NORMAL FUNCTIONS OF THE KIDNEY

- Rid the body of metabolic waste products
- Regulate fluid volume
- Regulate the composition of electrolytes
- Assist in maintaining acid-base balance
- Aid in regulation of blood pressure
- Regulate red blood cell production

Removal of Waste

- Primary means of eliminating waste products of metabolism no longer needed by the body.
  - Urea
  - Creatinine
  - Uric Acid
  - End products of HGB breakdown

Water Regulation

- Thirst
- ADH
- Countercurrent mechanism of the kidney

Regulation of Electrolytes

- Sodium 135-148
- Potassium 3.5-5.3
- Magnesium 1.6-2.4
- Calcium 8.8-10.2
- Phosphate 2.5-4.5
- Chloride 92-108
SODIUM

HYPERNATREMIA

**CAUSE**
- Fever, dehydration, hypertonic IV's, polyuria, Diabetes Insipidus

**HYponatREMIA**

**CAUSE**
- SIADH (syndrome of inappropriate antidiuretic hormone), Volume overload, renal failure, diuretic misuse

**SYMPTOMS**
- Thirst, dry mucous membranes, lethargy, disorientation

**SYMPTOMS**
- Nausea, headache, confusion and fatigue

**TREATMENT**
- D5W or .45% NS slowly, monitor neuro status

- NS, 2%, 3%, 5%

POTASSIUM

HYPERKALEMIA

**CAUSES**
- Acidosis, renal failure, hemolysis, cell death

**HYPOKALEMIA**

**CAUSES**
- Diuresis, correction of acidosis, GI losses

**SYMPTOMS**
- Nausea, Weakness, Muscle cramps, Flaccid Paralysis, Peaked T Waves, Widened QRS, Sine wave, Ventricular Fibrillation

**SYMPTOMS**
- Fatigue, GI hypomotility, ectopy, broad T waves, Cardiac arrest

**TREATMENT**
- IV CaCl, IV insulin and D5W, HCO3, albuterol, Kayexalate, Dialysis

- IV/PO replacement, ensure Ca and Mg not low

MAGNESIUM

HYPERMAGNESEMIA

**CAUSE**
- Renal Failure

**HYPOMAGNESEMIA**

**CAUSE**
- Diuresis, malnutrition, chelation, DKA

**SYMPTOMS**
- Hypotension, lethargy, Bradycardia, AV block, short QT

**SYMPTOMS**
- Paresthesia, long QT, tetany, Bradycardia, seizures, de pointes

**TREATMENT**
- Diuresis, dialysis

- IV/PO replacement

CALCIUM

HYPERCALCEMIA

**CAUSE**
- Malignancy, hyperparathyroidism

**HYPOCALCHEMA**

**CAUSE**
- Sepsis, chelation (lyzing of cells), PTH insufficiency

**SYMPTOMS**
- Weakness, hypotonia, short QT, confusion

**SYMPTOMS**
- Paresthesia, long QT, tetany, Bradycardia, seizures

**TREATMENT**
- Fluids, diuresis, mithramycin, pamidronate

- IV/PO replacement

PHOSPHORUS

HYPERPHOSPHATEMIA

**CAUSE**
- Renal failure, hypoparathyroidism

**HYPOPHOSPHATEMIA**

**CAUSE**
- Diuresis, high PTH, refraining syndrome, IV insulin infusion (DKA)

**SYMPTOMS**
- Paresthesia, Long QT, tetany, Bradycardia, Hypotension, Seizures

**SYMPTOMS**
- Decreased cardiac contractility, respiratory failure, weakness, impaired oxygen delivery

**TREATMENT**
- Limit intake (renal failure), Phosphate binders

- IV/PO replacement, treat underlying cause

Acid-Base Balance
- Bicarbonate Reabsorption
- Hydrogen Ion Secretion
- Renal Buffers of Hydrogen Ions
Blood Pressure Regulation

- Maintenance of Volume and Composition of ECF
- Aldosterone – body Sodium Balance
- Renin- Angiotensin-Aldosterone System
- Renal Prostaglandins
- Kallikrein-kinin System

Angiotensin II

- Brand Name: Giapreza
- Vasoactive Agent
- Continuous infusion – 10-20 ng/kg/minute
- Maximum maintenance dose – 40 ng/kg/minute
- Used for Septic or other distributive shock

RBC Production

- Erythropoietin

DIURETICS

- Thiazides
- Loop Diuretics
- Potassium-Sparing Diuretics
- Osmotic Diuretics
- Carbonic Anhydrase Inhibitors

Thiazides

- Chlorothiazide (Diuril)
- Chlorthalidone
- Hydrochlorothiazide (Microzide)
- Indapamide
- Metolazone

Loop Diuretics

- Bumetanide (Bumex)
- Ethacrynic acid (Edecrin)
- Furosemide (Lasix)
- Torsemide (Demadex)
Potassium-Sparing Diuretics

