

## Urinary System Chronic Kidney Disease (CKD)

Involves progressive, irreversible loss

**Defined** as one of the following:

1. Kidney damage (markers of damage)
2. Low glomerular filtration rate  
    < 60 mL/min for 3 months or longer

Disease staging based on decrease in GFR:

Normal GFR: 125 mL/min (creatinine clearance)

Last stage of kidney failure: GFR < 15 mL/min  
End-stage kidney disease (ESKD)

### Stages of Chronic Kidney Disease

Table 1. Stages of CKD <sup>a</sup>			R I F L E
Stage	Description	GFR (mL/min/1.73 m <sup>2</sup> )	
1	Kidney damage with normal or GFR	≥ 90	
2	Kidney damage with mild GFR	89-60	
3A	Mild to moderate GFR	59-45	
3B	Moderate GFR	45-30	
4	Severe GFR	30-15	
5	Kidney failure	< 15 or dialysis	
<small>CKD, chronic kidney disease; GFR, glomerular filtration rate.  <sup>a</sup>Adapted from the Renal Association. <a href="http://www.renal.org/whatwedo/InformationResources/CKDeGUIDE/CKDstages.aspx">http://www.renal.org/whatwedo/InformationResources/CKDeGUIDE/CKDstages.aspx</a>. Accessed November 16, 2013.</small>			

- Recognized later
- Remaining nephrons compensate
- End result- every organ involved
- Prognosis and course – variable
- Loss gradual or severe

### Incidence

- 1/9 Americans
- Mortality- 19-24% stage 5 on dialysis

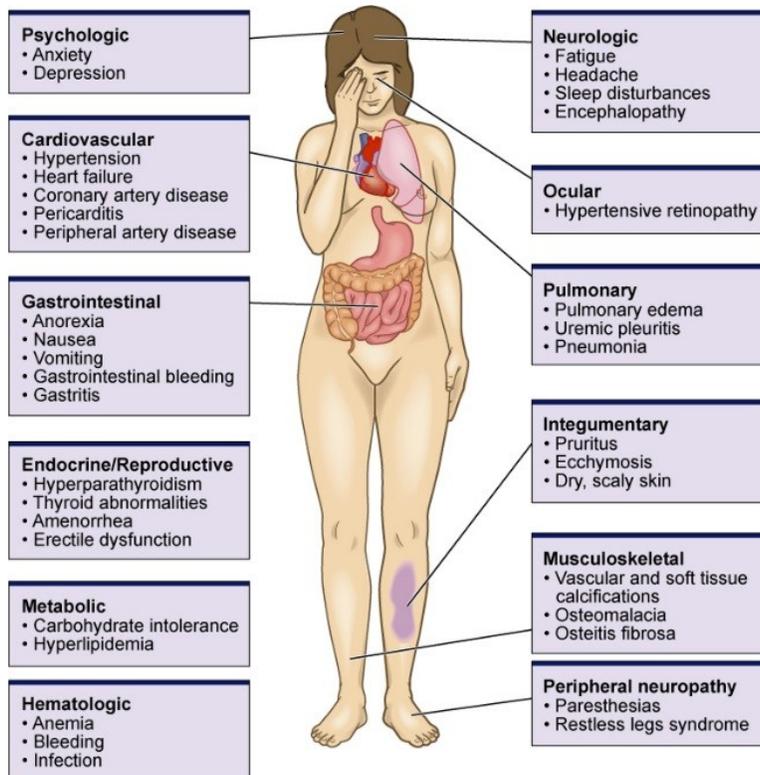
### Leading causes of ESKD

- Diabetes
- Hypertension
- Other: polycystic disease, chronic glomerulonephritis, repeat infections, nephrotoxins, SLE, sickle cell, scleroderma, TB, medications - NSAIDs

