



PROVINCIAL STANDARDS & GUIDELINES



Hemodialysis Guideline Nursing Management of Complications during Hemodialysis

Updated July 2024
Approved by BC Renal Hemodialysis Committee



Table of Contents

| | | |
|--------|-----------------------------------------------------------------|----|
| 1.0 | Scope of Guideline | 1 |
| 2.0 | Recommendations | 1 |
| 2.1 | Air in Bloodline | 1 |
| 2.2 | Air Embolus | 2 |
| 2.3 | Anaphylaxis | 2 |
| 2.4 | Blood in Dialysate..... | 3 |
| 2.5 | Cardiac Arrest (Intradialytic) with Resuscitation | 4 |
| 2.6 | Chest Pain (Intradialytic) in Dialysate | 4 |
| 2.7 | Clotted Extracorporeal Circuit | 5 |
| 2.8 | Immediate Reaction to Dialyzer / Membrane..... | 6 |
| 2.9 | Disequilibrium Syndrome | 7 |
| 2.10 | Hemolysis..... | 7 |
| 2.11 | Intradialytic Hypotension..... | 8 |
| 2.12 | Muscle Cramps..... | 11 |
| 2.13 | Nausea / Vomiting | 12 |
| 2.14 | Pyrogenic Reaction | 12 |
| 2.15 | Seizure..... | 13 |
| 2.16 | Vascular Access Complications..... | 14 |
| 2.16.1 | VA Disconnection/Needle Dislodgement (Arterial or Venous) | 14 |
| 2.16.2 | Acute VA Rupture/Hemorrhage (AVFs/AVGs) | 15 |
| 2.16.3 | Infiltrated Needle while on Dialysis | 16 |
| 3.0 | Sponsors..... | 17 |
| 4.0 | References | 17 |

IMPORTANT INFORMATION

This BC Renal guideline/resource was developed to support equitable, best practice care for patients with chronic kidney disease living in BC. The guideline/resource promotes standardized practices and is intended to assist renal programs in providing care that is reflected in quality patient outcome measurements. Based on the best information available at the time of publication, this guideline/resource relies on evidence and avoids opinion-based statements where possible; refer to www.bcrenal.ca for the most recent version.





For information about the use and referencing of BC Renal provincial guidelines/resources, refer to bcrenal.ca/health-info.



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1.0 Scope of Guideline

This guideline makes recommendations on the nursing management of complications during hemodialysis. An attempt is made to list the steps in sequential order; however, in reality, many of these steps are performed simultaneously depending on the clinical situation.

Applicability: In centre and community hemodialysis (HD) units

2.0 Recommendations

Recommendation #1: Implement the recommendations on the next set of tables for the nursing management of complications during hemodialysis.

2.1 Air in Bloodline

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Air in bloodline ^{2,34} | <ul style="list-style-type: none"> • Connections and caps loose within the extracorporeal circuit • Improper priming of dialyzer and bloodlines • Incorrect system settings • Clamp to the medication line left open upon accessing • Cracked catheter • Empty air vented IV bottle (e.g., albumin) • Defective manufactured product (e.g., small hole or puncture in the bloodline; flaw in dialysis needle/angiocath) • Low levels of blood in arterial or venous drip chambers | <ul style="list-style-type: none"> • Visible air in lines • Air detector alarm <p>If not remedied, potential to cause air embolism and circuit clotting.</p> | <ul style="list-style-type: none"> • Turn blood pump off • Immediately clamp patient's access and machine bloodlines • Investigate cause and magnitude of air in circuit • Secure any loose connections and clamp vented IVs • If air is noted after venous sensor, attach empty sterile syringe to patient's access and aspirate any air, if possible. Clamp • Keep access patent while troubleshooting as per HA protocol • If unable to clear or remove air from bloodline, do not return blood and use a new set up • Follow machine-specific guidelines as to how to remove the air from the circuit |

2.2 Air Embolus

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Air embolus^{1,4}</p> <p>Definition: An air embolism, also known as a gas embolism, is a blood vessel blockage caused by one or more bubbles of air or other gas in the circulatory systemⁱ</p> | <ul style="list-style-type: none"> Loose connection or leak in the extracorporeal circuit Open clamp during catheter care Accidental disconnection of vascular access Air entrapment during CVC insertion or removal Air infused during improper reinfusion Defective or faulty air detector on HD machine Faulty blood line | <ul style="list-style-type: none"> Patient complains of hearing the sound of a train or rushing air Visible air/foam in venous blood Chest pain, dyspnea, coughing, cyanosis Visual disturbances Churning sound on auscultation of heart Neurologic deficits: confusion, coma, hemiparesis Loss of consciousness Cardiac/respiratory arrest | <p>Immediate management of patient:</p> <ol style="list-style-type: none"> Turn off blood pump and DO NOT RETURN BLOOD Immediately clamp all lumens of patient's access & ALL bloodlines Place patient in a head down, feet up position on their LEFT side. Disconnect bloodlines & aspirate any remaining air with a 10cc syringe from both lumens beginning with the VENOUS lumen Check SpO2. As needed, place patient on high flow oxygen mask (100% oxygen). Monitor SpO2 Obtain assistance. Initiate resuscitation procedures, including calling Code Blue or 911, if indicated. Call MD/NP <p>Explore possible causes of air embolus: Refer to column 2 (Possible Cause(s)).</p> |

