Dialysis Complications

Chemicals in Dialysis

Dialysis Complications

Air in Blood

Cause	S & S	Prevention	Treatment
Too high QB for access, Loose connection, Low level in Arterial Drip Bulb, Inadequate priming procedure NS bag empty	Foam in Blood Air/Foam detector alarm	ID Access Problems Check connections	Correct cause of air entering system Remove air from system, by recirculation if necessary

Air Embolism

Cause	S & S	Prevention	Treatment
Disarmed or defective air bubble detector, with air in the blood lines	Air past the detector, SOB, Coughing, Cyanosis, Confusion, Seizure, Death	Use air detector!	Clamp Venous line, put patient Left Side Down (LSD), O2, Call 911, CPR may be needed

Blood Loss

Cause	S & S	Prevention	Treatment
Blood line separation, Dislodged Needle, Cracked dialyzer, Major blood leak	Observation of blood, Blood leak detector alarm, A/V Pressure alarm, Hypotension	Ensure tight blood line connections, access visibility, inspect dialyzer	Clamp lines, control bleeding, NS, blood transfusion

Clotting

Cause	S & S	Prevention	Treatment
Inadequate anti-coagulation, low blood flow rates, air in system	Blood darker than normal, VP or TMP alarm, poor rinseback	Adequate heparinization maitntain prescribed blood flow, avoid air in blood	Change out blood line or dialyzer as needed, re-assess anti-coagulation needs

Hypotension

Cause	S & S	Prevention	Treatment
Excessive UF, Anti-hypertensives, Poor Cardio vascular status	Gradual or sudden drop in BP, N/V, Yawning, flush or warm feeling	Correct EDW, Correct pre dialysis wt., with-hold BP meds, use NA profiling	Turn off UF, put patient in trendelenburg, give NS of other volume expander,

Hypertension

Cause	S & S	Prevention	Treatment
Fluid Overload, Inadequate BP Meds, Renin response	Dizziness, H/A, N/V, Edema, High measured BP	Control fluid and NA, Accurate EDW, Adjust BP Meds	Remove fluid, review EDW, review BP Meds, Nephrectomy (last resort)

Muscle Cramps

Cause	S & S	Prevention	Treatment
Excessive fluid removal, Osmotic gradient	Sever pain in muscles, calf muscles most often	Diet and fluid restrictions, NA modeling	Hypertonic Saline, NS, Return blood, massage muscle

Nausea & Vomiting

Cause	S & S	Prevention	Treatment
Hypotension, DDS, Microbiologic contamination	Pt complaint, vomiting	Close assessment of vital signs, don't eat on the run, avoid DDS	Minimize UF, trendelenburg, NS, medications

Headache

Cause	S & S	Prevention	Treatment
DSS, Fluid shifts, Hypertension Caffeine, withdrawal, anxiety	Pt Complaint of head pain	Depends on cause	Acetaminophen

Angina

Cause	S & S	Prevention	Treatment
Hypotension, Anemia, Cardio-vascular disease, anxiety	Chest pain	Asses EDW, accurate UF, maintain Hct.	D/C Dialysis, O2, nitro, minimize UF, treat hypotension

Fever and Chills

Cause	S & S	Prevention	Treatment
Micro-biological, either sepsis or endotoxin. Exposure from Reused Dialyzer, water, or cannulation	Fever, rigors, feels cold, hypotension. Probably pyrogenic if temp increases by 2 deg, with absolute > 100	Proper H2O treatment maintenance and reuse procedures. Aseptic technique when initiating dialysis	D/C dialysis, assess source of infection, administer antibiotics

Dialysis Dis-equilibrium Syndrome (DDS)

Cause	S & S	Prevention	Treatment
Too rapid removal of BUN. Brain cells swell from osmosis	HA, N/V, hypertension, restlesness, convulsions, coma, death	Short, frequent dialysis, concurrent dialysate flow	Termination of treatment

First Use Syndrome

Cause	S & S	Prevention	Treatment
Complement activation by dialyzer membrane or ETO	CP, Back Pain, Hypotension, SOB, N/V	Reuse dry dialyzer, use dialyzer sterilized with Gamma Radiation	D/C dialysis, change dialyzer order