## Clinical Manifestations

Result of retained substances

Urea  
Creatinine  
Phenols = C<sub>6</sub>H<sub>5</sub>OH  
Hormones  
Electrolytes  
Water  
Other substances



## Clinical Manifestations

### Uremia

Syndrome - incorporates all s/sx seen in various systems  
Often occurs when the GFR is  $\leq 10$  mL/min

### Urinary System

Polyuria – most noticeable symptom

Results from inability to concentrate urine  
Occurs at night  
Specific gravity fixed at 1.010

Oliguria

As CKD worsens

Anuria

Urine output  $< 40$  mL/24 hrs

As CKD worsens, fluid retention → need for dialysis; anuria

## Metabolic Disturbances

### Waste product accumulation

- As GFR ↓, BUN and serum creatinine levels ↑
- BUN level ↑ : Kidney failure, protein intake, fever, steroids, catabolism
- s/sx: N/V, lethargy, fatigue, impaired thought processes, and HA

**Serum creatinine clearance = GFR; most accurate indicator of function**

### Altered carbohydrate metabolism

- Caused by impaired glucose metabolism
- Insulin does not affect the cells of glucose like normal; **less sensitive**
- Mild to moderate hyperglycemia and hyperinsulinemia
  - insulin and glucose metabolism may improve with dialysis- may require less insulin*
- Patients with diabetes who develop uremia may require less insulin after onset of CKD
- Excretion of insulin dependent on kidneys – stays in circulation longer, **\*change dose for diabetics**

### Elevated triglyceride levels (cause atherosclerosis)

- Hyperinsulinemia stimulates hepatic production of triglycerides
- ↑ VLDLs, ↑ LDLs, ↓ HDLs
- Altered lipid metabolism:
  - ↓ Levels of enzyme lipoprotein lipase
    - Important in breakdown of lipoproteins
- most CKD patients die from CVD!!**

## Electrolyte/Acid-Base Imbalances

### *Potassium*

#### Hyperkalemia

- Most serious electrolyte disorder
- Fatal dysrhythmias (7 – 8 mEq/L)
- Results from: decreased excretion, protein breakdown, metabolic acidosis, food, supplements, IV infusions

### *Sodium*

- May be elevated, normal, or low
- Sodium is retained → Water is retained
  - o edema
  - o Hypertension
  - o HF

If large quantities of water is retained – dilutional hyponatremia  
Low sodium diet: 2 g/day

### *Calcium and phosphate alterations*

- Hypocalcemia (r/t low vitamin D)
- Hyperphosphatemia (r/t bone demineralization & less excretion)

### *Magnesium alterations*

- Hypermagnesemia: not a problem unless ingesting more (medications with magnesium)
- s/sx: absent reflexes, decreased mental status, cardiac dysrhythmias, hypotension, respiratory

failure

### *Metabolic acidosis*

Results from inability to excrete excess acid

Defective reabsorption/regeneration of bicarbonate

Acid is buffered by bicarb – wnl 80 – 90 mEq of acid/day; bicarb falls to 16-20 mEq/L (indirect measure of acidosis)

## **Hematologic system**

### *Anemia*

-r/t low erythropoietin production

-other: nutritional, decrease RBC lifespan, increased hemolysis of RBC's, frequent blood sampling, bleeding from GI tract

-s/sx: weakness, fatigue, HA, paleness, dizziness, SOB, chest pain, problems concentrating

### *Bleeding tendencies*

Defect in platelets

Caused by impaired aggregation and impaired release of platelet factor III

### *Infection*

- Change in WBC function
- Altered immune response: decreased inflammatory response = r/f infection
- Other factors: hyperglycemia, trauma (catheters, needles, vascular access)
- Impaired phagocytic cell ability

## **Cardiovascular system:**

**CVD-** most common cause of death in CKD patients

(MI, ischemic heart disease, PAD, HF, cardiomyopathy, CVA)

Risk factors: HTN, elevated lipids, vascular calcification, and arterial stiffness)

