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### ACUTE COMPLICATIONS DURING HEMODIALYSIS

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# WHAT IS MEANT BY ACUTE COMPLICATION?

• ACUTE : SUDDEN ONSET



### TYPES OF ACUTE COMPLICATIONS

- Patient related complications
- Blood related complications
- Dialysate related complications
- Access related complications

#### PATIENT RELATED COMPLICATIONS

- Dialysis Disequilibrium Syndrome
- First use syndrome
- Hypotension
- Hypertension
- Muscle cramps
- Nausea / Vomiting
- Headache

- Angina
- Pruritus
- Fever and chills
- Dyspnea
- Cardiac arrhythmias
- Seizures
- Cardiac arrest

### Dialysis Disequilibrium Syndrome



#### Dialysis Disequilibrium Syndrome

• If BUN is removed much faster from the blood than from the brain, disequilibrium is created and fluid moves into the brain cells.

#### PATHOGENESIS

#### (A) Pre Dialysis



Blood vessel Brain cell

Urea particles



- A. Urea concetration is equal around the blood bran barrier
- B. After Dialysis, Urea concentration in blood vessel get reduced
- C. As a result of high osmolarity in brain cell, fluid shift to the brain cell occurs untill it get balanced As a result there is edema in brain cells. This cause the cerebral edema.

### **RISK FACTORS**

- High serum urea nitrogen level (>150mg/dl)
- Aggressive urea removal during the first hemodialysis treatment
- Children
- Pre-existing neurological impairment
- Metabolic acidosis

### SIGNS AND SYMPTOMS

- Syndrome is usually mild, transient, and self-limited
- Symptoms develop during dialysis, immediately post-dialysis or within 24 hours after completion of dialysis
- Headache
- Nausea with or without vomiting
- Dizziness
- Muscle cramp
- Blurred vision
- Tremors
- Restlessness
- Agitation
- Alteration of consciousness
- Seizure
- Coma
- Sudden cardiac arrest (in severe form, rare)

### DIAGNOSIS

Laboratory tests and imaging studies should be ordered to identify other potential causes:

- *Blood glucose* (to exclude hypoglycemia)
- Serum calcium (to exclude hypocalcemia or hypercalcemia)
- *Serum sodium* (to exclude hyponatremia)
- Head CT scan or brain MRI (to exclude a cerebrovascular accident or subdural hematoma; dialysis disequilibrium syndrome is characterized by diffuse cerebral edema)

#### PREVENTION

- Slow, gentle initial hemodialysis session (aim for an, initial urea reduction ratio goal of 30%, which is equivalent to a single pool Kt/V of 0.6):
- Dialysis time 2 hours
- Blood flow rate 200 mL/min
- Small surface area (low efficiency) dialyzer
- High sodium dialysate/sodium profiling
- An increase in serum sodium level of 2 mEq/L yields an osmotic force equivalent to a serum urea nitrogen level of approximately 11 mg/dL.
- Consider using a fixed dialysate sodium level of 143-146 mEq/L for the initial hemodialysis treatment in high-risk patients
- Bicarbonate dialysate (30 mEq/L)
- Intra-dialytic administration of osmotically active substances
- Intravenous 50% dextrose in water (50 mL)
- Intravenous mannitol (1gm/kg) (optional)

#### TREATMENT

• Same as PREVENTION

• Termination of the dialysis procedure when signs and symptoms are identified.

### FIRST – USE SYNDROME

#### **Dialyzer reactions**

	Type A Anaphylactic	Type B Mild
Incidence	Rare (max 5/100000 dialyses)	Common (3-5/100 dialysis)
Onset	Usually 1 <sup>st</sup> min. Up to 30 min	30-60min
Symptoms	Moderate-severe Anaphylaxis Itching, urticaria, cough, abdominal cramps, dyspnoea, burning collapse, death	Mild Chest pain, back pain
Causes	Ethylene oxide (previously common, now rare; patients often have IgE anti-ethylene oxide antibodies) ACE inhibitors and AN69 membranes (activation of bradykini system by membrane amplified by ACEI Bacterial contamination of dialysis in high flux dialysis Reused dialyzers (bacterial contamination, endotoxin, unknown causes) Heparin allergy (rare) Acetate dialysate	Unknown Complement activation?
Treatment	Stop dialysis immediately Clamp lines and discard Cardiopulmonary resuscitation if necessary Intravenous antihistamines, steroids and adrenaline (SC/IM) if severe	Exclude other causes of chest pain Supportive O2 Continue dialysis
Outcome	Can be fatal-seek cause	Symptoms usually resolve after 30-69 min

### INTRADIALYTIC HYPOTENSION

Definition:

 A decrease in systolic BP ≥20 mm Hg or a decrease in MAP ≥ 10 mm Hg associated with symptoms.



