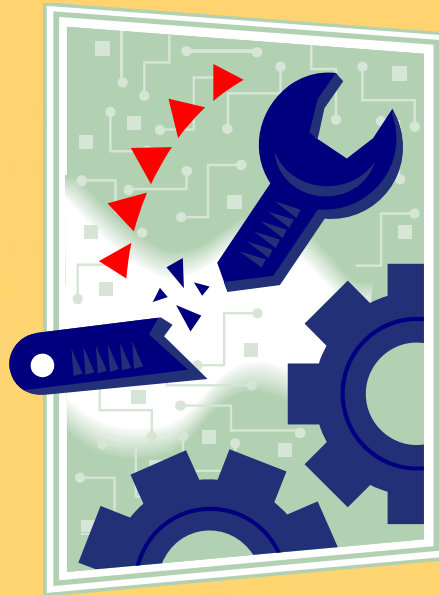


# Complications of Hemodialysis



# 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 patients 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

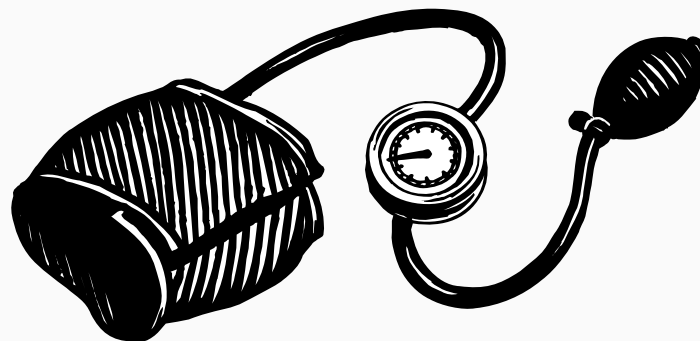
# Patient complications

- Hypotension (20-30%)
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- Nausea and Vomiting
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- Chest Pain
- Itching
- Fever and Chills
- Pyrogen reaction
- Hypertension



# 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



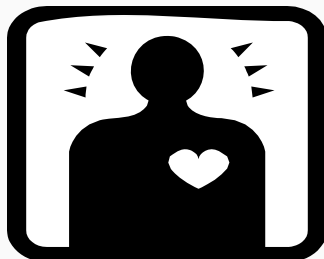
# Headache Treatment

- 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

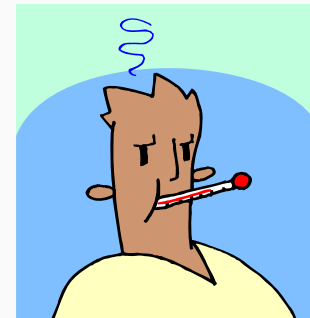
- Treat the symptoms:
  - Hypotension
  - Angina pain with Nitroglycerin
  - MI pain requires analgesics
  - Anxiety/stress
- Prevention
  - Accurate fluid removal and weight assessment

# 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?