2.3 Anaphylaxis

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Anaphylaxis⁵</p> <p>Definitions: Anaphylaxis is a potentially life-threatening allergic reaction that is rapid in onset. Anaphylaxis occurs with exposure to a trigger in a susceptible individual. Onset of symptoms usually occurs in minutes but can occur hours after exposure to a trigger. Death from anaphylaxis occurs as a result of severe respiratory complications, cardiovascular collapse, or bothⁱⁱ</p> | <p>May be allergic or non-allergic:</p> <ul style="list-style-type: none"> Allergic causes include medications, iron, latex, food, etc. If suspect dialyzer/ membrane allergy, refer to Immediate Reaction to Dialyzer/ Membrane Non-allergic causes include idiopathic anaphylaxis & anaphylactoid reactions (e.g., response to opiates, NSAIDs & radiocontrast dyes/ agents) | <p>Skin:</p> <ul style="list-style-type: none"> Angioedema and tingling to face and mouth Hives – may be delayed <p>Anaphylaxis can occur without presence of hives</p> <ul style="list-style-type: none"> Warm, itchy, red and blotchy <p>Respiratory:</p> <ul style="list-style-type: none"> Labored breathing - Hoarse voice, throat tightness, rapid breathing, wheezing, coughing, nasal flaring, nasal and chest congestion Rhinitis (stuffy or runny nose, itchy watery eyes and sneezing) Dyspnea – difficulty filling lungs | <ol style="list-style-type: none"> Assess client for signs & symptoms of anaphylaxis: <ul style="list-style-type: none"> Circulation, airway, breathing (CAB) Skin, mental status and GI Remove/stop offending agent/drug (if possible) Stop dialysis. Return the patient's blood to the patient. Maintain HD access until an adequate alternative is available Promptly perform simultaneously the following actions: <ul style="list-style-type: none"> Administer Epinephrine intramuscular (IM) as per MD/NP order/HA protocol <ul style="list-style-type: none"> Adults (14 yrs and older): 0.5 mg (of 1 mg/mL) IM mid lateral thigh Children (under 14 yrs): 0.01 mg/kg of 1 mg/mL to max 0.5 mg/dose IM mid lateral thigh Call Code Blue or 911 Reassess Circulation, Airway, Breathing (CAB) Administer oxygen for hypoxia if available. <p>Goal: SpO2 above 92%</p> |

ⁱ https://en.wikipedia.org/wiki/Air_embolism

ⁱⁱ Anaphylaxis: Initial emergency treatment by nurses (adult and pediatric) Clinical Decision Support Tool; http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Immunization/Vaccine%20Info/Anaphylaxis-Provincial_DST.pdf

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p><i>Anaphylactoid reactions</i> produce a clinical presentation similar to anaphylaxis but are not IgE mediated and occur through a direct nonimmune-mediated release of mediators from mast cells or direct complement activation</p> <p>If dialyzer is the suspected cause, refer to “Dialyzer reaction/membrane incompatibility”</p> | | <p>Cardiovascular:</p> <ul style="list-style-type: none"> • Weak and rapid pulse • Hypotension is less common in children • Hypotension alone after an exposure can represent anaphylaxis • Shock <p>Gastrointestinal:</p> <ul style="list-style-type: none"> • Nausea, vomiting, abdominal pain or cramping and diarrhea • Dysphagia (difficulty swallowing) and drooling in children <p>Other:</p> <ul style="list-style-type: none"> • Sudden lack of energy (lethargy), quietness or sleepiness in children • Headache, dizziness or light-headedness, decreased level of consciousness. Anxious or feeling of “impending doom”. Uterine cramps | <ul style="list-style-type: none"> • Place in recumbent position / elevate legs if possible • Call MD/NP <ol style="list-style-type: none"> 5. Continuous observation: Vital Signs Q5 minutes until transfer of care 6. Repeat Epinephrine (IM) Q5 minutes PRN x 2 doses as per MD/NP order/ HA protocol for ongoing signs and symptoms of anaphylaxis 7. Connect IV line with attached bag of normal saline to venous needle/lumen 8. Provide handover to Code Team or Paramedics: Time of onset and nature of symptoms <ul style="list-style-type: none"> • Interventions provided including timing and amount of epinephrine • Response to treatment |

2.4 Blood in Dialysate

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Blood in dialysate ^{2,6-8} | <ul style="list-style-type: none"> • Fractured dialyzer membranes • Cracked or faulty dialyzer headers • Hemolysis <p>May also be a false alarm which might have been caused by a faulty blood leak detector</p> | <ul style="list-style-type: none"> • “Blood in dialysate” alarm (HD machine) • Visible blood in outflow dialysate hose • Positive chemstrip | <ol style="list-style-type: none"> 1. Stop dialysis and clamp bloodlines and patient access 2. Check vital signs 3. Inspect the dialyzer and outflow dialysate hose for blood leak 4. If no visible blood leak, remove dialysate hose from the connector port & test dialysate outflow fluid with test strip (e.g., Chemstrip, Hemastix®) 5. If test strip negative, restart dialysis and increase blood pump slowly. If alarm reoccurs, test again with test strip 6. If chemstrip tests positive OR blood is visible, treat as blood leak: <ol style="list-style-type: none"> a. Do not return patient’s blood b. Contact MD/NP re: recommencing dialysis with new dialyzer and new machine and possible bloodwork (e.g., potassium) and prophylactic antibiotics c. Monitor vital signs d. Review recent bloodwork and notify MD/NP of blood loss as patient may require complete CBC to be drawn at next HD treatment e. Do heat and chemical disinfection on the original machine (do not run any other patients on this machine until disinfected) f. Record dialyzer lot number & retain dialyzer for post-investigation by the vendor g. Inform MD/NP, charge nurse & biomed of all blood leaks |

2.5 Cardiac Arrest (Intradialytic) with Resuscitation

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Cardiac arrest (intradialytic) with resuscitation ^{9,10}</p> <p>Definition: Sudden cardiac arrest is the sudden, unexpected loss of heart function, breathing and consciousness. Sudden cardiac arrest usually results from an electrical disturbance in your heart that disrupts its pumping action, stopping blood flow to the rest of your body ⁱⁱⁱ</p> | <ul style="list-style-type: none"> • Electrolyte/acid-base imbalance • Dysrhythmias • Myocardial infarction • Hypoxemia • Large air embolus • Pulmonary embolus • Hemolysis • Exsanguination • Hypotension • Hypovolemia • Hypoxia • Acidosis • Hypoglycemia • Hypothermia • Hyperthermia/overheated dialysate • Tension pneumothorax • Tamponade | <ul style="list-style-type: none"> • Absence of apical/ carotid or femoral pulse • Lack of spontaneous respiratory effort • Unresponsive to stimuli • Asystole or ventricular fibrillation on cardiac monitor | <p>Promptly perform simultaneously the following actions:</p> <ul style="list-style-type: none"> • Shout for help from other staff members – do not leave the patient • Review MOST if available • Notify MD/NP. • Call CODE BLUE/911: <ul style="list-style-type: none"> • In-centre units: Call CODE BLUE • Community Dialysis Units (CDUs): Call 911 or CODE BLUE as per unit policy • Commence CPR & activate the emergency resources used for cardiac arrest • Stop dialysis. Return blood to patient if safe to do so & bolus of 0.9% NaCl PRN. Disconnect bloodlines from patient's access. Connect IV line with attached bag of NS to venous needle/lumen • Flush with normal saline. Cap off other needles/ lumens • Move dialysis machine away from area if possible. • Secure access until transfer of care per CODE or 911 team, then remove needles/cap CVC (once alternate access established) • Patient's assigned nurse to provide handover • Delegate nurse to record CODE events • Follow health authority protocol for follow-up of patient |