Anaphylaxis

Cause	S & S	Prevention	Treatment
ETO sensitivity, medication reaction	Bronchio restriction, Anxiety, SOB, facial edema, respiratory difficulty, cardiac arrest, death	Rinse dialyzer well, test dose of high risk medication (IV Iron)	Manage S&S, teminate dialysisi, DO NOT RETURN BLOOD

Seizures

Cause	S & S	Prevention	Treatment
DDS, Electrolyte imbalance, Hypotension, Medication reaction	Jerking of arms and legs, can easily swallow tongue, eyes roll back	Avoid rapid BP drop, Minimize BUN drop (new patients), proper dialysate composition	Anti-convulsive meds

Cardiac Arrest

Cause	S & S	Prevention	Treatment
Electrolyte imbalance (K), arrhythmia, MI, Air embolism, exanguination	No pulse, no breath, unresponsive to EKG	Prevent causes	CPR, Return Blood, analysis of blood line and machine

Hemolysis

Cause	S & S	Prevention	Treatment
Hypotonic Dialysate, Overheated Dialysate, Pressure in bloodlines, Disinfectants, Copper, nitrates	Tightness in Chest, SOB, Back Pain, Hypotension, Cherry Pop colored blood, decrease Hct/Hgb, Seizures, cardiac arrest	Proper water treatment, maintain dialysis machines, test before treatments, verify absence of sterilant	Clamp Venous line, D/C Dialysis, DO NOT RETURN BLOOD!, Draw K+ & Hct, Give O2, replace volume, Dialysis

Access Recirculation

Cause	S & S	Prevention	Treatment
Low flow in access, too high Blood Flow Rate, Needles too close together, Lines hooked up backwards	Dark red blood, Arterial blood lightens after NS bolus, increased clotting	Ensure proper cannulation and hook up of lines, Monitor access function	Resolve cannulation or hook up issues, surgically restore or replace access

Infiltration

Cause	S & S	Prevention	Treatment
Improper Cannulation, Movement during dialysis	Pain, swelling, bruising, change in V or A Pressure reading	Proper Cannulation, Minimize movement during dialysis	Remove needle, put ice on site, restick away from infiltration

Access Infection Internal

Cause	S & S	Prevention	Treatment
Break in Aseptic Technique, Poor Hygiene, Seeding from another infection	Redness, Swelling, drainage from site, Fever, Chills	Good technique, don't stick inflamed area, Pt education	Draw blood cultures, Antibiotics, Surgical revision

Access Infection
Central Catheters

Cause	S & S	Prevention	Treatment
Poor Hook up technique, Colonization of fibrin sheath, tunnel, or exit site	redness, swelling, tenderness, and drainage, fever, exit site warmth.	Aseptic Technique, frequent catheter care, antibiotic ointment	Culture site, Antibiotics, catheter replacement

Hazardous Chemicals

Most hazardous chemicals in dialysis are disinfectants

A disinfectant is a chemical that has the ability to kill most, but not all of the microorganisms present.

Why are disinfectants so important in dialysis?

Disinfectants…….

- Minimize dialysis patient's exposure to toxins or bacterial by-products in water or dialysis equipment
- Improve the standard of patient care

However when used improperly,

- the disinfection process will be ineffective
- and the disinfectants themselves can cause great harm!!

Commonly Used Dialysis Disinfectants

- Peracetic Acid (PAA)
- Formaldehyde
- Glutaraldehyde
- Chlorine and/or Chloramine
- Ozone
- Citric acid

Peracetic Acid (PAA) Disinfectants

- Stabilized mixture of hydrogen peroxide and peracetic acid
- $CH_3C(O)OOH$

Uses for PAA Disinfectants

Use	Peracetic Acid Concentration	Time (minimum)	Temp
Dialyzer reuse	3.25%	11 hours	$\leq$ 21°C
Dialysis Machine Disinfection	0.5%	30 minutes	
Water Distribution Lines	0.5%	30 minutes	25°C
Bicarb Mixing & Delivery System	2%	2 hours	25°C
RO machines	0.75% - 1%	30 minutes	$\leq$ 25°C
*Always refer to the manufacturer's instructions for disinfectant concentration, temperature and dwell times as these parameters may change from one manufacturer to another			

