Objectives:

- Describe gross renal anatomy
- Describe the course of blood flow to and from the kidney
- Outline the anatomy and function of the nephron
- Summarize other renal functions

Gross Renal Anatomy

- Kidneys – Retroperitoneal
- Weight – 120-160 gm
- Size – 2x4 inches by 1 inch thick
- Nephron is the functional unit
- Ureters – Peristalsis
- Bladder – Storage tank
- Urethra – Exit from body
Internal Structure of the Kidney

- Cortex – 80–85% cortical nephrons; 15–20% juxtamedullary nephrons
- Blood flow faster through cortex than medulla
- Medulla – Pyramids, renal columns, loops of Henle, vasa recta
- Pyramids – Contain nephrons and their blood vessels
- Collecting ducts pelvis

Renal Blood Supply

- Receives ~25% of cardiac output
- Blood enters via renal artery into the afferent arteriole
- Glomerulus filters plasma
- Blood exits via efferent arteriole
- Peritubular capillary network – All cortical, most of juxtamedullary
- Vasa recta – juxtamedullary nephron loops of Henle only

Tubular Component

- Bowman’s capsule – Houses the glomerulus
- Proximal convoluted tubule
- Loop of Henle
- Distal convoluted tubule
- Collecting ducts

Juxtaglomerular Apparatus

- Decreased blood pressure sensed by macula densa cells in the afferent arteriole stimulates the juxtaglomerular apparatus to secrete renin
- It's converted to Angiotensin I in the liver, then converted to Angiotensin II in lung tissue
- Vasoconstriction and sodium and water retained = ↑ BP
Renin–Angiotensin System

- Angiotensin is a potent vasoconstrictor
- Angiotensin II stimulates cells of the adrenal cortex to secrete aldosterone
- Aldosterone stimulates the distal convoluted tubule to reabsorb more sodium and increases secretion of anti-diuretic hormone (ADH) which increases water reabsorption = increased BP and decreased renin

RAAS


Nephron Functions:

Water and Electrolyte Regulation
- Tubular reabsorption
- Tubular secretion
- Clearance
Water and Electrolyte Balance

Glomerulus
- Plasma filtered into Bowman’s capsule
- RBCs, WBCs, and proteins are not filtered
- Sympathetic innervation in response to decreased blood flow (bleeding, hypotension) causes release of epinephrine/norepinephrine:
  - Afferent arteriole vasoconstricts
  - Glomerulus permeability decreased

Proximal Tubule
- 65% of Na+ actively reabsorbed
- Chloride and H2O follow passively
- 100% glucose and amino acids reabsorbed
- Most K+ reabsorbed
- Some Mg++, Ca++ and PO4- reabsorbed
- Acid–base balance begins
- Filtrate leaves isotonic

Loop of Henle
- Counter current multiplying and exchange mechanism established between long, thin loops of Henle of juxtamedullary nephrons and adjacent vasa recta
- Ascending limb has diluting mechanisms: Filtrate leaves hypotonic

Distal Tubule
- Sodium and potassium are regulated by aldosterone
- Water is reabsorbed with sodium
- Antidiuretic hormone (ADH) regulates water reabsorption (by making distal tubule permeable to water) and determines final urine concentration and volume
Water and Electrolyte Balance

- Collecting Tubule
  - Approximately 1 to 1½% of the glomerular filtrate enters the collecting tubule
  - Enters collecting ducts, renal calyxes, renal pelvis, and ureter
  - Normal excretion of urine is 1–2 liters/day

- ADH – “Antidiuretic Hormone”
  - Same as “vasopressin”
  - Released by posterior lobe of pituitary gland
    - Triggered by osmoreceptors in the hypothalamus and baroreceptors in the aortic arch
    - Makes distal tubules permeable to water
    - Adjusts osmolarity by increasing reabsorption

Other Renal Functions:

- RBC production regulated by erythropoietin secretion
  - Secreted in response to renal hypoxia
  - Acts on bone marrow to increase the rate of RBC production

- Metabolism of Vitamin D
  - Kidneys are receptor site for PTH for conversion of Vit. D into its active form: 1,25-dihydroxycholecalciferol

Causes of Renal Failure
Objectives

- Differentiate between acute renal failure (Acute Kidney Injury or AKI) and chronic kidney disease.
- Describe three different etiologies of acute renal failure.

