Complications of Hemodialysis
Objectives

- Understand the problems and complications encountered during hemodialysis
  - The cause/s of each
  - The signs and symptoms of each
  - The management and intervention of each
- Special attention to:
  - Disequilibrium syndrome
  - Hypotension
  - Air embolism
Problems and Complications

- Monitoring during the dialysis treatment is done to prevent, detect, and treat complications.
- Observations should be recorded on the patient's hemodialysis treatment sheet, progress notes, or electronic medical record.
- Continuous monitoring and early detection can reduce and may even prevent problems and complications.
Common Complications

Patient Complications

- Hypotension (20-30%)
- Muscle Cramps
- Disequilibrium Syndrome
- Nausea and Vomiting
- Headache
- Chest Pain
- Itching
- Fever and Chills
- Pyrogen reaction
- Hypertension

Technical Complications

- Clotting
- Blood leak
- Power failure
- Hemolysis
- Air Embolism
  - Air in bloodlines
- Exsanguination
- Dialyzer reactions
Patient complications

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Hypotension

• Most common complication in hemodialysis
  – Defined as low blood pressure
  – Decreased systolic blood pressure by >20-30 mmHg from predialysis pressure
  – Systolic blood pressure <100 mmHg
Causes of Hypotension

Common Causes
- Removing too much weight
  - Inaccurate target weight
  - Inaccurate pre-weight
- Taking Antihypertensive pills before dialysis (BP meds)
- Heart disease
  - MI’s or arrhythmias
- Septicemia

Less Common Causes
- Anemia
  - Hemorrhage
- Low weight gain or dehydration
- Anaphylaxis
- Air embolism
- Eating/drinking during dialysis
- Dialyzer reaction
Signs and Symptoms of Hypotension

- Gradual or sudden decrease in B/P
  - Increase in pulse
- Cold, clammy skin (diaphoresis)
- Nausea/Vomiting
- Cramping
- Chest pain/angina
- Yawning, feeling dizzy, sleepy or weak
- Pallor
- Decreasing mental status to loss of consciousness
- Seizure
Treatment of Hypotension

• Treat the symptoms
  – Pay attention to how the patient feels
  – NS bolus
  – Place patient in trendelenburg position
  – Use Sodium modeling

• Prevention - determine the cause
  – Evaluate target and pre-weight for accuracy
  – Evaluate that fluid goal was correct
  – Review medication list for BP meds
Muscle Cramps

- Painful muscle spasms (usually in extremities)

Causes:
- Associated with removal of large amounts of fluid
  - Hypotension
- Changes in electrolytes (blood chemistry)
  - Rapid sodium removal
  - Low potassium levels
- Inaccurate fluid removal goal
Signs and Symptoms of Muscle Cramps

- Can occur anytime in dialysis, especially middle to end of treatment
- Muscle cramping of extremities that can often be seen
- Hypotension
Treatment of Muscle Cramps

- Treat the symptoms:
  - Normal saline bolus
  - Reduce UFR
  - Massage or apply opposing force
  - Assess dry weight

- Prevention:
  - Sodium modeling
  - Assess for accurate target weight
Disequilibrium Syndrome

• Defined as a set of systemic and neurologic symptoms that include
  – Nausea & vomiting
  – Headache
  – Restlessness
  – Hypertension
  – Slurred speech
  – Seizure and coma
Cause of Disequilibrium Syndrome

• Causes
  – Slower transfer of urea from the brain tissue to the blood
    • Fluid shift into the brain due to removal of wastes from the blood stream causing cerebral edema
  – Rapid changes in serum electrolytes, especially in new patients
    • Elevated BUN > 150
    • BFR to high
    • Treatment time too long
    • Dialyzer to big for first treatments (too efficient)
Treatment of Disequilibrium Syndrome

• Treat the symptoms:
  – Monitor new patients carefully for hypertension
  – Decrease BFR
  – Treat N/V and headache per protocol
  – Be alert for restlessness, speech/mental changes

• Prevention:
  – Assess new patients electrolyte levels
  – Use a smaller dialyzer, lower BFR and shorter dialysis time for first few treatments
Nausea and Vomiting

• Causes:
  – Hypotension
  – Uremia
  – Disequilibrium Syndrome

• Treatment the symptoms:
  – Hypotension = NS bolus
  – Determine relationship to dialysis
    • Is the patient sick?