Hypertension- most common CV problem- hypervolemia, RAAS

Heart failure- HTN and fluid overload

Left ventricular hypertrophy

Peripheral edema

Dysrhythmias- High K Mag, low Ca, acidosis, low perfusion

Uremic pericarditis- → pericardial effusion and cardiac tamponade (s/sx: friction rub, chest pain, low grade fever)

## **Respiratory system**

Kussmaul respirations – acidosis (remove excess CO<sub>2</sub> by exhalation)

Dyspnea may occur with:

Fluid overload

Pulmonary edema

Uremic pleurisy (predisposing factor for respiratory infections)

Pleural effusions

Respiratory infections → PNA

## **Gastrointestinal system**

Every part is affected r/t excessive urea

Mucosal ulcerations

Stomatitis- exudates, ulcerations, metallic taste

Uremic fetor- urinous odor of breath

GI bleeding- mucosal irritation and platelet defect

Anorexia, nausea, vomiting - if CKD not treated with dialysis

Constipation: ingestion of iron salts and/or calcium-containing phosphate binders (decreased activity and fluid restrictions)

## **Neurologic system**

Expected as renal failure progresses; CNS becomes depressed

Attributed to:

Increased nitrogenous waste products

Electrolyte imbalances

Metabolic acidosis

Atrophy

Demyelination of nerve fibers

-Lethargy, apathy, fatigue

-Restless legs syndrome: s/sx- burning feet, inability to find a comfortable position, gait changes, foot drop, paraplegia)

-Muscle twitching

-Irritability

-Decreased ability to concentrate

-Peripheral neuropathy

-Altered mental ability

- Seizures- ^ BUN
- Coma- ^ BUN
- Dialysis encephalopathy

\*Treatment for neurologic problems = dialysis or transplant  
 \*AMS is a **late manifestation** of CKD Stage 5

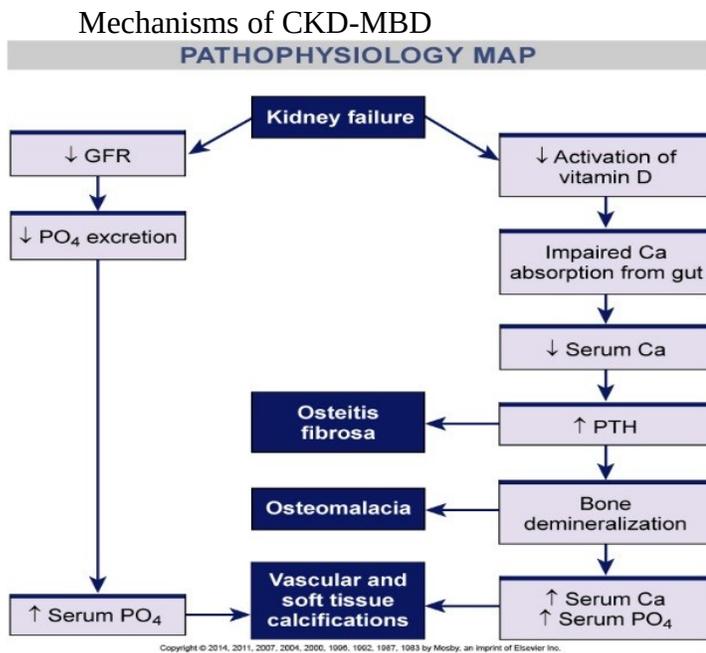
**Musculoskeletal system** (renal osteodystrophy)  
 CKD-MBD (mineral and bone disorder)  
 Systemic disorder of mineral and bone metabolism

Results in:

Skeletal complications: (osteomalacia, osteitis fibrosa: calcium reabsorption from bone and replacement with fibrous tissue)