Acute Kidney Injury

- Sudden rapid deterioration
- Severe
- Most common causes
  - Hypoperfusion
  - Nephrotoxins
- Often reversible

Mortality rate – 40–60%
Goal: Prevent life-threatening complications, such as infection and GI bleeding

✔ Remove the cause, restore kidney function

Etiology – Characterized by location and cause
- Pre-Renal – Before the kidney
- Intra-Renal – Within the kidney
- Post-Renal – After the kidney
Pre-renal Causes – 35%

- Hypovolemia
- Altered peripheral vascular resistance
- Cardiac disorders
- Renal artery stenosis or thrombosis

Intra-renal Causes – 50%

- Nephrotoxic Agents
  - Drugs
  - Contrast media
  - Biological substances: some herbal agents
  - Environmental agents: pesticides
  - Heavy metals
  - Plant and animal substances: mushrooms, snake venom

Intra-renal Causes

- Inflammatory processes
- Trauma
- Radiation nephritis
- Obstruction
- Intravascular hemolysis
- Systemic and vascular disorders

Post-renal Causes – 5 to 10%

- Obstruction
  - Ureteral
  - Bladder neck
  - Urethral
- Prostatic hypertrophy
- Abdominal or pelvic neoplasms
- Pregnancy
- Neurogenic bladder
Chronic Renal Failure

- Definition and criteria
  - Kidney damage, structural or functional for greater than 3 months
  - OR
  - GFR < 60 for greater than 3 months with or without kidney damage

Other Causes

- Glomerulonephritis
- Polycystic kidney disease
- Interstitial nephritis
- Obstructions – Birth defects, blocking objects, and scarring
- Autoimmune disease (SLE)

Chronic Renal Failure

- Insidious, progressive, irreversible
- 1995 – 257,000 people with ESRD
- 2006 – 465,000+ people with ESRD

Causes:
- #1 Diabetes
- #2 Hypertension

Other Causes (cont)

- Drug toxicity
  - Heroin and other recreational drugs
  - Nonsteroidal anti-inflammatory drugs (NSAIDs)
  - Antibiotics
  - Anti-rejection medications
Manifestations of Renal Failure

- Alterations in integument
- Electrolyte imbalance
- Alterations in acid/base balance
- Alterations in cardiovascular system
- Alterations in gastrointestinal system
- Endocrine problems
- Anemia
- Mineral & bone metabolism disturbances

Altering in Integument

- Signs/Symptoms:
  Skin that is grayish–bronze; pale, dry, and scaly skin, pruritis, ecchymosis
- Etiology:
  Retained urinary pigments, anemia, decreased activity of sweat and sebaceous glands, uremic toxins and calcium phosphate deposits in skin, sensory nerve irritation, capillary fragility, abnormal platelet adhesiveness
Alterations in Integument

- Management:
  - Moisturize skin with super-fatted soaps, bath oils, and lotions
  - Anti-pruritic medications
  - Correct calcium/phosphate imbalances with meds and dialysis
  - Dialysis

Electrolyte Imbalance

**Sodium (Na+)**
- Regulates water and fluid balance
- Can cause high blood pressure by holding onto extra water
- Hypernatremia - Excessive sodium can cause tissue swelling (edema)
- Hyponatremia - Too little sodium causes water to move into the cells = hemolysis

**Potassium (K+)**
- Involved in nerve and muscle function, contraction of the heart muscle
- Hyperkalemia - Too much potassium can cause the heart to beat irregularly or even stop
- Hypokalemia - Too little potassium
  - Extreme muscle weakness; hard to walk
- Signs and Symptoms
  1. Muscle weakness
  2. Tall–tented T waves
  3. Feel your heart beating (irregular)
  4. Cardiac arrest

**Calcium (Ca++)**
- Most of the calcium is within bone and teeth
- Regulates blood clotting
- Regulates enzymes
- Regulates hormone action
- Controls function of nerves and muscles
- Hypercalcemia - Confusion, lethargy, loss of appetite, nausea/vomiting, and abdominal pain
- Hypocalcemia - Seizures, tetany, numbness, increase PTH
Phosphate ($\text{PO}_4^{3-}$) – phosphorus