2.6 Chest Pain (Intradialytic)

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Chest pain (intradialytic) ^{2,4,11,12}</p> | <p>Cardiac causes:</p> <ul style="list-style-type: none"> • Underlying coronary artery disease with demand ischemia from low BP, high ultrafiltration rate, anemia • Myocardial infarction • Angina • Arrhythmia <p>Differential diagnosis:</p> <ul style="list-style-type: none"> • Pulmonary embolus • Air embolism • Hemolysis • Pericarditis • Dialyzer reaction • Fluid overload • Infection • Disequilibrium syndrome • Musculoskeletal • GERD | <p>General: pain or tightness in the chest, back, arm or jaw which may be accompanied by nausea, dyspnea and diaphoresis</p> | <p><i>Management:</i></p> <ul style="list-style-type: none"> • Place machine in minimum ultrafiltration rate (UFR) • Decrease pump speed to 250 ml/min • Assess vital signs • Assess nature of chest pain, including location, radiation, character, severity, exacerbating or relieving factors, duration and frequency and associated symptoms (e.g., syncope) • If chest pain accompanied by hypotension &/or hemodynamically unstable: <ul style="list-style-type: none"> • Position in supine with raised legs as tolerated, or lay flat if respiratory status allows • Return patient's blood and administer 0.9% NaCl 250 mL. • Call MD/NP. • If hypoxemic (SpO₂ <92% on room air), administer oxygen at 1-5L/min via nasal prongs or simple mask at 6-10L/min. |

ⁱⁱⁱ Mayo Clinic, <https://www.mayoclinic.org/diseases-conditions/sudden-cardiac-arrest/symptoms-causes/syc-20350634>

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| | | | <ul style="list-style-type: none"> • Titrate oxygen to achieve SpO2 >92% • If blood pressure is not substantively reduced when chest pain manifests: <ul style="list-style-type: none"> • If ordered, administer 1 - 2 sprays nitroglycerin (NTG) SL • If not resolved in 5 min and upon MD/NP order, repeat NTG SL Q5 min as necessary for a maximum of 3 doses. If still not resolved, call MD/NP and prepare patient for transfer of care/specialty consultation • Arrange investigations as ordered by MD/NP. e.g., troponin and STAT ECG, Hgb level • If chest pain resolves or a non-cardiac cause established, proceed with UFR and dialysis as directed by MD/NP <p><i>Prevention:</i></p> <ul style="list-style-type: none"> • Assess UF goal and ultrafiltration rate, and estimated dry weight • Avoid high UF rates |

2.7 Clotted Extracorporeal Circuit

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Clotted extracorporeal circuit ^{2,13,14} | <ul style="list-style-type: none"> • Inadequate heparin • Changes to systemic anticoagulation therapy (e.g., warfarin) • Inadequate blood flow/ blood pump speed during dialysis • Single needle dialysis • Kinked tubing, line clamps, infiltrated needle, etc • Hemoconcentration due to excess fluid loss • Elevated hemoglobin (high hematocrit) • Transfusion of PRBCs or parenteral nutrition with lipids • Change in dialyzer type (dialyzer new to patient) • Incomplete priming of dialyzer • Air in bloodline • Frequent pump stops during run | <ul style="list-style-type: none"> • Rising venous/ arterial pressures • Dropping venous pressure • Change to transmembrane pressure (TMP) • Decrease in dialysis clearance • Upon flushing circuit, visible streaking in dialyzer or clot/ dark red blood in the circuit • Transducer monitors filling rapidly with blood (older machines) | <ul style="list-style-type: none"> • If anticoagulant-free HD, intermittently flush circuit to visualize presence of clot(s) in chamber or dialyzer as per HA protocol. • Rule out causes such as kinked/occluded tubing, infiltrated needle, etc. • Flush circuit to determine extent of clotting as per Health Authority protocol. • If signs of clotted circuit are worsening, consider returning patient's blood. DO NOT <u>manually</u> (hand crank) return blood. • If circuit completely clotted, stop dialysis and discard the circuit. DO NOT RETURN BLOOD. Recommence HD with a new circuit as per HA protocol. Check hemoglobin next HD run or with resumption of HD. • Inform MD/NP to review heparin dose or follow HA protocol. |

2.8 Immediate Reaction to Dialyzer / Membrane

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Immediate reaction to dialyzer / membrane (Type A) 1,2,8,15,16</p> <p>Response may be anaphylaxis or anaphylactoid</p> | <ul style="list-style-type: none"> Hypersensitivity to dialyzer membrane or sterilant, especially ethylene oxide (ETO) Contamination by bacterial peptides <p>Risk factor: Use of ACE inhibitors in patients using AN69 dialyzer (Nephral)</p> | <p>Immediate (Type A, onset within 1st 10 min)</p> <ul style="list-style-type: none"> Skin: Pruritus, urticaria, angioedema Respiratory: Cough, sneezing, wheezing, SOB, laryngeal edema GI: Abdominal cramps, diarrhea, vomiting Other: Fever, chills, “impending sense of doom,” chest pain/back pain Anaphylactic shock: Hypotension, rash, wheeze → cardiac arrest <p>Note: Blood and dialyzer membrane interaction can cause significant thrombocytopenia</p> <p>Note: Delayed reactions may also occur. These are more common than immediate reactions and usually less severe. Symptoms generally improve with continuation of dialysis treatment. Actions:</p> <ul style="list-style-type: none"> Check vitals frequently and contact MD/NP. Consider stopping dialysis if symptoms progress. | <p>Immediate (Type A, onset within 1st 10 min), symptoms severe (anaphylactic shock):</p> <ul style="list-style-type: none"> STOP dialysis. Do not return blood circuit to patient. Keep access open Consider calling CODE BLUE Contact MD/NP Administer medications as per unit protocol: <ul style="list-style-type: none"> Epinephrine, if anaphylaxis Antihistamine (e.g., diphenhydramine) Steroids (e.g., hydrocortisone, methylprednisolone) Bronchodilators. (e.g., salbutamol nebulizer) <p>Follow up:</p> <ul style="list-style-type: none"> Update patient’s allergy status as per HA protocol MD/NP to order different type of dialyzer membrane & blood work to rule out thrombocytopenia |