Extraskeletal: vascular calcifications

\*as renal function deteriorates, less vitamin D = decreased calcium absorption; low Ca levels = release of PTH which demineralizes bone to release Ca; phosphate released too = hyperphosphatemia – also from reduced excretion by kidneys. Hyperphosphatemia results in further hypocalcemia & vitamin D activation



\* Blood vessels, joints, lungs, heart, and eyes (**uremic red eye- calcium deposits in eye**)

**Integumentary system**

Absorption and retention of urinary chromagens

Pruritus: multifactorial (dry skin, calcium-phosphate in skin, sensory neuropathy)

Uremic frost: rare; urea crystallizes on skin and seen with BUN levels are extremely elevated > 200 mg/dL

Dry brittle hair, thin nails, petechiae, ecchymosis

## **Reproductive system**

Infertility

Decreased libido

Low sperm counts

Sexual dysfunction: ? anemia, may improve with dialysis and normalize with transplant

- female: low estrogen, progesterone and LH → anovulation and usually amenorrhea

- male: loss of testicular consistency, low testosterone, low sperm counts, ED

## **Psychologic changes**

Personality and behavioral changes – can be dramatic depending on underlying personality

Emotional lability

Withdrawal & depression

Change in body image can contribute to depression, etc.

Life threatening disease = extreme stress

## **Diagnostic Studies**

History and physical

Dipstick evaluation (persistent proteinuria: 1+ protein two or more times over a 3 month period should be worked up further; usually first indicator of damage)

UA – RBC, WBC, casts, protein, and glucose

Albumin-to-creatinine ratio – first morning void

GFR - use MDRD study to calculate

Renal ultrasonography – detect obstructions and size of kidneys

Renal scan – establish diagnosis and cause

CT scan – establish diagnosis and cause

Renal biopsy – may need for definitive diagnosis

## **Conservative therapy:**

**detect and tx cause, preserve function, reduce CV risk, prevent complications, comfort**

-Correction of extracellular fluid volume

-Nutritional therapy

-Erythropoietin therapy - epogen

-Calcium supplementation, phosphate binders

-Antihypertensive 's

-Lower potassium

## Drug therapy

### **Hyperkalemia**

IV insulin – pushes K into cells; given with glucose; eventually diffuses back into blood

IV glucose – prevents hypoglycemia

IV 10% calcium gluconate – raises threshold

Sodium bicarbonate – corrects acidosis

Sodium polystyrene sulfonate (Kayexalate)

Cation-exchange resin

Resin in bowel exchanges potassium for sodium

S/fx: diarrhea; never give to paralytic ileus = bowel necrosis

**Hypertension** – target 130/80 CKD, and 125/75 for pts with significant proteinuria

Weight loss

Lifestyle changes – alcohol, smoking cessation, exercise

Diet recommendations – DASH

Sodium and fluid restriction

Antihypertensive drugs: dependent on whether diabetic or non-diabetic

(ACE & ARBs given to diabetic and those with non-diabetic proteinuria because they decrease proteinuria and delay progression)

Digoxin – cardiac output

Diuretics – furosemide

CCB – nifedipine, amlodipine, diltiazem

ACE inhibitors – captopril, lisinopril

ARB agents – irbesartan, losartan, valsartan

\*\*\* ACE & ARBs ↓ GFR and ↑ K<sup>+</sup> (CAUTION)

**CKD-MBD** – limit dietary phosphorus, admin phosphate binders, supplement vitamin D, control hyperparathyroidism

Phosphate not restricted until requires renal replacement therapy

Phosphate intake restricted to < 1000 mg/day

Phosphate binders: **admin with meals**

Calcium acetate (PhosLo)

Calcium carbonate (Caltrate) – bind phosphate in bowel and in feces

Sevelamer hydrochloride (Renagel) – lowers cholesterol and LDL levels

Side effect: constipation

### Supplementing vitamin D

Calcitriol (Rocaltrol) doxercalciferol/Hectorol, paricalcitol/Zemplar

Serum phosphate must be lowered before calcium or vitamin D administered

### Controlling secondary hyperparathyroidism

Calcimimetic agents: increase sensitivity to calcium receptors in parathyroid glands  
Cinacalcet (Sensipar)