- Hyperphosphatemia
  - Severe itching; crystal deposition under the skin, in blood vessel walls, and in the heart muscle
- Lowsers the levels of calcium, causing increase PTH excretion
- Hypophosphatemia
  - Weakness, coma, and bone softening

Bicarbonate – ($\text{HCO}_3^-$)

- Helps regulate acid-base balance (pH)
- Normal kidneys regenerate and keep bicarbonate; failed kidneys cannot
- Bicarbonate is a base, therefore it neutralizes acid
- Too little bicarbonate = metabolic acidosis
- Too much bicarbonate = metabolic alkalosis

Metabolic Acidosis

- Etiology:
  - Inability of kidneys to excrete hydrogen ions
  - Reduction in ammonia synthesis in renal tubular cells = decreased excretion of ammonium chloride
  - Inability of kidneys to reabsorb bicarbonate ions to buffer excess acids
  - Decreased ability of kidneys to produce and excrete titratable acids ($\text{HPO}_4^{2-}/\text{H}_2\text{PO}_4$)
  - Retention of acid end products of metabolism
  - Catabolism of body proteins

Metabolic Acidosis

Treatment

- Oral alkaline medications (bicarbonate)
- Intravenous sodium bicarbonate
- Dialysis
- Correct catabolism
Cardiovascular System

- Hyperkalemia
- Hypertension
- Pericarditis
- Left Ventricular Hypertrophy (LVH)

Hyperkalemia

**Etiology**
- GFR = $K^+$ secretion
- Metabolic acidosis
- Catabolism of body proteins
- Bleeding
- Blood transfusions
- Dietary indiscretion
- Meds and IVs with $K^+$

**Management:**
- Monitor intake
- Correct catabolism
- Avoid salt substitutes
- Correct acid/base
- Dialysis
- Pharmacologic therapy
  - Cation exchange, hypertonic glucose and insulin, IV bicarb, adrenergic blocker

Hypertension

**Etiology**
- Excess fluid and sodium contributing to vascular volume overload
- Malfunction of the renin–angiotensin (R–A) system
- Associated with development of LVH

**Management**
- Control fluid and salt intake
- Dialysis to remove fluid and sodium
- Antihypertensives
- ACE inhibitors and ARB’s to control R–A system

Pericarditis

**Etiology**
- Inflammation of pericardial membrane due to uremic toxins, occasionally bacterial and viral infections
- Chest pain, fever, friction rub
- Can progress to effusion and/or tamponade

**Management**
- Daily dialysis for two weeks without heparin
- Anti-inflammatory to reduce the swelling
**Gastrointestinal System**

**Signs and Symptoms**
- Oral: Fetor uremicus, gum ulcers, bleeding, metallic taste, stomatitis
- Anorexia, nausea and vomiting
- Stomach and intestines: Gastritis w/bleeding, gastric/duodenal ulcers, constipation/diarrhea

**Management**
- Frequent oral care
- Dialysis
- Bulk-forming laxatives or stool softeners
- Antidiarrheals

**Endocrine Function**

**Children:**
- Stop growing
  - Growth hormone, anemia, abnormal protein metabolism, acidosis, Ca/Po imbalance
- Failure to menarche
- Failure to develop secondary sex characteristics

**Adults:**
- Females: Decreased libido, failure to ovulate, amenorrhea, abnormal hormone levels
- Males: Decreased libido, impotence, decreased sperm production, testicular atrophy, low testosterone levels

**Anemia**

**Etiology**
- RBC: Shortened life span
- GI bleeding
- Blood loss during dialysis
- Decreased red blood cell production
- Infection and inflammation
- Hemolysis
- Iron deficiency

**Management**
- Iron supplementation
- Folic acid supplement
- Correct uremia
- EPO
- Blood transfusion
- Androgen therapy

**Goal of therapy**
- Changed since Black Box warnings about use in CKD patients
- Keep patients transfusion free
**Indication and Limitations of Use**

- EPOGEN® is indicated for the treatment of anemia due to chronic kidney disease (CKD) in patients on dialysis to decrease the need for red blood cell (RBC) transfusion.
- EPOGEN® has not been shown to improve quality of life, fatigue, or patient well-being.
- EPOGEN® is not indicated for use as a substitute for RBC transfusions in patients who require immediate correction of anemia.

