Vitamin D activation

• Nephron Structures

• Glomerulus
  — Cluster of branching capillaries
  — Cup-shaped membrane at the head of each nephron forms the Bowman’s capsule
  — Filters waste products from blood
  — Glomerular filtration rate: Preferred method of monitoring kidney function

• Tubules
  — Proximal tubule
  — Loop of Henle
— Distal tubule
— Collecting tubule

• Tubules
• Causes of Kidney Disease
• Infection and obstruction
• Damage from other diseases
• Toxins
• Genetic defect
• Risk factors

• Causes of Kidney Disease, cont’d
• Risk Factors and Causes of Kidney Disease

• Sociodemographic factors
  — Older age
  — Racial or ethnic minority status
  — Exposure to certain chemical and environmental conditions
  — Low income or education

• Risk Factors and Causes of Kidney Disease, cont’d

• Clinical factors
  — Poor glycemic control in diabetes
  — Hypertension
  — Autoimmune disease
Systemic infections

Urinary tract infections

Urinary stones

Risk Factors and Causes of Kidney Disease, cont’d

Clinical factors

- Lower urinary tract obstruction
- Neoplasia
- Family history of chronic kidney disease
- Recovery from acute kidney failure
- Reduction in kidney mass
- Exposure to certain nephrotoxic drugs
- Low birth weight


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Medical Nutrition Therapy

Based on the nature of the disease process and individual responses

- Length of disease
  - Long term: More specific nutrient modifications

- Degree of impaired renal function
  - Extensive: Extensive nutrition therapy required

- Individual clinical symptoms

Acute Glomerulonephritis or Nephritic Syndrome
Clinical symptoms: Hematuria, proteinurea, edema, mild hypertension, depressed appetite, possible oliguria or anuria

Acute Glomerulonephritis or Nephritic Syndrome, cont’d

Medical Nutrition Therapy

Acute glomerulonephritis

- Uncomplicated disease: Antibiotics and bed rest

- Advanced disease:
  - Possible restriction of protein, sodium
  - Liberal intake of carbohydrates
  - Potassium intake may be monitored
  - Fluid intake may be restricted

Nephrotic Syndrome

Clinical symptoms: Massive edema, ascites, proteinurea, distended abdomen, reduced plasma protein level, body tissue wasting

Medical Nutrition Therapy

Nephrotic syndrome

- Protein intake to meet nutrition/growth needs (without excess)

- Carbohydrate

- Lipids

- Sodium (~3 g/day)

- Potassium

- Water
Other minerals and vitamins

Chapter 21 Lesson 21.2

Key Concepts

The progressive degeneration of chronic renal failure requires dialysis treatment and modification according to individual disease status.

Key Concepts, cont’d

Current therapy for renal stones depends more on basic nutrition and health support for medical treatment than on major food and nutrient restrictions.

Kidney Disease

3.8 million Americans have some form of kidney disease.

42,000 persons die from such diseases each year.

Acute Kidney Failure

Prerenal

Intrinsic

Postrenal obstruction

Acute Renal Failure

Clinical symptoms: Oliguria, proteinurea, hematuria, loss of appetite, nausea/vomiting, fatigue, edema, itchy skin

Short-term dialysis may be needed

May progress to chronic renal failure
Medical Nutrition Therapy

Acute kidney failure

- Goal is to improve or maintain nutritional status
- Parenteral nutrition therapy may be required
- Recommendations for protein intake have been debated
- Individualized therapy based on renal function (indicated by glomerular filtration rate)

Medical Nutrition Therapy

Chronic Kidney Failure

- Caused by progressive breakdown of renal tissue, which impairs all renal functions
- Develops slowly
- No cure (other than kidney transplant)
- Clinical symptoms: Polyuria/oliguria/anuria, electrolyte imbalances, nitrogen retention, anemia, hypertension, azotemia, weakness, shortness of breath, fatigue, thirst, appetite loss, bleeding, muscular twitching

Medical Nutrition Therapy Objectives

- Reduce protein breakdown
- Avoid dehydration or excess hydration
- Correct acidosis
- Correct electrolyte imbalances
- Control fluid and electrolyte losses
- Maintain optimal nutritional status
- Maintain appetite and morale
- Control complications of hypertension, bone pain, nervous system involvement
- Slow rate of renal failure
Medical Nutrition Therapy Principles

- Provide enough protein therapy to maintain tissue integrity while avoiding excess
- Provide amino acid supplements for protein supplementation
- Reserve protein for tissue synthesis by ensuring adequate carbohydrates and fats
- Maintain adequate urine volume with water
- (Possibly) restrict sodium, phosphate, calcium
- Supplement diet with multivitamin

Stages of Chronic Kidney Disease

End-Stage Kidney Disease

- Occurs when patient’s glomerular filtration rate decreases to 15 ml/min
- Irreversible damage to most nephrons
- Dialysis or transplant are only options

Hemodialysis

- Uses an artificial kidney machine to remove toxic substances from blood, restore nutrients and metabolites
- Two to three treatments per week typically required
- Patient’s blood makes several “round trips” through machine
- Dialysis solution (dialysate) removes excess waste material

Hemodialysis, cont’d

Hemodialysis, cont’d

Hemodialysis Patient

Medical nutrition therapy
— Maintain protein and energy balance
— Prevent dehydration or fluid overload
— Maintain normal serum potassium and sodium levels
— Maintain acceptable phosphate and calcium levels