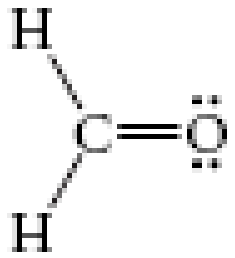
Composition of PAA Disinfectants

Chemical	**% Hydrogen Peroxide and PAA**	**Ratio of Hydrogen Peroxide to PAA**
Actril®	0.8% Hydrogen Peroxide 0.06% Peracetic Acid	13.3:1
Renalin®	20% Hydrogen Peroxide 4% Peracetic Acid	5:1
Minncare®	22% Hydrogen Peroxide 4.5% Peracetic Acid	4.8:1
Peracidin™	27% Hydrogen Peroxide 4.5% Peracetic Acid	6:1

Formaldehyde

- Formaldehyde is available as a solution of ~37% by weight formaldehyde gas in water with ~10% methanol added to prevent polymerization

- CH_2O



Uses for Formaldehyde Disinfectants

Use	Formaldehyde Concentration	Time (minimum)	Temp
Dialyzer reuse	4%	24 hours	20°C
	1% to 2%	24 hours	40°C
Dialysis Machine	1.5% - 2.0%	overnight	37°C
Water Distribution Lines	2%	1 hour	25°C
Bicarb Mixer & Delivery System	2%	2 hours	25°C
RO machines	4%	2 hours	25°C

*Always refer to the manufacturer's instructions for disinfectant concentration, temperature and dwell times as these parameters may change from one manufacturer to another

Glutaraldehyde Disinfectants

- Glutaraldehyde is a colorless liquid used for cold sterilization
- $C_5H_8O_2$
- Brand name - Diacide® and Diacide® HD
- Water soluble $\Rightarrow$ less rebound

Uses for Glutaraldehyde Disinfectants

Use	Glutaraldehyde Concentration	Time (minimum)	Temp
Dialyzer	0.8%	15 min	20°C
Dialysis Machines	0.75%	15 min	20°C

*Always refer to the manufacturer's instructions for disinfectant concentration, temperature and dwell times as these parameters may change from one manufacturer to another.

Chlorine Disinfectants

- Clorox or other bleach solutions containing

  Do not use bleach containing sodium hydroxide
- Amuchina
  - Alcavis 100 for dialysis machines & equipment
  - ARM Clean for dialyzer reuse
- 500 ppm use-dilution

Uses for Chlorine Disinfectants

Use	Chlorine Concentration	Time	Temp
Water Treatment System	500 ppm	2 hours	25°C
Water Distribution Lines	500 ppm	2 hours	25°C
Dialysate Mixing & Delivery System	500 ppm	2 hours	25°C
Dialysis Machine Disinfection	500-750 ppm	30-40 mins	25°C
*Always refer to the manufacturer's instructions for disinfectant concentration, temperature and dwell times as these parameters may change from one manufacturer to another			

Ozone

For adequate disinfection of water treatment systems the NANT Dialysis Technology manual recommends

- 1 ppm ozone for 10 minutes
- 0.5-ppm ozone for 20 minutes

Citric Acid & Heat

- In the presence of biofilm, heat & citric acid is effective for reducing both bacteria and endotoxin concentrations.

Citric Acid & Heat

Use	Concentration	Time	Temp
Dialyzer reuse	1.5%	21 hrs	95°C
Dialysis Machine	10% - 50%		95°C

*Always refer to the manufacturer's instructions for disinfectant concentration, temperature and dwell times as these parameters may change from one manufacturer to another

Disinfectant Standards for Hemodialysis

What is a Standard?

- A practice or a product widely recognized or employed, especially because of its excellence. A level of requirement.

- In hemodialysis, many of the standards are voluntary

Who sets the Standards?

1. **AAMI - Association for the Advancement of Medical Instrumentation**

   Alliance of healthcare professionals, industry representatives and government officials dedicated to the understanding and beneficial use of medical device technology.

Who sets the Standards?