**Important Safety Information including Boxed WARNINGS**

- **WARNING:** ESAs INCREASE THE RISK OF DEATH, MYOCARDIAL INFARCTION, STROKE, VENOUS THROMBOEMBOLISM, THROMBOSIS OF VASCULAR ACCESS, AND TUMOR PROGRESSION OR RECURRENCE.
  - Chronic Kidney Disease: In controlled trials, patients experienced greater risks for death, serious adverse cardiovascular reactions, and stroke when administered erythropoiesis-stimulating agents (ESAs) to target a hemoglobin level of greater than 11 g/dL.
  - No trial has identified a hemoglobin target level, ESA dose, or dosing strategy that does not increase these risks.
  - Use the lowest EPOGEN® dose sufficient to reduce the need for red blood cell (RBC) transfusions.

**Mineral & Bone Metabolism Disturbances**

- As GFR decreases there is also a decrease in the following:
  - 1,25-dihydroxycholecalciferol production
  - Intestinal absorption of calcium
  - Serum calcium
  - Phosphate excretion
  - Number of Vitamin D receptors

**Secondary Hyperparathyroidism (SHPT)**

- **Etiology**
  - Progressive parathyroid gland hyperplasia occurs with declining levels of Vitamin D, low serum Ca++, and high serum PO₄⁻
  - Begins in CKD stage 3; need to screen early

- **Management**
  - Vitamin D therapy
  - Calcimimetics (Cinacalcet)
  - Phosphate binder
  - Diet PO₄⁻ restriction
Secondary Hyperparathyroidism (SHPT)

Goal of therapy

› Low “normal” total corrected Ca\(^+\) (8.4–9.5mg/dL)
› Serum Phosphorus range (3.5 – 5.5mg/dL)
› Targets for iPTH (KDOQI) as follows:
  • Stage 3: 35 – 70pg/mL
  • Stage 4: 70 – 110pg/mL
  • Stage 5: 150 – 300pg/mL

Medications Needed in Renal Failure

Phosphate Binders

› Tums\(^\circledast\) (calcium carbonate), PhosLo\(^\circledast\) (calcium acetate), Renagel\(^\circledast\) (sevelamer HCl), Renvela\(^\circledast\) (sevelamer carbonate) and Fosrenol\(^\circledast\) (lanthanum carbonate)
› Taken with food to act as a binder
› Eliminated in the stool
› Non-compliance – Pill burden, upset stomach, constipation, diarrhea, cost

Phosphate Binders

› Paricalcitol (Zemplar\(^\circledast\)), doxercalciferol (Hectorol\(^\circledast\)), calcitriol (Rocaltriol\(^\circledast\), Calcijex\(^\circledast\))
› Goals of therapy:
  • Reduce/maintain iPTH in target range
  • Prevent hyperplasia/hypertrophy of parathyroid gland
  • Minimize bone resorption & prevent bone loss
Iron and Erythropoiesis—Stimulating Agents (ESA)

- What is needed for healthy erythropoiesis?
  - Iron needed when: TSat < 20% &/or Ferritin < 100
  - Renal vitamins (with folic acid)
  - Correction of infection/inflammation
- Monitor for HTN and treat
- Assess for blood loss

Components of Dialysis Delivery System

- Dialysate circuit
  - Fluid delivery system
  - Prepares dialysate solution and circulates it through the dialyzer
  - Monitors dialysate conductivity and temperature
- Blood circuit
  - Blood tubing set and dialyzer
  - IV administration line for normal saline
  - Heparin administration line
  - Blood pump, dialyzer and air detector

Principles of Dialysis

Blood Circuit

- FLOW – Determined by the amount of blood delivered by the heart (pump).
- RESISTANCE – Factors that slow down the flow of blood through the blood vessels.
- PRESSURE – Combination of flow from the heart and resistance in the blood vessels.
Dialysate

- A solution containing the electrolytes (calcium, sodium, bicarbonate, potassium, magnesium, and chloride) in the same concentration as the blood stream of people with normal kidney function.

