By: Jason Yeagle **Disease State: Renal Disease**

Etiology:

Acute Renal Failure (ARF): can be categorized as prerenal, postrenal, or renal; pre and postrenal causes are potentially reversible as are some renal causes; prerenal azotemia causes from 50 to 80% of ARF cases; inadequate renal perfusion is the result of extracellular fluid volume depletion or cardiovascular disease; postrenal azotemia is responsible for 5 to 10% of ARF which is the result of various types of obstruction in the voiding and collecting parts of the urinary system
Chronic Renal Failure (CRF): may result from any major cause of renal dysfunction; most common cause of end-stage renal failure (ESRF) is diabetic neuropathy, followed by hypertensive nephroangiosclerosis, and primary and secondary glomerulopathies; other less common causes include hereditary nephropathies, renal macrovascular disease,obstructive uropathy, and nephrotoxic agents

How the Condition is Diagnosed:

ARF: signs/symptoms relate to loss of excretory function and depend on the degree of renal dysfunction, rate of renal failure and the cause; community acquired ARF may only present with cola-colored urine; in hospitalized patients, ARF is typically associated with some recent traumatic, surgical, or medical event

Prerenal azotemia: may be suggested by any disorder lowering renal perfusion, renal artery disorder may be asymptomatic

Postrenal azotemia: should be considered in the absence of prerenal factors; history of difficult voiding, or reduced urinary stream, enlarged kidney, or palpable bladder suggest urethral or bladder neck obstruction

Intrinsic renal disease: may have three phases; the prodromal phase varies in duration depending on causative factors (amount of toxin, duration/severity of HTN); the oliguric phase averages 10 to 14 days, but varies from 1-2 days to 6-8 weeks, urine output typically varies between 50 and 400 mL/day, some patients are never oliguric, serum creatinine increases by 1-2 mg/dL/d and urea nitrogen by 10-20 mg/dL; in the post-oliguric phase urine output gradually returns to NL, however, serum creatinine and urea levela may not fall for several more days, tubulat disfunction may persist and is manifested by Na wasting, polyuria unresponsive to vasopressin, or hyperchloremic metabolic acidosis

CRF:

Diagnosis of CRF is based on clinical assessment, a history of chronic progressive debilitation, and gradual deterioration of renal function as determined by creatinine clearance tests; progession to CRF is common when serum creatinine concentration is .1.5-2.0 mg/dL; definitive diagnostic tool is renal biopsy; urea and creatinine are elevated; abnormal Ca, PTH, Vit.D metabolism occur; hypocalcemia and hyperphosphatemia also occur; moderate acidosis usually occurs as does anemia; urine specific gravity becomes fixed at 1.010; urinalysis may show proteinurea, glycosurea, erythrocytes, leukocytes, and casts (especially waxy)

Chronic Kidney Disease Stages

	GFR (ml/min)
1) Kidney Disease with Normal GFR	>90
2) Mildly Impaired GFR	60-89
3) Moderately Impaired GFR	30-59
4) Severely Impaired GFR	15-29
5) Kidney Failure	<15

***Normal GFR 110-130 ml/min**

Physiological Effects:

ARF:

GI: anorexia, N/V/D, constipation, stomatitis, bleeding, hematemesis, dry mucous membranes, uremic breath

Central Nervous System (CNS): headache, drowsiness, irritability, confusion, peripheral neuropathy, seizures, coma

Cutaneous: dryness, pruritus, pallor, purura, uremic frost (rare)

Cardiovascular: early in the disease- hypotension, later- hypertension, arryhythmias, fluid overload, heart failure, systematic edema, altered clotting mechanisms d/t Vit.D deficiency and thrombocytopenia

Respiratory: pulmonary edema, Kussmal's respirations

CRF:

Renal and Urologic: initially- salt wasting and consequent hyponatremia produce hypotension, dry mouth, loss of skin turgor, listlessness, fatigue, and nausea, later- somnolence and confusion develop, as number of functioning nephrons decreases so does Na excretion, resulting in Na retention and overload, accumulation of K causes muscle irritability, then muscle weakness as K continues to rise, fluid overload and metabolic acidosis also accur, urinary output decreased, urine is very dilute (isotonic to blood) and contains casts and crystals