2.9 Disequilibrium Syndrome

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Dialysis disequilibrium syndrome (DDS) ^{2,4,17-21}</p> <p>Many believe DDS is related to an acute increase in brain water content due to the rapid lowering of the plasma solute level during dialysis. This causes the plasma to become hypotonic with respect to the brain cells. This results in water shifting from the plasma into the brain tissue (urea concentration in blood declines faster than in brain → water shifts from blood into brain)</p> | <p>Patient risk factors:</p> <ul style="list-style-type: none"> Advanced age Pre-existing neurological condition Other conditions that could cause cerebral edema (hyponatremia, hepatic encephalopathy, hypertensive emergency, etc) Concomitant conditions with increased blood brain barrier permeability (sepsis, vasculitis, TTP/HUS, meningitis, encephalitic, etc) Very high serum urea. e.g., patients who have missed several HD runs in a row <p>Treatment risk factors:</p> <ul style="list-style-type: none"> Full clearance dialysis (e.g., high QB; longer dialysis duration; high dialysate flow). Highest risk is in first 3 dialysis runs Significant change in dialysis prescription which increases the clearance rate (e.g., change in treatment setting from regular to hemodialfiltration (HDF) or expanded dialysis) | <ul style="list-style-type: none"> Mild confusion Dizziness Headache Restlessness Seizures Nausea and vomiting Hypertension Somnolence Occasional muscle twitching Blurred vision If untreated, may lead to coma and death | <p><i>Management:</i></p> <ul style="list-style-type: none"> Monitor closely for symptoms Notify MD/NP if symptoms occur Reduce pump speed or discontinue treatment depending on the severity of the symptoms (based on consultation with MD/NP) Provide nursing interventions specific to symptom(s) (e.g., seizure) <p><i>Prevention:</i></p> <ul style="list-style-type: none"> Identify at risk patients and review with MD/NP MD/NP may modify the dialysis prescription to mitigate risk (e.g., reduce pump speed for first few runs, low flux dialyzer, reduce treatment duration, lower dialysate flow rate, connect dialysate flow concurrent to blood flow, sodium modelling). |

2.10 Hemolysis

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Hemolysis ^{1,4,12,14,22-24}</p> <p>Definition: Rupture of erythrocytes with release of hemoglobin and potassium into the plasma. If not detected early can result in death</p> | <p>Elevated extracorporeal circuit pressures:</p> <ul style="list-style-type: none"> Blood pump malocclusion Single-needle high flow HD High QB with small needle gauge High access pressure +/-250 mm Hg Partial occlusion of HD catheter or malposition of needle that restricts flow. | <ul style="list-style-type: none"> Sudden more positive blood volume detected by HD machine Blood leak alarms or pink discoloration of dialysate Blood appears translucent, deep burgundy or cherry-red in colour post dialyzer Rapid onset of pallor &/ or anemia Symptoms associated with hyperkalemia (e.g., dysrhythmias, tachycardia, chest pain, muscle weakness) | <ul style="list-style-type: none"> Immediately STOP dialysis Immediately clamp venous line Visually inspect dialysate fluid for changes in color – test for contamination Do NOT return (hemolyzed) blood Monitor vital signs, notify MD/NP stat Observe for dysrhythmias, hypotension and shortness of breath Maintain vascular access (i.e., leave needles in situ or catheter ready for access) Administer oxygen If necessary, replace volume with NS Contact MD/NP to obtain order for: <ul style="list-style-type: none"> Bloodwork (e.g., anticipate CBC, electrolytes, cross match STAT - LDH, peripheral blood smear, haptoglobin, reticulocyte count, hematocrit and bilirubin) |

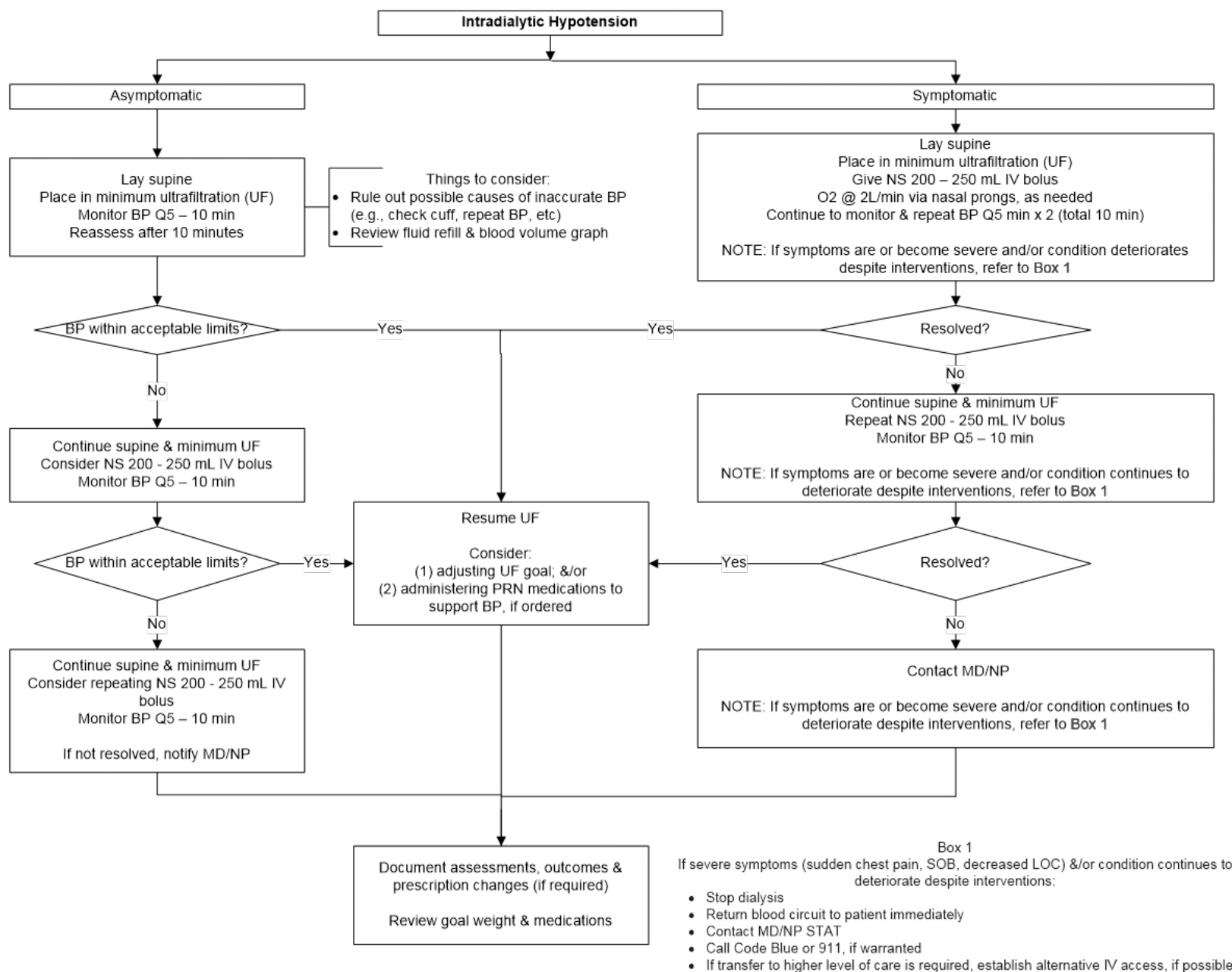
| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| | <ul style="list-style-type: none"> Kinked or faulty tubing Access flow rate lower than pump speed <p>Dialysate related:</p> <ul style="list-style-type: none"> Chemicals in dialysate from contaminated water Blood exposure to cleansing agents Hypotonic or hypertonic (less common) dialysate/ IV solutions High dialysate temperature | <ul style="list-style-type: none"> Abdominal pain, back pain, chest pain/ tightness Nausea/vomiting/ diarrhea Dyspnea, shortness of breath, hypoxemia Hypotension (can be initially hypertension) Fever/diaphoresis/ chills Localized pain/burning at access site Malaise Deepening skin pigment/jaundice | <ul style="list-style-type: none"> ECG (to determine hyperkalemic changes and assess for acute cardiac ischemia) Obtain pre- and post-dialyzer samples of dialysate for testing If MD/NP says safe to proceed with HD, set up new machine with new dialyzer Inform biomedical engineering. Sequester machine, tubing and dialyzer Watch for other patients with similar signs and symptoms (if problem was in the water/ centre dialysate system). <p>Note: If >1 patient develops hemolysis within the same unit, contamination of the dialysate should be suspected</p> |