Diffusion

- The movement of particles from an area of higher solute concentration to an area of lower concentration via a semipermeable membrane.

Osmosis

- The movement of fluid (water) from an area of lower solute concentration to an area of higher solute concentration.

Ultrafiltration

- The movement of fluid with additional pressure applied, either positive or negative via a semipermeable membrane.
Semipermeable Membrane

- A membrane surface that has variable size pores that allow some, but not all, particles to pass through.

Factors that Influence Diffusion

CHARACTERISTICS OF MEMBRANES:
1. Size & number of pores in membrane
2. Surface area of the membrane
3. Resistance: film layer
4. Thickness of membrane
5. Ultrafiltration coefficient

CHARACTERISTICS OF SOLUTIONS:
1. Concentration gradients
2. Molecular weight of the solutes
3. Temperature of solutions on either side of membrane
4. Flow geometry
5. Solute drag or convective removal

Convection

- The process of transporting solutes across the semipermeable membrane together with fluid, which occurs in response to a transmembrane pressure (TMP) gradient
  - As water (a solvent) moves from the blood compartment to the dialysate compartment, molecules of dissolved solute are dragged along (solvent drag).
Limitations to Fluid Removal

- Anything that interferes with positive pressure, negative pressure, or resistance in the dialyzer and lines can affect the rate and amount of ultrafiltration.
- Net flux is the amount of solute leaving the blood & entering the dialysate per unit of time.

Inaccurate gauges

- A dialyzer surface area reduced by blood clotting
- Length of treatment time
- Excessive intake of salt

Clearance

- Amount of blood completely cleared of a solute per unit of time—measured in mL/min or L/min
- Expresses the performance of the dialyzer

Transmembrane Pressure (TMP)

- Definition: The pressure difference across the dialyzer membrane, measured in mmHg pressure. It is the total net pressure exerted on the membrane.
- TMP can be accomplished using positive pressure, negative pressure and a combination of positive and negative pressure.
Positive Pressure

- Applying positive pressure on one side of the membrane and pushing fluid to the other side. An example of positive pressure is squeezing water out of a sponge.

Negative Pressure

- Applying negative pressure on the other side and pulling water through. An example of negative pressure is a milkshake being pulled through a straw.

Vascular Access for Hemodialysis

Objectives

- Describe the advantages of each type of vascular access.
- List the complications of vascular access.
- Explain the rules for cannulating using site rotation.
- Describe the differences between Rope Ladder technique and Buttonhole technique.
Types of Accesses

- Arteriovenous fistula
- Arteriovenous graft
- Cuffed tunneled catheter
- Uncuffed catheter
- Port access

Arteriovenous Fistula

- Artery and vein anastomosed
- Use a tourniquet for every cannulation
- Needles are inserted into the arterialized vein
- “Best Access” (National Kidney Foundation Kidney Disease Outcomes Quality Initiative [KDOQI], 2006)

Arteriovenous Fistula

- Artery and vein anastomosed
- Use a tourniquet for every cannulation
- Needles are inserted into the arterialized vein
- “Best Access” (National Kidney Foundation Kidney Disease Outcomes Quality Initiative [KDOQI], 2006)

Order of Choice of Veins

- Radial–cephalic
- Brachial–cephalic
- Brachial–basilic
### Advantages vs. Disadvantages

- Lasts longer than other accesses
- Fewer infections
- Fewer surgical interventions
- Takes 4 to 6 weeks to mature
- May fail to mature
- Technically more challenging to cannulate
- Body image issues

### Patient Education

- Check daily for thrill and intensity
- Check for infection, pain, tenderness, redness
- Exercise new accesses one week post-op
- No heavy packages, purses, tight clothing, watches, or sleeping on access
- Remove needle dressings before bedtime
- No IVs, BPs, or blood draws in access arm

### Arteriovenous Graft

- Made of synthetic, biologic, or semi-biologic materials
- Material is placed between an artery and a vein
- Needles are placed in the graft material
- May be straight, looped, or curved configuration