#### CAUSES

#### Excessive decrease in blood volume

- High UFR
- Target dry weight set too low
- Dialysis solution sodium level too low
- Anemia
- Food ingestion

#### Lack of vasoconstriction

- Acetate dialysate
- Warm dialysate
- Autonomic neuropathy
- Antihypertensive drugs
- Anaphylaxis

#### **Cardiac factors**

- Systolic dysfunction
- Diastolic dysfunction
- Age related poor myocardial contractility
- Myocardial calcification
- Amyloidosis
- Pericarditis

#### **RISK FACTORS**

- 1/3 of dialysis patients
- Low body mass
- Poor nutritional status and hypoalbuminemia
- Old age (>65 years)
- Large interdialytic weight gain
- Cardiovascular disease

### SIGNS AND SYMPTOMS

- Gradual or sudden drop in BP which may be associated with dizziness, nausea, vomiting, pallor, perspiration(sweat) or cold, clammy(sweaty) skin.
- An early warning sign may be complaints of *feeling* warm & fanning themselves.
- Yawning
- Feeling faint
- Dizziness upon standing
- Tachycardia
- Loss of consciousness

#### MANAGEMENT

- Trendelenburg position
- Normal saline of 100 ml or as necessary
- Stop UF
- Reduce BFR to 150 mL/min
- Resume UF once BP increases



- As an alternative to saline, glucose, mannitol, or albumin solutions can be used to treat the hypotensive episode.
- IDH may respond better to rapid administration of hypertonic saline (over 2 minutes) than to slower administration (5 minutes).

#### PREVENTION

#### Evaluate and re-fix target dry weight

- Review medications
- Review dietary sodium intake and any other reasons for excess fluid intake. Fluid intake should ideally be <1 L per day in anuric patients</p>
- Avoid food during dialysis
- □ Sodium and UF modeling
- □ Lower dialysate temperature (34-36°C)

#### Advice patient

- To limit weight gain (<1-1.5 kg/day)</li>
- L-Carnitine 20mg/kg/treatment IV/at the end of the session
- Midodrine 2.5-10 mg Oral/30 mins before dialysis
- Sertraline 50-100 mg/day Oral
- □ Switch to Peritoneal dialysis
- Blood volume monitoring

#### Sodium modeling

#### Goal

 To shift water from intracellular to extracellular compartments, where this added water supports circulation

#### Benefit

- Reduced incidences of dialysis disequilibrium, vascular instability, muscle cramps
- ♦ Example
  - First period of dialysis : sodium concentration of 160 mEq/L
  - Second equal period : 120 mEq/L

S/E : greater thirst, interdialytic weight gain, hypertension

#### Linear, Step-wise, and Exponential Sodium Profiles



## Goals of UF Profiling

- Provide adequate ultrafiltration (UF)
- Minimize symptoms related to hypovolemia
- Enhance plasma refill
- Allow the patient to reach estimated dry weight (EDW) Hypovolemia: Decreased blood volume

Plasma refill: Refilling of the blood compartment, or vascular space from the surrounding tissue spaces Hypovolemia: Decreased blood volume leads to decreased cardiac output which can cause hypotension





Multiple of average UF-Rate

Treatment time

#### INTRADIALYTIC HYPERTENSION

Definition :

- MAP of ≥15 mmHg during or immediately post dialysis.
- Hypertension during 2nd or 3rd hr of HD after significant UF removed.