2.11 Intradialytic Hypotension

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Intradialytic hypotension ^{2,25-27}</p> <p>Definition: Decrease in systolic blood pressure (BP) >20mmHg or a decrease in mean arterial pressure by 10 mmHg, provided that the decrease in BP is associated with clinical events and need for nursing interventions²⁸</p> <p>Hypotension may be minor or severe, asymptomatic, or symptomatic</p> | <p>Excessive or rapid decreases in blood volume with insufficient hemodynamic compensation. Possible causes:</p> <ul style="list-style-type: none"> Excessive ultrafiltration which exceeds the plasma refilling rate Rapid reduction in plasma osmolality which causes extracellular water to move into the cells Active bleeding <p>Fluid volume excess/ overload: Patient unable to tolerate high fluid removal due to large interdialytic weight gain</p> <p>Miscalculated target weight</p> <p>Lack of vasoconstriction due to:</p> <ul style="list-style-type: none"> Sepsis Eating a large meal before or during dialysis | <ul style="list-style-type: none"> Low blood pressure Weakness Dizzy or light-headed Nausea, vomiting, abdominal pain Yawning/sighing Muscle cramps Restless & anxious Pale, diaphoretic &/or cold clammy skin Tachycardia HD machine shows blood volume trending low & not refilling; triggers arterial pressure alarm <p>If hypotension not addressed, further symptoms may include:</p> <ul style="list-style-type: none"> Chest pain Loss of consciousness Cardiac decompensation leading to coronary and/or cerebral ischemic events if untreated | <p><i>Management</i> – Refer to attached algorithm (Table 1).</p> <p><i>Prevention</i> (may require MD/NP order as per site protocol):</p> <ul style="list-style-type: none"> Accurate dry weight assessment Dialysate sodium modeling/UF modeling (profiling) – separate or in combination Isolated UF followed by either a reduced UF or isovolemic (no UF) dialysis Lower dialysate temperature Use of hematocrit, blood volume monitoring, or hemoscan monitoring with an UF feedback control mechanism Review of prescribed anti-hypertensive medications and dose timing related to dialysis (may need to be taken post) Alpha adrenergic agonists –midodrine or pseudoephedrine Avoid food during dialysis Limit interdialytic salt intake Extend length of dialysis time or increase dialysis frequency Review dialysate composition (e.g., Ca, Mg) Consider medications for hypotension (occasionally) Consider use of intradialytic exercise program if available and patient is agreeable Patient teaching re: salt intake, fluid restrictions, medications, recognizing and reporting symptoms |

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| | <ul style="list-style-type: none"> • Autonomic neuropathy (e.g., diabetes) • Intake of antihypertensive medications • Reactions to the dialyzer membrane • Increased synthesis of endogenous vasodilators, such as nitric oxide • Allergic reaction to intradialytic medications <p>Insufficient cardiac function related to:</p> <ul style="list-style-type: none"> • Diminished cardiac filling and cardiac reserve • Sudden release of adenosine during organ ischemia • Arrhythmias or pericardial effusion with tamponade • High magnesium concentrations in the dialysate <p>Underlying serious medical conditions (e.g., infection, arrhythmias, tamponade, MI, hemolysis, dialyzer reaction)</p> | | <ul style="list-style-type: none"> • Lower dialysate temperature • Use of hematocrit, blood volume monitoring, or hemoscan monitoring with an UF feedback control mechanism • Review of prescribed anti-hypertensive medications and dose timing related to dialysis (may need to be taken post) • Alpha adrenergic agonists –midodrine or pseudoephedrine • Avoid food during dialysis • Limit interdialytic salt intake • Extend length of dialysis time or increase dialysis frequency • Review dialysate composition (e.g., Ca, Mg) • Consider medications for hypotension (occasionally) • Consider use of intradialytic exercise program if available and patient is agreeable • Patient teaching re: salt intake, fluid restrictions, medications, recognizing and reporting symptoms |