### Advantages vs. Disadvantages

- Can be used in 2 to 3 weeks (once swelling has gone down)
- Good choice if veins are of poor quality or flows not sufficient to arterialize a fistula
- Easier to cannulate than fistulae
- Stenosis formation frequent
- Thrombosis common
- Infection more common than fistulae
- Skin erosion possible
- More intervention required
Patient Education

- Check for thrill daily
- Check for infection, erosion, pain, tenderness, redness, drainage
- Keep clean and dry
- Remove needle dressings before bedtime
- No IVs, BPs, or blood draws in access arm

ANATOMY OF AVF & AVG

Tunneled Cuffed Catheter

- Can be used immediately after insertion
- Sites: Jugular (preferred), femoral, trans-lumbar, trans-hepatic, and subclavian (least preferred)
- Cuff allows for ingrowth to anchor catheter
- Cuff prevents migration of microorganisms into the bloodstream

Advantages vs. Disadvantages

- Can be used immediately
- For patients with poor cardiac output and unusable vessels
- No needles needed
- Frequent infection
  ~Exit site
  ~Sepsis
- Thrombosis
- Possible air embolus and exsanguination
- May require frequent declotting and/or replacement
Patient Education

- Do not pull on catheter
- Do not get catheter wet
- Do not remove dressing; reinforce, if necessary
- Only dialysis staff can use the catheter
- If catheter dislodges, hold pressure over site for 20 minutes, then notify dialysis center

Non-Tunneled Uncuffed Catheter

- Can be used in acute situations
- Must have verification of placement by X-ray before use and to rule out pneumo- or hemothorax
- Sites for placement include jugular, femoral, and subclavian
- Will be sutured in place

Advantages vs. Disadvantages

- Can be placed at the bedside
- X-ray confirmation
- Easy access to vascular system
- Pneumo- or hemothorax possible
- Clotting
- Infection
- Exit site
- Sepsis
- Dislodgement, if sutures break

Patient Education

- Do not pull on catheter
- Do not get catheter wet
- Do not remove dressing
- Assess for pain and tenderness
- Only dialysis staff can use catheter
- If catheter dislodges, apply pressure at insertion site for 20 minutes, then notify dialysis unit
Port Access

- Internal access
- Requires 14-gauge needles to open mechanism to access vascular system
- Requires making a buttonhole access
- Will change from sharp to blunt needles once track is formed

Advantages vs. Disadvantages

- Internalized catheter-type access
- Access for patients with poor cardiac output and/or poor blood vessels
- Infection
- Requires specific training on the device and the buttonhole technique
- Clotting

Patient Education

- Monitor sites for pain, tenderness, warmth, or drainage
- Monitor for elevated temperature
- Keep dressings over sites clean and dry

Assessment of Access

- **Inspection** for swelling, infection, redness, curves, aneurysms, discoloration of skin, drainage, prior cannulation sites (scabs)
- **Auscultation** of bruit for quality and continuousness, pitch
- **Palpation** of thrill for patency and quality, flat spots and stenosis, and aneurysm evaluation, depth of access
Complications

- Infection
- Thrombosis
- Stenosis
- Steal syndrome
- Infiltration
- Aneurysm
- Pseudoaneurysm
- Recirculation

Cannulation Techniques

- Use tourniquets on all AV Fistulae regardless of age of the access
  - Stability
  - Better visualization
  - Better feel to determine depth
- Keep needles at least 1.5 inches apart and at least 1.5 inches from the anastomosis
- Recommended angle of insertion 25 degrees for AVF (KDOQI)

Rope Ladder (Site Rotation)

- Use new sites each treatment
- Avoid scabs, curves, flat spots, aneurysms
- All fistulae – Place a tourniquet in the axilla area of upper arm, lightly applied
Buttonhole (constant site)

- Requires the same cannulator until track/tunnel is formed
- Uses blunt needles once track/tunnel is formed
- Locate scabs and remove
- Cannulators enter the same site at the same angle of the originator’s every time

Cannulating New AV Fistulae

- Assessment:
  Has diameter of vessel increased?
  Has the wall thickened to prevent infiltration?
  If the answer to either of these questions is no, DO NOT CANNULATE.
- Requires physician’s order

Cannulating New AV Fistulae

- Tourniquet required – Apply lightly in the axilla area of the upper arm regardless of access location
- Needle size – start with 17 gauge needles, advance as access can tolerate
- Pump speed – 200 ml/min first treatment, advance as access can tolerate