Cardiovascular: hypertension, arrhythmias (including ventricular tachycardia or fibrillation), cardiomyopathy, uremic pericarditis, pericardial effusion with possible cardiac tamponade, heart failure, peripheral edema

Respiratory: reduced pulmonary macrophage activity with increased susceptibility to infection, pulmonary edema, pleuritic pain, pleural friction rub and effusions, uremic pleutitis and uremic lung, dyspnea d/t heart failure, and Kussmaul's respirations d/t acidosis

GI: inflammation and ulceration of GI mucosa cause stomatitis, gum ulceration and bleeding, possibly parotitis, esophagitis, gastritis, duodenal ulcers, lesions on the small and large bowel, uremic colitis, pancreatitis, and proctitis, metallic taste in mouth, uremic fetor (ammonia breath), anorexia, N/V

Cutaneous: skin is pallid, yellowish bronze, dry, and scaly; severe itching, purpura, ecchymosed, petechiae, uremic frost; thin, brittle finger nails with characteristic lines; dry, brittle hair that may change color and fall out easily

Neurologic: restless leg syndrome (one of first signs of peripheral neuropathy) causes pain, burning, and itching in the legs and feet; condition progresses to paresthesia and motor nerve dysfunction (usually bilateral footdrop) unless dialysisis initiated; muscle cramping and twitching; shortened momory and attention span; apathy; drowsiness; irritability; confusion; coma; seizures; electroencephalogram changes indicate metabolic encephalopathy

Hematopoietic: anemia; decreased red blood cell (RBC) survival time; blood loss from dialysis and GI bleeding; mild thrombocytopenia, and platelet defects; increased bleeding and clotting disorders demonstrated by purpura, hemorrhage from body orifices, easy bruising, ecchymoses, and petechiae

Skeletal: calcium-phosphorus imbalance and consequent hyperparathyroid hormone imbalances cause muscle and bone pain, skeletal demineralization, pathologic fractures, and calcifications in the brain, eyes, gums, joints, myocardium, and blood vessels; arterial calcification may produce coronary artery disease (CAD); in children, renal osterdystrophy (renal rickets) may develop

Nutritional Implications of Disease State:

Decreased 1-alpha-hydroxylase activity contributes to Vit.D deficiency, decreased Ca absorption, increased bone Ca resorption; monitor electrolytes, watch for hyperkalemia: muscle cramping, diarrhea, muscle irritability, weak pulse rate, tall peaked T-waves, widening QRS segment, prolonged PR interval, and disappearance of P waves; pt may require sodium bicarbonate for acidosis; monitor for pulmonary edema: dyspnea, restlessness, and crackles, pt may require diuretics;

Lab Alterations Seen in Disease State:

Lab Test Alteration	Normal Value	Alteration	Cause of
ARF:			
Serum Creatinine	**8-25 mg/dL**	**rise of 1-2 mg/dL/d**	**decrease in renal function**
		>2 mg/dL/d	**rhabdomyolysis**
CO_2:	**22-29 mmol/L**	**15-20 mmol/L**	**abnormal acid-base balance**
Urea nitrogen:	**7-11 mg/dL**	**10-20 mg/dL**	**decreased excretion**
		30-100 mg/dL/d	**accelerated catabolism**
Serum potassium:	**3.5-5.1 mmol/L**	**slow conc. increase**	**decreased excretion**
		1-2 mmol/L/d rise	**accelerated catabolism**
Serum sodium:	**136-146 mmol/L**	**125-135 mmol/L**	**hypervolemia/Na wasting**
Hct:	**42-52%(men) 37-47%(women)**	**25-30% normochromic normocytic**	**deficient EPO**
Urinary Sediment:	**negative**	**RBC, WBC, casts**	**damage to glomerulus**
CRF:			
Creatinine:	**see above**		
Serum Urea:	**7-18 mg/dL**	**elevated**	**decreased renal function**
Serum Calcium:	**9-11 mg/dL**	**depressed**	
Serum potassium:	**see above**		
Vitamin D:	**10-52 ng/ml**	**depressed**	**decreased hydroxylation of 1-alpha position on Vit.D**

CO_2:	**22-29 mmol/L**	**15-20 mmol/L**	
Hct:	**see above**	**20-30%**	**deficient EOP**
Urinary Sediment:	**negative**	**broad casts**	**glomerular damage**