### CAUSES

- Disequilibrium syndrome
- Fluid overload
- Noncompliance with antihypertensive medications
- EPO therapy
- Renin response (hyper reninism)
- Endothelial dysfunction
- Increased dialysate Na+
- Increased sympathetic activity
- Increased cardiac output
- Intradialytic K+ / Ca2+ variations

#### SIGNS AND SYMPTOMS

- Dizziness
- Headache
- Nausea & vomiting
- Edema
- Patients may be asymptomatic

#### MANAGEMENT

- Aggressive UF in the presence of fluid overload.
- Antihypertensive medications
- Phlebotomy if the Hematocrit is >38%
- Low salt diet

### PREVENTION

- Control fluid overload by limiting fluid and sodium intake interdialytically.
- Adhere to antihypertensive medications.
- Establish & maintain an accurate dry weight.
- Sodium modelling

#### MUSCLE CRAMPS

CAUSES :

- Hypotension
- Patient below dry weight
- Use of low sodium diet
- Hypokalemia



#### SIGNS AND SYMPTOMS

- Painful muscle cramps, often in hands and feet.
- Hypotension

#### MANAGEMENT

- Normal saline
- Quinine (to treat malaria)
- Vitamin E
- Reduce UFR
- Massage or apply opposing force
- Hypertonic solutions
- L Carnitine
- Sodium modelling

#### PREVENTION

- Sodium modeling
- Refix target dry weight
- Vitamin E
- L Carnitine
- Prevent hypotension

#### NAUSEA AND VOMITING

- CAUSES :
- Hypotension
- Early manifestation of DDS
- Caffeine/Alcohol withdrawal during dialysis

#### SIGNS AND SYMPTOMS

- Nausea
- Vomiting
- Headache
- Hypotension



#### MANAGEMENT

- The first step is to treat any associated hypotension
- If nausea persists, an antiemetic can be administered.
- Avoidance of hypotension
- Avoidance of disequilibrium
- Avoidance of pyrogenic reactions

### HEADACHE

CAUSES :

- Dialysis Disequilibrium syndrome
- Acetate containing dialysis solution
- Caffeine withdrawal during dialysis
- Hypertension
- Fluid shifts
- Change in sodium levels
- Anxiety / nervous tension



• Pain in the head or face

- Administer Acetaminophen during dialysis
- Caffeine replacement in coffee drinkers
- Antihypertensives in case of hypertension

- Use bicarbonate dialysate
- Same as the preventive measures of hypertension & DDS

### ANGINA



- Chest pain due to low oxygen levels in the heart. CAUSES :
- Coronary artery disease
- Anemia
- Hypotension
- Anxiety

• Chest pain

- Anti anginal drugs can be considered
- Discontinue dialysis if necessary
- Administer oxygen
- Decrease UF
- Assess and treat volume depletion

- Monitor BP closely to avoid hypotension
- Maintain hematocrit
- Calculate the UF goal correctly

# PRURITUS

- CAUSES :
- Uremia
- Decreased sweat and sebaceous gland activity leading to dry skin
- Increased serum phosphorous level
- Secondary Hyperparathyroidism
- Hyper calcemia
- Hepatitis
- Drug induced hypersensitivity
- Histamine release due to an allergic response to such things as heparin, blood tubing plasticizers, and ETO
- Iron deficiency

- Severe generalized itching on and off dialysis, if due to an allergic reaction, itching will be only during dialysis.
- Reddened skin
- Crusting



- Optimization of dialysis dose
- Correction of anemia
- Treatment of Secondary hyperparathyroidism
- Ultraviolet phototherapy
- Topical emollients
- Antihistamines

- Keep skin clean and moisturized
- Adequate dialysis therapy
- Control hyperphosphatemia
- Control hyperparathyroidism
- Correction of iron deficiency
- Switch from ethylene oxide sterilized dialyzers

# FEVER AND/ OR CHILLS

CAUSES :

- Access infection
- Contamination of dialysate
- Too cold dialysate
- Poor aseptic cannulation technique
- Contaminated dialyzer or bloodlines
- Poorly reprocessed dialyzer



- Patient feels cold after initiating dialysis which may include involuntary shaking.
- Fever during dialysis
- Redness, swelling, tenderness, warmth, or drainage from access or other sites (eg, feet, skin wounds)