• Prevention
  – Uremic patient or one with Disequilibrium Syndrome require careful pre-assessment and monitoring during the initial treatments
Headache

• Causes:
  – Hypertension
  – Inaccurate dry weight with too much fluid removed
  – Rapid fluid or electrolyte shift - Disequilibrium Syndrome
  – Anxiety/nervous tension
  – Caffeine withdrawal

• Symptoms
  – Pain in the head or facial area
  – Hypotension
  – Nausea or vomiting
Headache Treatment

• Treat the symptoms
  – Unit policy for analgesics
  – Hypertension: BP assessment
  – Hypotension – NS bolus

• Prevention:
  – Patients require careful pre-assessment and monitoring during treatments
  – Goal is to identify the cause and then prevent it in the future
Chest Pain

Angina:
- Chest pain
- Caused from ischemia (lack of oxygen to tissue)
- Resolved by Nitroglycerin

Myocardial Infarction
- Chest pain
- Caused from ischemia that results in tissue death
- Not resolved by Nitroglycerin
Causes of Chest Pain

• Ischemia to heart muscle (Coronary Artery Disease)
• Anemia
• Hypotension from fluid depletion
• Hypovolemia
• Anxiety-stress, physical exertion, illness
• Blood flow rate increased too rapidly on patient with known cardiac disease
Angina and MI Symptoms

**Angina**
- Pressure, pain localized or may radiate to neck, jaw, shoulders, arms—may come and go
- Apprehension
- Choking/strangling sensation
- Squeezing/crushing/pressure sensation
- **Duration 1-2 minutes**
- Nausea
- Pallor, cool clammy skin

**MI**
- Pressure, pain localized or may radiate to neck, jaw, shoulders, arms—may come and go
- Apprehension
- Choking/strangling sensation
- Squeezing/crushing/pressure sensation
- Nausea
- Pallor, cool clammy skin
- Hypotension
Treatment

• Treat the symptoms:
  – Hypotension
  – Angina pain with Nitroglycerin
  – MI pain requires analgesics
  – Anxiety/stress

• Prevention
  – Accurate fluid removal and weight assessment
Itching

• Causes:
  – Dry skin
  – Secondary hyperparathyroidism
  – Abnormal levels of calcium, magnesium and phosphorus in tissues
  – Allergies
  – Uremia with an elevated BUN

• Treatment:
  – Adequate dialysis to regulate electrolyte levels
  – Lotions or medications for dry skin/allergies

• Prevention:
  – Control of uremia and secondary hyperparathyroidism
  – Adequate dialysis to regulate electrolyte levels
Chills and Fever

• Causes:
  – Infection or septicemia
    • Vascular access
    • Respiratory illness
  – Cold dialysate or malfunctioning thermostat
    • Patient has shaking/shivering without fever
  – Pyrogenic reaction
Symptoms

- **Infection:**
  - Fever during dialysis
  - Feeling cold with a fever
  - Redness, swelling, tenderness, warmth or drainage from access site
- **Septicemia:**
  - Fever, chills, vomiting and headache
  - Hypotensive shock
- **Respiratory**
  - Productive cough
Pyrogenic Reaction

- Fever reaction due to presence of dead bacteria endotoxins
  - Low molecular weight endotoxin fragments may be able to cross any membrane, irrespective of membrane pore size distribution
- Caused by contamination of:
  - Bicarbonate containers/system
  - Water system
  - Machine
  - Dialyzer or bloodlines
Symptoms of Pyrogenic Reaction

- Symptoms:
  - Cold sensation upon treatment initiation (40-70 minutes into treatment)
  - Sudden shaking chills, then temperature elevation (1-2 hours after chills) - resolves after end of treatment
  - Note increased pulse before chills develop
  - Hypotension (drop in B/P >30 mm/Hg)
  - Headache/Muscle aches

- Treatment:
  - Remove from dialysis immediately
  - Gather samples of dialysate/blood per company policy

- Prevention
  - Proper disinfection/sterilization
  - Use of aseptic technique
Hypertension

- **Causes:**
  - Fluid overload
  - Non-compliance with blood pressure medications
  - Anxiety
  - Renin overproduction

- **Symptoms: (frequently asymptomatic)**
  - Gradual or sudden rise in BP
  - Headache, blurring vision
  - Nausea/Vomiting
  - Dizziness
  - Seizure

- **Treatment**
  - Review of BP medications
  - Assessment of target weight and fluid removal goal
Technical Complications

- Clotting
- Blood leak
- Power failure
- Hemolysis
- Air Embolism
  - Air in bloodlines
- Exsanguination
- Dialyzer reactions
Clotting in the Extracorporeal Circuit

- Formation of blood clots in the dialyzer and blood lines
- Causes:
  - Inadequate anticoagulation
  - Low blood flow rate
  - Air in blood lines
    - Poor priming techniques
    - Loose connections
Clotting

- **Signs of Clotting:**
  - Increasing venous pressure readings
  - Dark blood in lines or drip chambers
  - Fibrin in drip chambers ("furry" appearance)
  - Visible clots or clumping of dark blood in the drip chamber or dialyzer
  - TMP alarm problems