Medications Commonly Used in Disease State:

Medication	Action	Nutritional Concerns
Calcium acetate	**Phosphate binder**	**Avoid Ca supplement, decreased Fe absorption, anorexia, N/V, Constipation, increased serum Ca, decreased serum P**
Corticosteriods	**Immunosuppresive**	**Increased peripheral insulin resistance, decreased insulin production, abdominal distention, increased appetite, N/D, bone resorption d/t abnormal Ca, P, and Vit.D metabolism, catabolism**
Anti-thymocyte Globulin (ATG)	**Immunosuppresive**	**Allergic Rxn, serum sickness, thrombocytopenia, increase in viral/fungal infection**
OKT-3	**Immunosuppresive**	**Flu-like symptoms, diarrhea, fever, chills, pain, decreased appetite**
Cyclosporin	**Immunosuppresive**	**Decreased insulin production, inhibits insulin secretion, toxic to B-cells, hyperlipidemia, hypomagnesemia, N/V/D**
Cellcept (mycophenolate mofetil)	**Immunosuppresive**	**Leukopenia, thrombocytopenia, anemia, N/V/D**
Prograft (tracrolimus)	**Immunosuppresive**	**same as cyclosporin, possible more diabetogenic, thrombocytopenia, leukopenia**
Rapamune	**Immunosuppresive**	**N/V/D, hyperglycemia, UTI, anemia, leukopenia**

Vitamin D	**Increases Ca absorption**	**Increased intestinal Ca absorption,**
		increased renal Ca resorption, increased bone-Ca resorption
Calcium supplement	**Increased serum Ca levels**	**Increased bone minerization**

Medical Treatment of Disease:

See medications above
See diet changes listed under Nutritional Treatment

Surgical Treatment of Disease:

- **Kidney transplant**
  - **Living Donor**
    - **Related**
    - **Non-related**
  - **Cadaver**
- **Dialysis**
  - **Hemodialysis**
    - **Continuous Arteriovenous Hemofiltration (CAVH)**
      - **Prevent/treat fluid overload**
      - **Prevent/treat edema**
      - **Prevent/treat hyponatremia**
      - ***Used for ARF**
    - **Continuous Arteriovenous Hemodiafiltration (CAVDH)**
      - **Combines hemodialysis and hemofiltration**
      - **Removes greater amounts of solutes**
      - ***Used for ARF**
    - **Hemodialysis**
      - **Requires permanent access to bloodstream**
      - **Waste products and electrolytes removed via osmosis**
      - **Treatment required 3 to 4 days per week, 3 to 5 hours per treatment**
      - ***Used for CRF**
    - **Peritoneal Dialysis**
      - **Continuous Cycling Peritoneal Dialysis (CCPD)**
        - **High-dextrose dialysate**
        - **Uses peritoneal membrane as semi-permeable filter**
        - **Can be done during sleep**
        - **Done once daily**
        - **Pump used to move dialysate**
        - ***Used for CRF**
      - **Continuous Ambulatory Peritoneal Dialysis (CAPD)**
        - **Similar to CCPD, but uses gravity to move dialysate**
        - **Done 4 to 5 times a day, making it a 24 hour treatment**
        - **Less fluctuations in blood chemistry**
        - **More normal lifestyle for pt**
        - ***Used for CRF**

Nutritional Treatment of Disease:

ARF:

Protein: 0.6-0.8 g/Kg/d for nonhypermetabolic, nondialyzed pt. with GFR <10 ml/min, 60% as HBV; Energy: typically 35 kcal/Kg/d, can be as high as 45-55 kcal/Kg/d; Fat and CHO: should be provided in quantity to spare protein, tends to be higher in fat since K is restricted and CHO foods tend to have high K, fats should be in a healthy ration of P:S:M of 10%:7%:13%; Vitamins and Minerals: electrolytes need to be closely monitored, serum K and phosphate generally elevated and serum Na typically lower in nondialyzed pt. who is oliguric, oliguric and anuric pt. receiving hemodialysis usually require Na restriction of 2-3g/d and K restriction of 1.5-3g/d, pt. undergoing peritoneal or frequent dialysis usually have more liberal Na and K allowances; Fluid: daily fluid intake for oliguric pt. should = urine output + 500 mL to replace insensible loss, most anuric pt. can tolerate 1000mL/d with hemodialysis 3x wk, IV treatment can cause fluid overload and may be combined with Continuous Arteriovenous Hemofiltration (CAVH), *pt. with ARF at high risk for malnutrition d/t underlying illness, trauma, surgery, can accelerate degradation of lean body mass and result in poor wound healing, increased infection and high mortality