Table 1: Management of Intradialytic Hypotension



2.12 Muscle Cramps

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| Muscle cramps ^{2,4} | <ul style="list-style-type: none"> Hyponatremia (most common) Plasma volume contraction (2nd most common) Poor plasma refilling due to (1) autonomic dysfunction or (2) cardiomyopathy High volume removal in relation to dry weight Low sodium dialysate Incorrect dry weight Intradialytic hypotension Mineral and electrolyte imbalances (e.g., hypokalemia, hypocalcemia, hypomagnesemia, elevated leptin levels) Vitamin deficiencies (B1 Thiamine, B5 Pantothenic acid, B6 Pyridoxine, Vitamins C & E) Medications. e.g., IV iron sucrose, oral contraceptive, nifedipine, pyrazinamide, statins, long-acting β-agonists, diuretics (especially potassium-sparing and thiazide-like diuretics), β-blocker intrinsic sympathomimetic, benzodiazepines Tissue hypoxia | <ul style="list-style-type: none"> Involuntary & sustained contraction of muscle without relaxation, lasting from seconds to minutes Pain/discomfort: hands, legs, feet Restlessness, agitation, anxiety Muscular firmness, tenderness, bulging, soreness | <p><i>Management</i></p> <ul style="list-style-type: none"> Reduce UFR to minimum and decrease total UF target Massage and stretch the cramped muscle, as appropriate Apply hot or cold to the tight muscle (e.g., warm towel or massage muscle with ice) Suggest low intensity exercise (e.g., stationary bike) during dialysis Reinfuse normal saline IV as per unit protocol Consider obtaining order or carry out prescribed order: <ul style="list-style-type: none"> Sodium profiling Higher sodium dialysate 50% dextrose infusion Dialysate thermal control Hypertonic saline IV Other management: <ul style="list-style-type: none"> Reversal of low blood pressure, if present Stop or decrease ultrafiltration Review causes of interdialytic hypotension <p><i>Prevention:</i></p> <ul style="list-style-type: none"> Regularly & systematically assess the: <ul style="list-style-type: none"> <i>Ideal weight/trend in weight:</i> recent illness/hospitalization, appetite (stress/holiday-related) nausea, vomiting, diarrhea <i>Co-morbidities:</i> cardiac failure leading to hypotension <i>Hydration status:</i> minimal or absence of residual renal function, edema, blood pressure^{iv}, engorged IJ veins, dyspnea; hematocrit; RBV^v, <i>Fluid removal/UF goal:</i> UF tolerance, headaches, washed-out feelings, thirsty/ croaky voice. Sequential UF/dialysis UF profiling; minimize excessive UF; avert dialysis hypotension Consider blood volume monitoring (BVM) ultrafiltration (UF) control with hematocrit monitoring Minimize/substitute medications associated with leg cramps. Consider vitamin E, carnitine. If not effective, try Gabapentin. Refer to BCR pamphlet at: www.bcrenal.ca/resource-gallery/Documents/Management%20of%20Muscle%20Cramps%20in%20Patients%20with%20Chronic%20Kidney%20Disease.pdf Consider referral to dietitian Patient education: <ul style="list-style-type: none"> Minimize interdialytic weight gain Review fluid & sodium restriction^{vi} Exercise before bed Refer to BCR patient pamphlet www.bcrenal.ca/our-research-site/Documents/Symptom%20Management%20Patient%20Teaching%20Tool-Muscle%20Cramps.pdf |

^{iv} Preferably measured with patient sitting & standing

^v Poor refilling may be present in spite of an expanded volume (in patients with diabetes and autonomic dysfunction or in patients with cardiomyopathy)

^{vi} Fluid: 1L/day plus estimated urine output; Sodium: 4 – 6 g/day

2.13 Nausea / Vomiting

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| Nausea/ vomiting ^{2,4,29,30} | <p>Dialysis-related:</p> <ul style="list-style-type: none"> Excessive fluid removal (hypotension) – most common cause Hemolysis Dialyzer reaction Can be an early manifestation of disequilibrium syndrome Contaminated or incorrectly formulated dialysis solution (high sodium, calcium) Exposure to water contaminants Dialysis inadequacy <p>Patient-related:</p> <ul style="list-style-type: none"> Eating during dialysis - some patients Uremia Hypercalcemia Diabetic gastroparesis¹ Nephrotic syndrome² AKI rhabdomyolysis² Concurrent medication/ treatment side effect | Nausea &/ or vomiting | <ul style="list-style-type: none"> Rule out possible dialysis-related and patient-related causes and treat underlying issue (treatment dependent on suspected cause) <ul style="list-style-type: none"> As hypotension is most frequently the cause, check BP for all new-onset nausea/vomiting Treat hypotension Administer anti-emetics if ordered & BP allows Elevate head of bed Patient teaching (depending on suspected cause) could include: (1) Interdialytic fluid gain; (2) eating during treatment; and (3) dietary counselling (limiting salt and fluid intake) Assess patient's HD adequacy (clearance, PRU) Access flow, recirculation, HD schedule and frequency, dialyzer size, Qb and Qd If history of nausea/vomiting > 3 days, contact MD/ NP: <ul style="list-style-type: none"> MD/NP may wish to check electrolytes As per MD/NP order, implement HD techniques that may help relieve symptoms (isolated UF, sodium profiles/modeling) |

2.14 Pyrogenic Reaction

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Pyrogenic reaction^{12,14,31-33}</p> <p>Definition: A febrile phenomenon caused by infusion of contaminated solution, and commonly manifested by cold, chill and fever</p> | <p>Dialysis-related:</p> <ul style="list-style-type: none"> Pyrogens or endotoxins in the dialyzer or bloodlines, HD machine, water system &/or bicarbonate containers/system Contaminated medication administered through the dialysis circuit <p>Patient related:</p> <ul style="list-style-type: none"> Bacteremia (access site or non-access related) Break in aseptic practices (may cause bacteremia which may lead to a pyrogenic reaction) <p>Differential diagnosis: Blood transfusion reaction (oral temperature >38°C; >1°C higher than baseline; or presence of chills/rigors)</p> | <p>Most common:</p> <ul style="list-style-type: none"> Patient feels cold soon after initiation of dialysis, accompanied by chills and fever, often within the first 45 – 75 min of treatment Hypotension Nausea and vomiting <p>Less common:</p> <ul style="list-style-type: none"> Headache Myalgia (muscle pain) Hemodynamically unstable | <p>Management:</p> <ul style="list-style-type: none"> Assess for signs and sources of infection such as: vascular access, foot ulcer, pressure ulcer, respiratory or urinary tract Take vital signs, including pre-dialysis temperature Notify MD/NP. If ordered: <ul style="list-style-type: none"> Obtain blood cultures from patient Administer antibiotics until culture results are known Administer antipyretics Discontinue HD without returning blood if pyrogen or endotoxin is suspected Obtain water (system) and inlet/outlet samples of dialysate to culture for bacterial endotoxins <p>Prevention:</p> <ul style="list-style-type: none"> Strict adherence to guidelines for the chemical and bacteriologic quality of water used to prepare dialysis fluid and circuit Ensure dialysis equipment and water system are carefully and properly disinfected Ensure concentrate containers are not reused to prevent growth of bacteria Minimize the length of time supplies & extracorporeal system are prepared before treatment initiation Maintain aseptic technique throughout dialyzer preparation and HD Best practices such as good hand hygiene and aseptic techniques for accessing the vascular access |