- Administer Antipyretics (Paracetamol)
- Administer Antibiotics

- Check vital signs.
- Obtain blood cultures & Obtain dialyzer inlet and outlet dialysate cultures as well as water culture of the water entering the delivery system to test water and equipment for bacteria or pyrogens/endotoxins.
- Proper cleaning & disinfection of the dialysis machine.
- Proper dialyzer reuse procedures.
- Proper bicarbonate preparation, storage, and handling procedures as well as bicarbonate container cleaning and disinfection procedures.
- Follow Aseptic technique in the preparation of dialyzer & blood lines. Preparation should not occur more than 2 hours prior to the planned treatment.
- Aseptic technique to be used to initiate dialysis.

# CARDIAC ARRHYTHMIAS

CAUSES :

- Changes in electrolyte levels & blood pH brought about by dialysis, especially potassium.
- Hypotension
- Underlying heart disease
- Dialyzing off antiarrhythmic medications during dialysis
- Low potassium level or rapid drop in potassium in conjuction with digitalis therapy
- Hypoxemia

- Slow or rapid irregular pulse (skipped or extra beats)
- Palpitations

- Antiarrhythmic medications are required
- Give oxygen if needed
- Look/treat electrolyte abnormalities
- Stop UF
- Discontinue dialysis for severe, symptomatic dysrhymias.

- Use a higher dialysate potassium concentration if the patient is on digitalis therapy while restricting dietary potassium to avoid predialysis hyperkalemia.
- Control of hypotension.
- In patients with MI, antianginal prophylaxis may be necessary in addition to alterations in dialysate potassium & calcium levels.
- Appropriate monitoring of heart rate & rhythm.

### SEIZURES

### CAUSES :

- DDS
- Electrolyte imbalances
- Severe Hypotension
- Seizure disorder

- Change in level of consciousness
- Jerking movements of the arms and legs.

- Frequent BP monitoring
- Same as DDS

- Avoid large, rapid drop in BUN during dialysis
- Monitor BP and support during treatment
- Administer anticonvulsant medications

### CARDIAC ARREST

- CAUSES :
- Electrolyte imbalance, especially hyperkalemia
- Dysrhymias
- MI
- Cardiac tamponade
- Large air embolism
- Hemolysis
- Severe blood loss
- Hyperthermia

- Absence of apical or carotid pulse
- Lack of respiration
- Nonresponsiveness
- Asystole or ventricular fibrillation on ECG

- Stop UF
- Return the blood
- Flush access
- Start CPR

- Careful assessment predialysis & during dialysis.
- ECG monitoring of patients considered at risk during dialysis.

### **BLOOD RELATED COMPLICATIONS**

### EXTRACORPOREAL CIRCUIT





- 1. Air in Blood
- 2. Air Embolism
- 3. Blood Loss (Exsanguinations)
- 4. Access recirculation
- 5. Clotting in the extracorporeal circuit
- 6. Needle infiltration

### AIR IN BLOOD

### CAUSES

- 1. Kink in the arterial blood tubing preblood pump resulting in inadequate blood flow through arterial needle.
- 2. Poor connections in EC pre-blood pump
- 3. Low levels in drip chambers.
- 4. Not priming the heparin administration line prior to initiating infusion.
- 5. Not removing all air during dialyzer priming.
- 6. Empty IV containers pre-blood pump left opened to the EC.
- 7. Inadequate deaeration of the dialysate.
- Cold normal saline exposed to dialysate can form a type of condensation resulting in air bubble formation.

### SIGNS & SYMPTOMS

- 1. Air-in-blood alarm.
- 2. Air bubbles or foaming in the blood.
- Pre-blood pump may jump when related to inadequate blood flow through arterial needle.

### AIR IN BLOOD

#### TREATMENT

- 1. Correct cause of air entering the EC.
- Small amounts of air may be removed by the drip chambers & then readjusting their levels as necessary.

- 1. Ensure effective cannulation & adequate anticoagulation to maintain good flow. through the arterial needle throughout the treatment.
- 2. Ensure proper connection of all fittings & that lines remain unkinked.
- 3. Ensure correct dialyzer priming procedures including heparin administration line.
- 4. Ensure correct drip chambers levels are maintained at all times.
- 5. Ensure IV containers are not empty & that they remain clamped when not in use.
- 6. Use IV solutions at room temp only.