CRF, Predialysis:

Protein: 0.6-0.8 g/Kg/d, 65% as HBV, as GFR and excretion of nitrogenous wastes decreases it is necessary to limit protein intake, need to achieve nitrogen balance without overloading the kidneys, if significant protein urea exists calculated losses should be added into needs, additional protein may also be required d/t increased catabolism resulting from corticosteroid use or surgery; Energy: 35-50 kcal/Kg/d is required for effective protein utilization, should include both simple and complex CHO; Fat and CHO: as with ARF increased fat may be needed, should increase MUFA and PUFA and decrease SFA; Sodium: as renal failure progresses, renal Na excretion falls, Na intake may need to be limited since urinary excretion is normally major Na loss, otherwise Na retention could lead to general edema, HTN, and/or CHF, Na restriction of 2-3g/d is normal; Potassium: restriction typically unnecessary until latter stages of CRF, when serum K levels are >5 mEq/L a K restricted diet of 2-3g/d is suggested, if ACE inhibitors are being used, K restriction may be called for since this suppresses the rennin-angiotensin system resulting in reduced aldosterone secretion and therefore elevated K levels; Calcium and Phosphate: Ca supplementation and P restriction are generally needed when GFR <25 ml/min d/t decreased Ca absorption secondary to abnormal Vit.D levels and decreased excretion of phosphate, a phosphate restriction of 8-12 mg/Kg/d is suggested, when P is restricted a Ca supplement is required since dairy is a major source of Ca and also a major source of P; Water Balance and Fluid Restriction: if (fluid in = fluid out), pt. does not need to be restricted, if edema present may require loop diuretic(increase Na and fluid excretion) will return balance, latter stages of CRF require fluid = uirne vol. + 500mL to replace insensible fluid loss

Vitamins and Iron: usual supplements: folic acid 1 mg/d, pyridoxine 5 mg/d, other B-Complex vitamins at DRI, Vit.D as needed, Vit. A should not be supplemented, Fe supplement often necessary, *renal vit-min supplements available

CRF, Hemodialysis:

Protein: 1.2-1.4 g/Kg/d, >60% as HBVdiabetic may need 1.2-1.5 g/Kg/d; Energy: 30-35 kcal/Kg/d; Sodium: 2g/d; Potassium: 2-3 g/d; Phosphorus: 12-15 mg/g dietary protein; Calcium: 1-1.5 g/d; Fluid: output + 1000cc; Vitamins and Minerals: C-60-100 mg/d, B6-5-10 mg/d, Folate-0.8-1.0 mg/d, RDA for Fe, Zn Vit.D, Ca

CRF, Peritoneal Dialysis:

Protein: 1.2-1.5 g/Kg/d, >60% as HBV; Energy: 25-35 kcal/Kg/d including dialysate calories, 20-25 kcal/Kg/d for wt. loss; Sodium: 2-4 g/d; Potassium: 3-4 g/d; Phosphorus: 12-15 mg/g dietary protein; Calcium: 1.0-1.5 g/d; Fliud: monitor, most tolerate 2000cc/d; Vitamins and Minerals: C-60-100 mg/d, B6-5-10 mg/d, Folate-0.8-1.0 mg/d, RDA for FE, Zn, Vit.D, Ca

Transplant:

Protein: 1.3-1.5 g/Kg/d post-op, 1.0 g/Kg/d chronic and stable; Energy: 25-35 kcal/Kg/d for maintenance, limit fat to 30% of kcals, <300mg cholesterol/d; Sodium: 2-4 g/d post-op, 3-4 g/d chronic and stable; Potassium: usually unrestricted, although cyclosporin may cause hyperkalemia;

Phosphorus: unrestricted, monitor; Calcium: 1.0-1.5 g/d; Fluid: unrestricted unless overload; Vitamins and Minerals: Daily RDA