2.15 Seizure

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Seizure ^{2,4}</p> <p>A seizure is a sudden, uncontrolled electrical disturbance in the brain. It can cause changes in your behavior, movements or feelings, and in levels of consciousness. There are many types of seizures, which range in severity. Seizure types vary by where and how they begin in the brain. Most seizures last from 30 seconds to two minutes. A seizure that lasts longer than five minutes is a medical emergency. (Mayo Clinic; www.mayoclinic.org/diseases-conditions/seizure/symptoms-causes/syc-20365711)</p> | <p><i>Dialysis-related:</i></p> <ul style="list-style-type: none"> • Acute renal failure • Hypotension • Electrolyte imbalance • Disequilibrium syndrome • Severe hypertension • Dialysate composition errors • Anticonvulsant /seizure medications is dialyzed out <p><i>Patient-related:</i></p> <ul style="list-style-type: none"> • Seizure disorder • Hypertensive encephalopathy • Intracranial hemorrhage (e.g., post-fall), intracranial mass, intracranial infection and large ischemia stroke • Medications (i.e., narcotics). • Alcohol withdrawal • Toxins • Metabolic: <ul style="list-style-type: none"> • Hypocalcemia • Hypernatremia (accidental due to hemodialysis machine malfunction) or hyponatremia • Hypoglycemia • Anoxia secondary to: <ul style="list-style-type: none"> • Cardiac abnormalities • Severe hypotension • Air embolism • Allergic reaction | <p>Depends upon type of seizure (focal vs generalized)</p> <p>Common symptoms include:</p> <ul style="list-style-type: none"> • Aura • Loss of consciousness • Seizure activity | <p><i>These activities may happen concurrently</i></p> <ul style="list-style-type: none"> • Ask for help • Note time, type and duration of seizure • Discontinue dialysis – return blood if safe to do so • If hypotension/hypovolemia/hypoglycemia present, treat as per HA protocol • Maintain airway <ul style="list-style-type: none"> • Apply oxygen, if indicated • Set up suction • Protect patient from injury <ul style="list-style-type: none"> • Turn patient to side to prevent aspiration (recovery position) • Protect patient’s access site from separation/dislodgement • Call MD/NP STAT • Call Code BLUE if seizures persist • As ordered by MD/NP: <ul style="list-style-type: none"> • Administer medications (e.g., IV diazepam or lorazepam, and phenytoin if required) • Treat metabolic disturbance(s), if present • Obtain blood samples for electrolytes and serum calcium • If hypoglycemia suspected, follow HA hypoglycemia protocol • After care: <ul style="list-style-type: none"> • Offer reassurance • Provide for safety • Remain with patient until fully conscious and reoriented • Discuss resumption of dialysis with MD/NP |

2.16 Vascular Access Complications

2.16.1 VA Disconnection/Needle Dislodgement (Arterial or Venous)

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>VA disconnection/ needle dislodgement (arterial or venous) <small>2,35,36</small></p> <p>Definitions: Dislodgement = Fistula/graft needle or catheter falls out.</p> <p>Disconnection = Separation of vascular access line(s)</p> | <ul style="list-style-type: none"> Poorly secured access. e.g., improper taping of access tubing to skin, loose luer lock tubing connection, bloodlines not looped loosely enough, needles <2.5 cm (<1 in) Patient factors. e.g., confused, restless, agitated, cognitively impaired &/or sedated, frequent manipulation of lines and connections, excessive movement of arm or body, hypotension or muscle cramps during treatment, diaphoresis or pruritus, non-adherent skin (e.g., excess body hair, waxy skin), unwilling to keep access areas & bloodlines uncovered, on nocturnal &/or home HD | <ul style="list-style-type: none"> Blood circuit pressure alarm (venous or arterial) BE AWARE: Pressure alarms are not always reliable & may not provide an alert Patient reports moisture in area of access Visible blood leakage or spray Hypotension with alteration in level of consciousness | <p><i>Management:</i></p> <ul style="list-style-type: none"> Don Personal Protective Equipment (PPE) Stop blood pump Call for help Secure access (CVC: clamp; Fistula/graft: apply pressure) Check vitals If excessive blood loss, give NS bolus into an available access If circuit is contaminated, do not return blood Obtain STAT CBC & cross match orders; inform MD/NP <p><i>Prevention:</i></p> <ul style="list-style-type: none"> Proper securing of access, blood lines and caps. Refer to Staff Guide at www.bcrenal.ca/resource-gallery/Documents/VA-Prevention_of_VA_Disconnection_Needle_Dislodgement_Staff_Guide.pdf Visibly check the access, needle sites, blood line positions & all luer connections as part of routine monitoring & each time an alarm is activated. Document checks on HD run log Set the lower limit of the venous pressure alarm as close as possible to the current venous pressure, as allowed by the dialysis equipment For patients at higher risk for needle dislodgement (see signs and symptoms under patient factors), consider using a device intended to detect moisture (blood loss) Patient teaching: Keep access area & bloodlines visible at all times, check access frequently during dialysis, do not touch needles/catheter, connection or tape holding the access in during dialysis, be aware of access when moving (move slowly). Refer to Patient Teaching sheet at www.bcrenal.ca/resource-gallery/Documents/VA_Disconnection-Needle_Dislodgement_Patient_Teaching_Handout.pdf |