### AIR EMBOLISM

### CAUSES

 Disarmed or defective airin-blood detector with air in the EC.

### **SIGNS & SYMPTOMS**

- 1. Air in the EC.
- 2. Chest pain, dyspnea, coughing & cyanosis.
- 3. Visual disturbances including double vision & blindness.
- 4. Neurologic complications including confusion, restlessness, fear, hemiparesis, seizures & coma.
- 5. Death
# AIR EMBOLISM

#### TREATMENT

- 1. Stop blood flow immediately.
- Place patient in trendelenburg position on his/her left side.
- 3. Assess vital signs
- 4. Administer oxygen
- 5. Start CPR.

- Always use the air-in-blood detector when the patient is connected to the EC.
- Carefully visualize the venous blood line if disarming the alarm.

# **BLOOD LOSS**

#### CAUSES

- Blood line separation or needles dislodging from circulatory access.
- Dialyzer membrane leak.
- Dialyzer casing becomes cracked or the header cap is improperly fitted.
- Fistula aneurysm or anastomosis ruptures.

- Visual observation of blood.
   eg:on patient clothing or skin, chair, floor, etc.
- Blood leak detector alarm & possible red-tinged dialysate post dialyzer (if a dialyzer membrane leak).
- Arterial and or venous pressure alarms may occur.
- Hypotension, vomiting, and convulsions.

# **BLOOD LOSS**

#### TREATMENT

- Stop blood pump immediately & clamp blood lines.
- Apply pressure to access if a needle has dislodged.
- Tighten & secure loose fittings if no separation has occurred.
- If a dilayzer membrane leak has occurred, return blood based on severity of leak.
- Assess severity of blood loss & treat patient accordingly including administration of oxygen & volume expander for hypotension.

- Ensure all blood lines & needle connections are secure.
- Tape needles to minimize movement & or the potential for dislodgement.
- Ensure the blood leak detector is properly maintained & calibrated.

### ACCESS RECIRCULATION



# ACCESS RECIRCULATION

#### CAUSES

- 1. Needles are too close togetherless than 2 inch apart.
- 2. Inadequate access flow for the desired blood flow rate.
- 3. Access outflow stenosis & less often inflow stenosis.
- 4. Access thrombosis.
- 5. Tourniquet placed above the venous needle.
- 6. Bloodlines placed backwards. Eg: the arterial line placed on the venous needle.
- 7. Fistula aneurysm.

- 1. Increased pre & post dialysis chemistries.
- 2. Progressive darkening of the blood during dialysis.
- 3. Lightening of the arterial blood during saline infusion through the venous line.
- 4. Change in quality of bruit.
- 5. Possible increase in venous pressure and or reduction in arterial pressures.
- 6. Possible difficulty in establishing prescribed BFR.
- 7. Reduced clotting times & need for increased anticoagulation.

- Ensure proper cannulation & bloodline connection.
- Prompt reporting & follow-up of patient assessment findings & intradialytic observations.

### CLOTTING IN THE EXTRACORPOREAL CIRCUIT



Without fibrin

Presence of fibrin/clot

Difficult/impossible to reinfuse



### CLOTTING IN THE EXTRACORPOREAL CIRCUIT

### CAUSES

- 1. Incorrect and or inadequate anticoagulation therapy.
- 2. Low BFR.
- 3. Hemoconcentration resulting from access recirculation or UF continuing when the blood pump is off.
- 4. Increased Hct.
- 5. Air in the EC.
- 6. Change in the patient's status or medications.
- 7. Clotting disorder.

- Fibrin or clot formation in the EC.
- Blood becomes darker in color.
- If clotting is occurring in dialyzer

   there is increase in post Blood pump arterial pressure & decrease in venous pressure; If clotting is occurring in venous drip chamber – there is increase in venous pressure.
- Progressive lower Hct/Hb.
- Air in EC.
- Poor rinse-back at the end of dialysis.
- Dialyzer volume loss while reuse.