Infection Control in Hemodialysis
INFECTION IN HD PATIENTS

- 2nd most common cause of death
- Immunocompromised
- Ongoing inflammation due to:
  - Vascular access
  - HD environment
  - Age
  - Co-morbidities
  - Frequent hospitalizations

CDC Recommendations

- Standard Precautions
- Hep B – No reuse, isolation
- Hep C and HIV/AIDS – Reuse, no isolation
- PPE – Gloves, gowns, mask and eye protection if splashing likely
- Offer vaccinations to patients

OSHA

- Bloodborne pathogens regulations
  - Exposure control plan
  - Infection Control program
  - Exposure determination
  - Mandatory annual training
  - Hepatitis B vaccination – Free for employees at risk

HEPATITIS B

- 1.2 million have chronic Hepatitis B in US (<0.5%)
- Virus is stable in environment and remains viable for at least 7 days on surfaces at room temperature
- Blood work:
  - HBsAg if positive means current infection
  - HBsAB measured quantitatively, >10mLu/mL suggests immunity
  - HBCAb if positive means patient was exposed in the past, recovered from infection
**INTERPRETATION OF HEPATITIS B PANEL**

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Four possible interpretations (see next slide)

**FOUR POSSIBLE INTERPRETATIONS OF ISOLATED ANTI-HBc POSITIVE**

1. May be recovering from acute HBV infection.
2. May be distantly immune and test not sensitive enough to detect very low level of anti-HBs in serum.
3. May be susceptible with a false positive anti-HBc.
4. May be undetectable level of HBsAg present in the serum and the person is actually a carrier.

**ANTIBIOTIC-RESISTANT BACTERIA**

- **MRSA**
  - Most common method of entry into the bloodstream is through vascular access

- **VRE**
  - HD patients have played a key role in the growth of vancomycin resistance due to it's overuse in this population
  - The use of infection control precautions for all your patients will reduce the spread of drug-resistant bacteria

**AIRBORNE DISEASE**

- **Tuberculosis (TB)**
  - Infectious disease that spreads from person to person on airborne droplets
  - Active or Latent

  Precautions to prevent transmission
  - TB skin testing per facility protocol
  - Dialyze infected patients in an isolation room with negative air flow
  - Encourage medication compliance
Acute Therapies

- Apheresis or Therapeutic Plasma Exchange (TPE)
- Continuous Renal Replacement Therapy
  - Continuous arteriovenous hemofiltration (CAVH)
  - Continuous venovenous hemofiltration (CVVH)
  - Continuous arteriovenous hemodialysis (CAVHD)
  - Continuous arteriovenous hemodialfiltration (CAVHDF)
  - Slow continuous ultrafiltration (SCUF)
- Slow low efficiency daily dialysis (SLEDD)

Apheresis or TPE

- Indications for treatment divided into four categories
  - Category 1 should be treated with TPE
  - Category 2 may be treated with TPE
  - Category 3 may or may not be treated with TPE
  - Category 4 should not be treated with TPE unless in approved clinical trial

Apheresis or TPE

- Replacement fluids
  - 5% Albumin
  - Fresh frozen plasma (FFP)
  - Cryoprecipitate–reduced plasma (CRP), also called "cryo–poor plasma"
  - Normal saline
  - Combination of above
- Anticoagulation
  - Citrate: need to replace calcium
  - Heparin

CRRT

- CAVH, CAVHD and CAVHDF all use the arteriovenous extracorporeal circuit.
  - Can use patients heart as the pump for movement of blood through the circuit
  - Replacement fluid usually after the dialyzer
- CVVH, CVVHD and CVVHDF is from vein to vein using a blood pump
  - CVVH clearance is largely convective
  - CVVHD clearance is largely diffusive
  - CVVHDF is modification of CVVHD; clearance both convective and diffusive
- SCUF is continuous fluid removal in response to hydrostatic pressure
SLEDD

- Slow Low Efficiency Daily Dialysis

- Modified intermittent hemodialysis to meet needs of ICU patient with AKI or ESRD

- Excellent solute removal and fluid management without hypotensive episodes

References


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