• Hemodialysis Patient, cont’d

• Other dietary concerns
  — Avoid protein energy malnutrition by careful calculation of protein allowance
  — Maintain body mass index of 25 to 28 kg/m²
  — Fluid intake: 1000 ml/day, plus amount equal to urine output
  — Sodium: 2000 mg/day
  — Potassium: 2000-3000 mg/day
  — Supplement of water-soluble vitamins (e.g., B complex, C)

• Peritoneal Dialysis
• Performed at home
• Patient introduces dialysate solution directly into peritoneal cavity four to five times per day
• Surgical insertion of permanent catheter is required
• Disposable bag containing dialysate solution is attached to catheter
• Diet is more liberal than with hemodialysis

• Peritoneal Dialysis, cont’d
• Peritoneal Dialysis, cont’d
• Peritoneal Dialysis, cont’d
• Medical nutrition therapy
  — Increase protein intake to 1.2 to 1.5 g/kg body weight
  — Increase potassium with a wide variety of fruits and vegetables
  — Encourage liberal fluid intake of 1500 to 2000 ml/day
  — Avoid sweets and fats
  — Maintain lean body weight

• Comorbid Conditions

• Osteodystrophy
  — Bone disease resulting from defective bone formation
  — Found in about 40% of patients with decreased kidney function and 100% of patients with kidney failure

• Neuropathy
  — Central and peripheral neurologic disorders
  — Found in up to 65% of patients at the initiation of dialysis

• Kidney Stones
• Basic cause is unknown
• Factors relating to urine or urinary tract environment contribute to formation
• Present in 5% of U.S. women and 12% of U.S. men
• Major stones are formed from one of three substances:
  — Calcium
  — Struvite
  — Uric acid
• Kidney Stones, cont’d

• Risk Factors

• Calcium Stones

• 70% to 80% of kidney stones are composed of calcium oxalate

• Almost half result from genetic predisposition

• Other causes
  — Excess calcium in blood (hypercalcemia) or urine (hypercalciuria)
  — Excess oxalate in urine (hyperoxaluria)
  — Low levels of citrate in urine (hypocitraturia)
  — Infection

• Examples of Food Sources of Oxalates

• Fruits: Berries, Concord grapes, currants, figs, fruit cocktail, plums, rhubarb, tangerines

• Vegetables: Baked/green/wax beans, beet/collard greens, beets, celery, Swiss chard, chives, eggplant, endive, kale, okra, green peppers, spinach, sweet potatoes, tomatoes

• Nuts: Almonds, cashews, peanuts/peanut butter

• Beverages: Cocoa, draft beer, tea

• Other: Grits, tofu, wheat germ

• Struvite Stones

• Composed of magnesium ammonium phosphate

• Mainly caused by urinary tract infections rather than specific nutrient

• No diet therapy is involved

• Usually removed surgically
• Other Stones

• Cystine stones
  — Caused by genetic metabolic defect
  — Occur rarely

• Xanthine stones
  — Associated with treatment for gout and family history of gout
  — Occur rarely

• Kidney Stones: Symptoms and Treatment

• Clinical symptoms: Severe pain, other urinary symptoms, general weakness, fever

• Several considerations for treatment
  — Fluid intake to prevent accumulation of materials
  — Dietary control of stone constituents
  — Achievement of desired pH of urine with medication
  — Use of binding agents to prevent absorption of stone elements
  — Drug therapy in combination with diet therapy

• Nutrition Therapy: Calcium Stones

• Low-calcium diet (~400 mg/day) recommended for those with supersaturation of calcium in the urine and who are not at risk for bone loss

• If stone is calcium phosphate, sources of phosphorus (e.g., meats, legumes, nuts) are controlled

• Fluid intake increased

• Sodium intake decreased

• Fiber foods high in phytates increased

• Nutrition Therapy: Uric Acid Stones
• Low-purine diet sometimes recommended

• Avoid:
  — Organ meats
  — Alcohol
  — Anchovies, sardines
  — Yeast
  — Legumes, mushrooms, spinach, asparagus, cauliflower
  — Poultry

• Medical Nutrition Therapy:
  Cystine Stones

• Low-methionine diet (essentially a low-protein diet) sometimes recommended

• In children, a regular diet to support growth is recommended

• Medical drug therapy is used to control infection or produce more alkaline urine

• General Dietary Principles: Kidney Stones

• Summary

  The nephrons are the functional units of the kidneys. Through these unique structures the kidney maintains life-sustaining blood levels of materials required for life and health.

  The nephrons accomplish their tremendous task by constantly “laundering” the blood many times each day, returning necessary elements to the blood and eliminating the remainder in concentrated urine.

• Summary, cont’d

• Various diseases that interfere with the vital function of nephrons can cause kidney disease.

• At its end stage, chronic kidney disease is treated by dialysis or kidney transplantation.
• Dialysis patients require close monitoring for protein, water, and electrolyte balance.

• Summary, cont’d

• Kidney diseases have predisposing factors (e.g., recurrent urinary tract infections may lead to renal calculi, and progressive glomerulonephritis may lead to chronic nephrotic syndrome and kidney failure).

• Kidney stones may be formed from a variety of substances. For some patient, a change in dietary intake of the identified substance (e.g. fluid, sodium, oxalate, purine) may decrease stone formation.