Subtotal parathyroidectomy: only if it becomes severe; parathyroid tissue auto-transplanted into forearm and if PTH becomes excessive, remove cells from forearm

## **Anemia**

### Erythropoietin

Epoetin alfa (Epogen, Procrit)

Darbepoetin alfa (Aranesp) – weekly or every 2 weeks

IV or subQ

Increased hemoglobin and hematocrit in 2 - 3 weeks

Side effect: HTN, iron deficiency

Use lowest dose first to reduce r/f CV events

### Iron supplements

If plasma ferritin level is less than 100ng/mL

Side effects: GI irritation, constipation, dark stool

Do not administer PO iron with phosphate binders

### Folic acid supplements (RBC formation)

Goal- avoid blood transfusions (unless acute loss or symptomatic)

Transfusions suppress erythropoiesis

Transfusions increase amount of antibodies developed → difficult to cross-match for transplant

## **Dyslipidemia**

### Goal

Lowering LDL level below 100 mg/dL

Lowering triglyceride level below 200 mg/dL

### Statins

HMG-CoA reductase inhibitors – most effective for lowering LDL

Simvastatin ^ r/f myopathy, if developed switch to atorvastatin

Fibrates – gemfibrozil/Lopid lower triglycerides and can increase HDL levels

## **Complications**

Drug toxicity: delayed and decreased elimination = accumulation; adjust dosages and frequencies  
Digoxin – excreted by kidneys  
Diabetic agents – metformin  
Antibiotics – many nephrotoxic  
Pain medication (meperidine/Demerol- seizures, NSAIDs)

## **Nutritional therapy**

Calorie-protein malnutrition

Dietary guidelines for HD & PD differ (PD – excessive protein loss)

**Protein restriction** – not routinely restricted for dialysis

Benefits are being studied

Monitor labs: serum albumin, prealbumin, ferritin, and BMI = nutritional status

**Water restriction**

Intake depends on daily UO

Fluid = anything liquid at room temperature

Insensible loss + previous day's output = daily allowance- hemodialysis

**Sodium restriction**

Diets vary from 2 – 4 g, depending on edema & HTN

Sodium and salt should not be equated (1g NaCL = 400 mg Na)

Salt substitutes – do not use (potassium chloride)

Avoid high sodium foods!

**Potassium restriction**

Limit: 2 – 3 g

Avoid: oranges, melons, bananas, tomatoes, beans, legumes, green/yellow veggies

**Phosphate restriction**

Limit: 1000 mg/day

Most foods high in phosphate are high in protein – phosphate binders, high protein diet

Dairy products

## **Nursing Management: Nursing Assessment**

Complete history – any existing renal disease, family history

Long-term health problems

Diet habits

Current & past prescription medications, OTC, herbal remedies

(antacids, NSAIDs, decongestants, antihistamines)

## **Nursing Management: Nursing Diagnoses**

Excess fluid volume

Risk for electrolyte imbalance

Risk for injury

Imbalanced nutrition: less than body requirements

## **Nursing Management: Nursing Implementation**

### Health promotion

Identify individuals at risk for CKD

- History of renal disease
- Hypertension
- Diabetes mellitus
- Repeated urinary tract infection

Urinary appearance, frequency, and volume

DM – urine checked for microalbuminuria if negative for protein

Reduce risk for CV disease

### Acute intervention

Daily weight (1 lb wt gain = 500 mL retained fluid)

Daily BP

Identify signs and symptoms of fluid overload

Identify signs and symptoms of hyperkalemia

Strict diet adherence

### Ambulatory and home care

HD, PD, and transplantation

Patient and family need clear explanation of dialysis and transplantation

### Acute intervention

Medication

Motivate management