2.16.2 Acute VA Rupture/Hemorrhage (AVFs/AVGs)

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Acute VA rupture/hemorrhage ^{1,37-41} while in dialysis unit (AVF/AVG)</p> <p>Although thrombosis and stenosis are more frequently seen, hemorrhage from a VA can result in life-threatening blood loss. Rupture may occur underneath the skin, or it can break through the skin.</p> | <p>VA-related:</p> <ul style="list-style-type: none"> Rupture of vascular access (e.g., aneurysm/pseudoaneurysm) <p>HD-related:</p> <ul style="list-style-type: none"> Too much heparin in the HD machine (over-anticoagulation) <p>Patient-related:</p> <ul style="list-style-type: none"> On anticoagulants (e.g., warfarin or clopidogrel) Coagulopathy disorder e.g., platelet dysfunction; uremia | <p>Massive bleeding from access site</p> | <p><i>Management of major VA hemorrhage:</i></p> <ul style="list-style-type: none"> Don PPE Stop the bleeding: <ul style="list-style-type: none"> If bleeding is life threatening, apply tourniquet or strong manual pressure proximal to the puncture site (extreme measure as this will result in thrombosis formation within the AVF/AVG and make it nonfunctional) If bleeding is not life threatening, apply firm direct pressure to access at the site of bleeding using a 2-handed technique: Use dominant hand to put pressure in the bleeding point and non-dominant hand to put pressure proximal to the bleeding point (from Mayo Clinic article). Do not apply adhesive bandages until hemostasis is achieved Call MD/NP immediately As per MD/NP orders <ul style="list-style-type: none"> Adjust patient/HD factors contributing to hemorrhage (e.g., heparin dosage) Refer to vascular surgeon/radiologist (ligation, repair &/or reconstruction of access, etc) <p>Note: For management of VA bleeding after leaving the HD unit, refer to BCR patient handout: www.bcrenal.ca/resource-gallery/Documents/VA%20for%20Hemo%20-%20Bleeding%20Fistula%20or%20Graft.pdf</p> <p><i>Prevention:</i></p> <ul style="list-style-type: none"> Proactively manage warning signs of VA rupture/hemorrhage (rapid increase in size, pain, thinning & degeneration of the overlying skin of the skin, shiny & pulsating and infection) Refer to BCR documents: <ul style="list-style-type: none"> Prevention of aneurysms (patient handout): http://www.bcrenal.ca/resource-gallery/Documents/VA-Ways_to_Prevent_Aneurysms_in_Fistulas_and_Grafts.pdf Prevention of VA disconnection/needle dislodgement (staff & patient handout) www.bcrenal.ca/resource-gallery/Documents/VA-Prevention_of_VA_Disconnection_Needle_Dislodgement-Staff_Guide.pdf Careful removal of needles post-HD (guideline): www.bcrenal.ca/resource-gallery/Documents/Care%20of%20Needling%20Sites%20Post%20Hemodialysis%20for%20Fistulas%20%20Grafts%20(Hemostasis).pdf |

2.16.3 Infiltrated Needle while on Dialysis

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| <p>Infiltrated needle while on dialysis</p> <p>Definition: Needle dislodges from inside the vein (fistula) or graft during needle insertion or during dialysis treatment. Blood leaks out of the vein into the surrounding tissues.</p> | <p>Cannulation-related:</p> <ul style="list-style-type: none"> • Fragile or new access (higher risk) • Accidental “back or side wall” puncture • Needle malposition • Not enough of the needle in the vessel • Vessel spasm <p>Other reasons:</p> <ul style="list-style-type: none"> • Poorly secured access • Patient factors • (refer to section on VA disconnection/needle dislodgement guideline) | <ul style="list-style-type: none"> • Sudden onset of pain &/or discomfort in the access area • Feeling of warmth/moisture &/or pressure near the cannulation site • Swelling at cannulation site • Arterial or venous pressure alarms | <p><i>Management:</i></p> <p>When two needles are in-situ:</p> <ol style="list-style-type: none"> 1. Ask for assistance 2. Consider returning blood or putting HD circuit on “circle” 3. If patient has not received heparin <ul style="list-style-type: none"> • Shut off the pump • Remove the needle • Apply digital pressure to the exit site by placing two fingers along the access for at least one inch in the area of the infiltration • If a back or side infiltration is suspected, use two fingers along the access and a thumb on the backside of the arm to apply posterior pressure (“C-clamp” method). It can be difficult to control back or side wall bleeding because it is not possible to place direct pressure on the puncture site 4. If patient has received heparin: <ul style="list-style-type: none"> • Assess the infiltration site to see if the needle should be pulled out or left in place with ice applied over the site until the dialysis treatment is complete • If the hematoma is increasing in size during the treatment, shut off the pump, remove the needle and apply digital pressure as described above • If the hematoma size is stable, it is acceptable to leave the needle in until the end of the treatment 5. Apply ice as soon as able to the infiltrated access for 20 minutes. Instruct the patient to apply ice another six to eight times for the next 24 hours to reduce pain and swelling. After 24 hours, instruct the patient to apply warm (not hot) compresses (e.g., warm wash cloth) on the area for 20 minutes several times a day to promote healing 6. In the meantime, revert back to using the CVC (if present) for dialysis. If there is no CVC, consult the nephrologist and VA Nurse (they may suggest single needle dialysis, temporarily needling above or below the infiltrated area, giving the patient the day off of dialysis to rest the access or inserting a CVC) 7. Assess infiltration at each dialysis treatment and resume use once the majority of swelling/bruising has subsided and the AVF/AVG can be easily palpated (usually takes one to two weeks). When the AVF/AVG is ready for use again, reinstitute the |

| Complication | Possible Cause(s) | Signs & Symptoms | Nursing Management |
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| | | | <p>sequence at the last successful level (i.e., level reached prior to “blow”). If the access appears to be compromised, consider using a smaller gauge needle</p> <p><i>Prevention:</i></p> <ul style="list-style-type: none"> • Use ultrasound to guide cannulation • Consider angiocaths, especially if patient has limited capacity to keep limb immobilized • Avoid repeated attempts at cannulation • Cannulate slowly and with care, stop with any resistance • Ask for guidance on cannulating an unfamiliar access • Secure the access as per BC Renal guideline: http://www.bcrenal.ca/resource-gallery/Documents/VA-Prevention_of_VA_Disconnection_Needle_Dislodgement-Staff_Guide.pdf (Appendix 1) • Remind patient to immobilize limb with needles • Keep needled access exposed throughout treatment |

3.0 Sponsors

Developed by:

- BCR Renal Educators Group (REG)

Reviewed by:

- Nephrologists practicing in Interior Health, Fraser Health & Vancouver Island Health

Approved by:

- BC R Hemodialysis Committee (January 13, 2021)

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