- Administer adequate anticoagulation.
- Adjust anticoagulation according to changes in patient status or treatment parameters.
- Maintain prescribed BFR.
- Prevent and or promptly correct causes of blood related alarms to minimize the time the blood pump is off.
- Correct causes of access recirculation.
- Correct causes of air in EC.

### NEEDLE INFILTRATION



# NEEDLE INFILTRATION

#### CAUSES

- Improper venipuncture technique.
- 2. The needle moves after insertion generally from poor or o secure.
- 3. The patient moves the access extremity.

- Burning or tenderness at the access site.
- Sweeling, hardness & bruising of the access.
- Increased pre-blood pressure if the arterial needle is infiltrated, increased venous pressure if the venous needle is infiltrated.

# NEEDLE INFILTRATION

#### TREATMENT

- Remove needle if necessary & insert a new needle above original site.
- A cold pack can be applied to reduce swelling, after 24 hours warmth should be applied to the site.

- Correct venipuncture technique.
- Securing the needles to prevent movement or displacement.

## DIALYSATE RELATED COMPLICATIONS

- 1. Hemolysis
- 2. Crenation

### HEMOLYSIS

#### CAUSES :

- Hypotonic dialysate
- Overheated dialysate (<43 degree celsius)</li>
- Undetected pre-blood pump arterial pressure in excess of -250mmHg.
- Chloramines, copper or nitrates in the water used to prepare dialysate.
- Formaldehyde or bleach in the dialysate; Formaldehyde in reprocessed dialyzers.
- Other nondialysate related causes include a rapid bolus of hypotonic solution, improper occlusion of the blood pump rollers, & kinks in tubing post blood pump.



- Tightness in the chest & dyspnea.
- Back pain
- Hypotension
- Cherry kool-aid appearance of the blood.
- Pain & burning at the venous access site
- Decrease in hematocrit
- Hyperkalemia
- Dysrhythmias
- Seizures
- Cardiac arrest

- SIGNS & SYMPTOMS FOR HYPOTONIC DIALYSATE INCLUDE :
- Warmth in throat
- Erratic BP
- Throbbing headache
- Anxiety & restlessness
- Nausea, vomiting, abdominal cramping, diarrhoea.
- SIGNS & SYMPTOMS FOR HYPERTHERMIC DIALYSATE INCLUDE :
- Patient complains of feeling hot in the skin & may feel dry.
- Headache & delirium
- Rapid, weak respiration
- Derangement of normal clotting mechanisms
- Increased WBCs as a result of physiologic stress.
- Lactic acidosis from anaerobic metabolism & hemolysis.

# HEMOLYSIS

#### TREATMENT

- Discontinue dialysis.
- Immmediately clamp the venous blood line & DO NOT return the blood to patient.
- Monitor vital signs, place on an ECG & observe for dysrythmias, hypotension, & shortness of breath.
- Check patients Hct & electrolytes as well as dialysate electrolytes.
- Administer oxygen
- Replace volume and or blood transfusion if symptoms are severe.

- Carbon filtration in water treatment system to remove chloramines.
- Routine cleaning of concentrate containers, lines and filters.
- Verify actual temperature and conductivity values.
- Monitor pre-blood pump arterial pressure and establish an alarm limit of < 250mmHg.</li>

### **CRENATION** (Shrinking of RBCs)





### CRENATION

- CAUSES :
- 1. Hypertonic dialysate
- 2. Rapid bolus of hypertonic saline for muscle cramps or hypotension.



# CRENATION

### **SIGNS & SYMPTOMS**

- Very dark red blood
- Hypernatremia
- Intracellular dehydration & hyperosmolality-contraction in cell size.
- Gradient for calcium influx occurs.
- Contracted or expanded extracellular volume.
- Headache
- Nausea

- Routine cleaning of concentrate containers, lines & filters.
- Verify actual coductivity values.
- Regular preventive maintenance of conductivity control systems, monitors, alarms & bypass systems.
- Hypertonic saline is best administered in 1:1 dilution with NS over 30 seconds.

### ACCESS RELATED COMPLICATIONS

- 1. Internal access infection
- 2. Central venous access infection
- 3. Internal access thrombosis
- 4. Central venous catheter thrombosis
- 5. Aneurysm
- 6. Pseudoaneurysm
- 7. Steal syndrome

# THANK YOU..



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