2. **Dialysis Industry**

   The collective expertise of healthcare professionals, industry representatives, medical device manufacturers and government officials

AAMI Standards & Guidelines

- Standards - information supplied by the medical device manufacturer to ensure safe & effective use in the clinical environment
- Guidelines - procedures & practices to help ensure the device is used safely and effectively & its performance is maintained

Standards for Disinfectants

Disinfectant	Potency	Residual
Peracetic Acid	1% –3.5%	<3 ppm
Formaldehyde	4%	<5 ppm
	0.8% - 1.0%	
Glutaraldehyde	0.8%	<2 ppm
Bleach (NaOH)	0.25% - 0.50%	<0.5 ppm
Free Chlorine	Not Applicable	<0.5 ppm
Chloramine	Not Applicable	<0.1 ppm
Ozone	PMI*	PMI*
Citric Acid & Heat	1.5% - ?? %	

Disinfectant Tests Used in Hemodialysis

Format of Disinfectant Tests

- Liquid colorimetric tests
- Powdered colorimetric tests
- Dry-reagent test strips or papers

Format of Disinfectant Tests

Tests can be read visually by

- observing for the development of color
- comparing the reacted test to a color standard

Some liquid tests can also be read electronically using a meter

Proper Storage & Handling

Deviation from the storage conditions can result in deterioration of the test's performance.

Poor treatment = Poor performance

Proper Storage & Handling

- Protect all tests from heat
- Protect dry-reagent test strips from humidity
- Keep strips in original container
- Recap bottles immediately

Proper Storage & Handling

Only use product within the Expiration Date

- Shelf Life - the time limitation within which a device is fit for its intended use when stored per its labeling

- Use Life - the period of time the test strips will still perform to specifications after opening and closing the bottle during typical usage

Test abuse

1. Leaving cap off the bottle of strips
2. Not storing product in refrigerator

Selecting the Right Disinfectant Test

You have to know:

- the disinfectant are you testing for
- what is the target concentration of the disinfectant for a particular use
- what sensitivity and specificity do you require
- is the test specifically developed, labeled and tested for use in dialysis

Performance Characteristics

- Sensitivity
- Specificity
- Potency or Residual
- Quantitative, Semi-quantitative, Qualitative

Technique

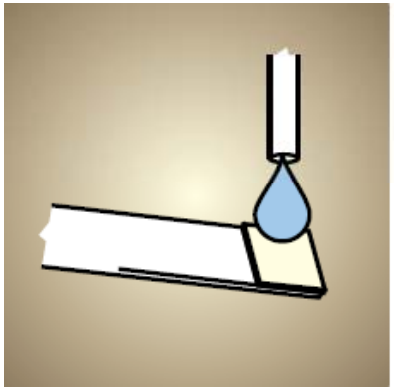
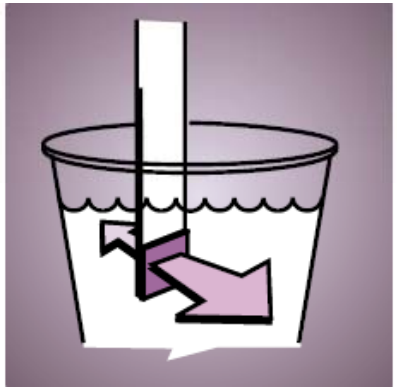
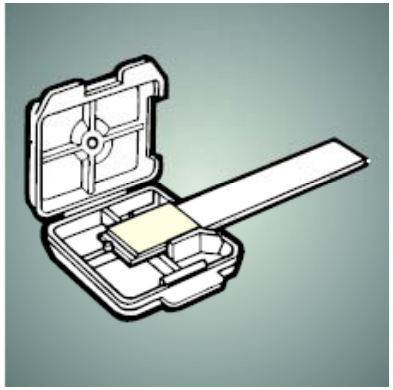
Disinfectant tests are quick & easy to use, compared to the alternative.

However……

Simple to use ≠ don't follow instructions

Technique

- Follow the “Directions for Use” closely

Interpretation of Results

- Variations in the read time can affect the accuracy
- Variation in lighting conditions is another factor that may affect test results.
- Your color perception can also affect interpretation of test results.

Test Strip Technical Tips

- Proper use & testing of disinfectants
- Read insert
- Instructions for use

Inappropriate Tests

- Starch paper
- HemaStix Urine Strips
- CliniTest Urine Tablets