- Eplerenone (Inspra)
- Triamterene (Dyrenium)
- Spironolactone (Aldactone, Carospir)
- Amiloride (Midamor)

Osmotic Diuretics

- Mannitol (Osmitrol)

Carbonic Anhydrase Inhibitors

- Acetzolamide (Diamox)
- Dichlorphenamide (Daranide, Keveyis)
- Methazolamide (Neptazane)

RENAL FAILURE

- Pre renal
- Intrarenal
- Post renal

Pre Renal

- The insult is a decrease in renal blood flow
- 30%-40% of all AKI
- Responsive to interventions that augment systemic blood flow
- BUN:Cr > 20:1

Treatment

- PREVENTION !!
- VOLUME
- VASOPRESSOR THERAPY
- IMPROVE CARDIAC OUTPUT
- DOPAMINERGIC THERAPY(?)
Intrarenal

- Bun:Cr < 10:1
- ATN
- Rhabdomyolysis
- AIN

ATN

- 50% of all AKI
- Inflammatory injury in the epithelial lining of the renal tubules
- Manifested by severe sepsis, septic shock, radiocontrast dye, nephrotoxic drugs or rhabdomyolysis

Rhabdomyolysis

- Characterized by muscle necrosis and release of intracellular muscle constituents into the circulation

Signs and Symptoms

- MYALGIA
- WEAKNESS
- TEA COLORED URINE

Treatment

- Prevention
- Fluids
- Urine Alkalization
- Loop diuretics and Mannitol
- Treatment of metabolic abnormalities

AIN

- Inflammatory injury of the renal interstitium
- Caused mainly by hypersensitivity drug reaction but infections can also be involved
- May be caused by Autoimmune disorders
- Drug induced is often accompanied by fever, rash and eosinophilia
- Usually resolves with discontinuation of offending agent.
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### Treatment
- Discontinuation of causative agent
- Immunosuppressive therapy

### Post Renal
- Responsible for 10% of AKI cases
- Bun:Cr 10-20:1
- Obstruction Post kidney

### Assessment
- Urine output
- Azotemia (elevated Bun) with significant obstruction
- Flank pain and fever
- Hematuria

**TREATMENT**
- Relieve the obstruction
- Monitor urine output, Bun, Cr
- Maintain fluid balance
- Avoid nephrotoxins

### Why Kidneys Fail
- Inherited or congenital. Polycystic kidney disease (PKD).
- Acute kidney injury (AKI)
  - Loss of fluids
  - Drugs or poisons
  - Blunt trauma
  - Hypotension

  _When AKI is corrected early most likely reversible_

- Chronic kidney disease occurs slowly over time. Mainly due to HTN or Diabetes.
- When kidney function drops <15% the person will need renal replacement therapy.

### Acute Kidney Injury
- Abrupt decline or cessation in renal function...
  - Over hours to days
  - Often reversible if:
    1. Recognized early
    2. Treated appropriately

### Renal Replacement Therapy
- **PERITONEAL DIALYSIS**
- **HEMODIALYSIS**
- **CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT)**
  - **SCUF**: Slow continuous ultra filtration
  - **CVVH**: Continuous venovenous hemodialysis
  - **CVVHDF**: Continuous conavenous hemodiafiltration
Renal Access

- AV Fistula
- AV Graft
- Peritoneal Tenckhoff Catheter
- Permacath
- Quinton or TDA

Tests For Kidney Function

URINALYSIS

- BLOOD UREA NITROGEN (BUN) - normal 8-23.
- CREATININE - normal .7-1.25
- GFR
- BUN/CREATININE RATIO

Urinalysis

- VISUAL EXAM
- OSMOLALITY
- SPECIFIC GRAVITY
- CULTURE AND SENSITIVITY
- PH
- GLUCOSE
- ACETONE
- PROTEIN
- SPOT URINE ELECTROLYTES
- URINARY SEDIMENT
  - CASTS
  - BACTERIA
  - ERYTHROCYTES
  - LEUKOCYTES
  - RENAL EPITHELIAL CELLS
  - CRYSTALS
  - EOSINOPHILS

Creatinine

- Freely filtered so its production is normally equal to its secretion.

- Reliable indicator of renal function

- Significant elevation correlates with percentage of nephrons damaged

BUN

- Unreliable indicator of renal damage on its own.