- **Treatment:**
  - Anticoagulation
  - Vascular access
    - Needle placement
    - CVC problems
Blood Leak

- **Cause:**
  - Membrane rupture allowing RBC’s to cross over the membrane into the dialysate

- **Signs:**
  - Blood leak alarm
  - Positive test for blood in dialysate

- **Interventions**
  - Check dialysate outflow with Blood leak strip
  - If positive, stop treatment, do not return blood
  - If negative may need to get different machine
Power Failure

• Cause:
  – Electricity is disrupted to the machine
    • Storm/tornado/fire/construction
• Signs:
  – Unable to mute alarms
  – Air detector trips, clamping venous line
• Intervention:
  – Know how to free venous line and hand crank blood
  – Company policy
Hemolysis

- Breakdown or destruction of RBC’s
  - Releases potassium from damaged cells into the blood stream
  - Decreasing the oxygen carrying capacity of the RBC
- Potentially life threatening
Causes of Hemolysis

**Mechanical**
- Poorly functioning or incorrectly calibrated blood pump
- Excessive negative pressure in the extracorporeal circuit
- Deformity in lines (kinks, folds, etc)
- Over occlusion of blood pump

**Chemical and Thermal**

**Chemical:**
- Delivery of improperly prepared dialysate
- Dialysate contaminated with chemical agents such as formaldehyde, bleach, chlorine, copper, nitrates and nitrites

**Thermal**
- Overheated dialysate (> 42 degrees C)
Signs of Hemolysis

- **Dialyzer/blood lines:**
  - Cherry colored blood in venous line
- **Patient:**
  - Shortness of breath
  - Chest, abdominal and/or back pain
  - Cardiac arrest
- **Intervention**
  - Stop dialysis and DO NOT return blood to the patient
  - By symptom
Air Embolism

Introduction of enough air into extracorporeal system to stop circulation

- Causes:
  - Empty IV bag
  - Air leak in blood lines
  - Air detector not armed
  - Loose connections
  - Separation of blood lines
  - Patient inhales while central vascular catheter is open to air
  - Pre-safety checks not done or done improperly
Signs and Symptoms of Air Embolism

- **Extracorporeal System:**
  - Air pocket or foam (pink) in venous line

- **Patient:**
  - Coughing, shortness of breath
  - Chest pain or pressure
  - Tachycardia
  - Distended neck veins
  - Cyanosis/Gray color
  - Slight paralysis on one side of body (cerebral)
  - Confusion, convulsions, coma
  - Possible cardiac/respiratory arrest
Treatment of Air Embolism

• Clamp blood lines and stop blood pump
• Place patient in trendelenburg position turning them on their LEFT side
• Treat symptoms:
  – Oxygen to address shortness of breath and chest pain
  – Normal saline to support blood pressure
• Call 911
Air in Bloodlines

• Causes:
  – Under filling drip chambers
  – Empty saline bag
  – Loose connections
  – Dialysis needle removed while blood pump is running
  – Poor priming
Air in Bloodlines

• Signs:
  – Air bubbles/foam in bloodlines
  – Air in blood alarm

• Intervention/prevention
  – Keep level of drip chambers up
  – Replace empty saline bags immediately
  – Tighten connections when priming
  – Tape needles securely
  – Follow correct priming procedure
Exsanguination

Extreme blood loss

• Causes:
  – Blood line separation
  – Needles dislodging from access
  – Rupture of access (at anastomosis or aneurysm)
  – Crack in dialyzer casing/Rupture of dialyzer
  – Loose dialyzer caps/connections

• Symptoms:
  – Blood on the floor or in the chair
    • Obvious bleeding source
  – Hypotension
  – Machine pressure change alarms
  – Shock
  – Seizures
  – Cardiac arrest
Treatment of Exsanguination

• Identify the source of blood loss
• Stop dialysis
  – Return blood if possible (not contaminated system)
• Treat the symptoms:
  – Normal saline to support blood pressure
  – Oxygen for shortness of breath
• Call 911
Dialyzer Reactions

• Causes
  – First use syndrome
  – Hypersensitivity to membrane
Dialyzer Reactions

First Use Syndrome
• Back pain
• Chest pain
• Hypotension
• Pruritis
• Nausea
• Vague discomfort

Hypersensitivity
• Anxiety
• Hives, pruritis
• Dyspnea, wheezing
• Chest tightness
• Possible cardiac arrest
Dialyzer Reactions

• Intervention
  – Stop treatment if anaphylactic response
    • Respiratory distress
    • Cardiac distress
  – Symptom management

• Prevention
  – Use of synthetic membrane
  – Reuse of dialyzers
  – Proper priming of reuse and new dialyzers
QUESTIONS?