- Can be influenced by urine flow, hypoperfusion, corticosteroids, GIB, diet and metabolism

Kidney Imaging

- Ultrasound
- CT
- MRI
- Plain Film
- IV Urogram
- Renal arteriography
- Renal venography
- VCGU
- Radionuclide studies
- Retrograde or Anterograde pyelography
Kidney Biopsy
- Four Types - CT guided, transjugular, open and laparoscopic
- Used to help determine how the disease is advancing, or why transplant organs are failing.
- Tissue examined by a pathologist. Looking for deposits, scarring or organisms.
- Nursing Intervention
  - Consent
  - Hold ASA and blood thinning medications 1-2 weeks prior NPO

Chronic Renal Failure
- Progressive decline in renal function
- End-Stage Renal Disease (ESRD)

Five Greatest Risk Factors for ESRD
1. Diabetes - 40% of people with Type I and 5-10% of Type II will develop diabetic nephropathy (accounts for 35% of all causes of ESRD).
2. Hypertension - damage to the glomeruli and the arteriolar walls. Accounts for 30% of ESRD.
3. Proteinuria
4. Family History
5. Increasing Age

Stages of Chronic Renal Failure
- Stage 1 - Kidney damage with normal kidney function
- Stage 2 - Mild loss of kidney function
- Stage 3 - Mild to moderate loss of kidney function
- Stage 4 - Severe loss of kidney function
- Stage 5 - Kidney failure and need for transplant or Dialysis

Therapies/Intervention in CRF
- Care of the dialysis access
- Fluid restrictions
- Medication dosing for renal failure/dialysis
- EPO; Vitamin B,C,D, folate, calcium, phosphate binders
- Dietary restrictions

Renal Transplant
- Criteria
- Rejection
- Ethical issues

Rejection
- Hyperacute - minutes to hours post-op
- Accelerated - 2-5 days post-op
- Acute – often reversible with high dose of antirejection meds. Weeks to years post-op.
- Chronic - Cannot be reversed.
Immunological

- Impaired T cell function - Increased levels of uremic toxins can lead to impaired immune and inflammatory responses.
- Infection is a common occurrence in patients with ESRD that often results in hospitalization and death.
- PREVENTION!!!!

Hematological

- Anemia
  1. Decreased RBC production, kidney's inability to produce adequate amounts of erythropoietin stimulating factor
  2. Shorter RBC life - 2nd to uremia
  3. Iron deficiency - Diminished iron and B12 intake
  4. Dialysis patients have increased blood loss from frequent blood draws, clotting of the dialyzer and residual blood in the filter.
- Impaired Platelet Aggregation - from Uremia. Monitor for bleeding.

Pulmonary

- Infiltrates and pulmonary edema
- Metabolic acidosis
- Low oncotic pressure and low oxygen carrying capacity

Cardiovascular

- Arrhythmias
- CHF
- Hypertension
- Pericarditis

Gastrointestinal

- Increased incidence of gastritis
- Stress ulcers
- Anorexia
- Nausea
- Vomiting
- Halitosis
- Metallic taste in mouth
- Bleeding gums and oral cavity ulcers

Neurological

- Uremic encephalopathy - lethargy, confusion, impaired thinking.
- Peripheral neuropathy - restless legs, impaired gait and fine motor movement
- Hypothermia
- Dialysis disequilibrium
Genitourinary

- Obstruction
- Retention
- Incontinence

Renal Trauma

- MVA
- FALLS
- ASSAULT
- SPORTS-RELATED INJURY
- DECELERATION/ACCELERATION INJURY
- GUNSHOT/STAB WOUNDS
  - Right kidney low-less protection from ribcage.
  - Kidney injury often accompanied by other injuries.
    - L Kidney - spleen
    - R Kidney - Liver

QUESTIONS

The type of renal failure caused by a back-leak of glomerular filtrate is:

a) Pre-renal failure
b) Postrenal failure
c) Intrarenal failure
d) Obstructive renal failure

QUESTIONS

Which of the following assessment findings would be consistent with a serum potassium level of 7.2 mmol/L?

a) Muscle cramps, oliguria, short PR interval, bradycardia
b) Anxiety, hunger, tachycardia, long QT measurement
c) Confusion, thirst, long PR interval, numb fingers
d) Anorexia, fatigue, wide QRS complex, tall T-wave

Questions

What should the nurse consider when implementing orders for intravenous magnesium and potassium replacement therapy?

a) Administer the least amount of fluid as possible.
b) Administer the magnesium first.
c) Administer the potassium first.
d) Administer whichever is available first.
Questions
Which of the following conditions would most likely contribute to prerenal acute renal failure

a) Aminoglycoside antibiotics
b) Transfusion reaction
c) Prostate hypertrophy
d) Septic shock

Questions
The most common reason for beginning dialysis

a) Fluid overload
b) Hyponatremia
c) Hyperkalemia
d) Metabolic Acidosis

Questions
Which diuretic is frequently used to prevent ARF

a) Mannitol
b) Furosemide
c) Spironolactone
d) Bumetanide

Questions
A patient with multisystem organ dysfunction has an acute kidney injury. The CVP is 16 and patient is on a norepinephrine infusion. What therapy should the nurse anticipate for this patient?

a) Hemodialysis
b) CRRT
c) Peritoneal Dialysis
d) Kidney Transplant

Questions
Hemodialysis would be an appropriate treatment for an overdose of

a) Acetaminophen
b) Tricyclic antidepressant
c) Aspirin
d) Cocaine

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Thank you
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