PROVINCIAL STANDARDS & GUIDELINES

BCRenal
an agency of the Provincial Health Services Authority

Chemical & Chlorine Sampling of Dialysis Water

December 2017

Developed by the BCPRA Hemodialysis Committee

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IMPORTANT INFORMATION

This BCPRA 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.bcrenalagency.ca for the most recent version.

For information about the use and referencing of BCPRA provincial guidelines/resources, refer to http://bit.ly/28SFr4n.

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1.0 Scope of Guideline

This guideline applies to in-centre and community dialysis units (CDUs) that provide hemodialysis (HD) and/or hemodialfiltration (HDF). It is applicable to both adult and pediatric units.

The purpose of this guideline is to support the implementation of common standards and processes for chemical and chlorine sampling of dialysis water within BC's HD units. It also provides standards and processes for follow-up of test results when contaminants exceed acceptable limits.

2.0 Summary of the Literature & Internet

Patients undergoing conventional hemodialysis three times per week are exposed to 300-600 litres of water per week, depending on their prescription (Coulliette, 2013). More than 90% of the dialysate delivered to the dialyzer is water (Layman-Amato, 2013).

The source of water used in HD consists basically of drinking water, purified by various techniques, whose composition and quality depend on its origin. Water treatment systems employ several physical and/or chemical processes either singly or in combination. These systems may be portable units or large facility systems.

The quality of the source water can change from season to season or even day to day (Layman-Amato, 2013). Monitoring of the quality of water used for dialysis is a vital aspect of hemodialysis treatment. Minerals in the water can be toxic to patients and harmful to equipment.

3.0 Definitions & Abbreviations

Chloramine: Difference between total chlorine and free chlorine.

Chlorine, combined: Chlorine that is chemically combined, such as chloramine compounds.

Chlorine, free: Portion of chlorine in a solution that has not chemically combined with other substances; dissolved molecular chlorine.

Chlorine, total: Sum of combined chlorine and free chlorine.

Dialysis water: Water that has been treated to meet the requirements of the CSA standard and is suitable for HD use in applications.

Disinfection: Destruction of pathogenic and other kinds of microorganisms by thermal or chemical means.

Feed water: Water supplied to a water treatment system or an individual component of a water treatment system.

Hemodialysis (HD): Form of renal replacement therapy in which waste solutes are removed primarily by diffusion from blood flowing on one side of a membrane into dialysis fluid flowing on the other side.

PSLS: Patient Safety & Learning System.

RO: Reverse osmosis. Water is pushed through a membrane with pores small enough to remove most contaminants, including ions.

4.0 Recommendations

Recommendation #1: Sample dialysis water for chemicals and chlorine as per the schedule on Table 1 (based on CSA-ISO).

Table 1: Components, Method & Frequency for Cleaning and Disinfecting Water Treatment Equipment

Sample	Frequency
Chemical sampling	• Upon installation of a water treatment system or replacement of RO membranes. Testing should be initiated prior to patient use and, ideally, the results received prior to using for dialysis. If results are not possible, dialysis may proceed pending results. • Annually thereafter.

Chlorine sampling (manual or automated)	• RO system:
	  • Beginning of each treatment day.[1] For units that run 24/7, unit to determine time of day for sampling.
	  • Changes to feed water (e.g., during construction or a policy or technology change within the city water treatment system).
	  • After completing work on the carbon tank treatment system.
	• Portable ROs:
	  • Prior to every treatment.
	  • After replacing carbon filters.
	
	Automated systems are acceptable but performance should be verified annually.

[1] Testing for total chlorine should be performed at the beginning of each treatment day prior to the patient's initiating treatment. Where chloramine is used to disinfect the potable water supply at a level of 1 mg/l or more, testing should be repeated prior to the beginning of each patient shift; if there are no set patient shifts, testing should be performed approximately every 4 h during operation. More frequency monitoring could be appropriate during temporary operation with a single carbon bed, which can occur following breakthrough of the first bed. In such instances, testing is performed on water exiting the second carbon bed in a series-connected pair. The decision to change the frequency of monitoring should be based on the past performance of the system and on whether changes in feed-water quality have occurred. Samples should be drawn when the system has been operating for a least 15 min. The analysis should be performed onsite, since total chlorine levels will decrease if the sample is not assayed promptly. Results of monitoring should be recorded in a log sheet.

Recommendation #2: Utilize the standards on Table 2 for maximum acceptable concentrate levels (based on CSA-ISO).

Table 2:
Maximum Acceptable Concentrations of Chemicals & Chlorine in Dialysis Water

Sample	Maximum Acceptable Concentrations (mg/L)	t
Chemical sample	*Contaminants with documented toxicity to HD*	
	• Aluminum	0.01
	• Copper	0.1
	• Fluoride	0.2
	• Lead	0.005
	• Nitrate (as N)	2
	• Sulfate	100
	• Zinc	0.1
	Electrolytes normally included in dialysis fluid	
	• Calcium	2 (0.05 mmol/L)
	• Magnesium	4 (0.15 mmol/L)
	• Potassium	8 (0.2 mmol/L)
	• Sodium	70 (3.0 mmol/L)
	Trace elements	
	• Antimony	0.006
	• Arsenic	0.005
	• Barium	0.1
	• Beryllium	0.0004
	• Cadmium	0.001
	• Chromium	0.014
	• Mercury	0.0002
	• Selenium	0.09
	• Silver	0.005
	• Thallium	0.002
Total chlorine sample	Maximum acceptable concentration: Less than 0.1 mg/L. Action level: Greater than 0.05 mg/L.	

5.0 Procedure

Biomedical Technologists, Renal Dialysis Technicians, Renal Nurses and other personnel or external service providers who are trained and have demonstrated competency in dialysis water procedures may collect samples for chlorine testing and perform the necessary actions should test results exceed maximum acceptable concentrations.

Biomedical Technologists, Renal Dialysis Technicians and other personal or external service providers who are trained and have demonstrated competency in dialysis water procedures may also collect samples for chemical testing.

5.1 Sample Collection

Chemical Sampling

1. Collect samples when the system is operating under stable conditions representing normal operation.
2. Collect samples as follows:

- Feed water: Collect from source water, prior to the first water treatment filter.
- Dialysis water: Collect from a point in the distal segment of the loop, immediately prior to where water returns to the RO, or immediately prior to where the water re-enters the storage tank, if one is present.
  - For portable ROs, collect from the outlet of the portable RO.
  - For dual pass ROs, sample each RO in standalone mode. In systems with other membrane configurations, ensure each membrane is sampled.
- Follow the laboratory's instructions on collecting and preserving the sample.

3. Send samples to the third party laboratory for testing. Document actions and log all incoming results. List of laboratories currently approved (March 31, 2016) by the BC Provincial Health Officer for water testing is available at http://lmlabs.phsa.ca/Documents/PHO%20Approved%20Laboratory%20List.pdf (alphabetical order):
   - Agat Laboratories
   - ALS Environmental – Calgary, Ft St John, Kamloops, Vancouver
   - BCCDC PHMRL Environmental Microbiology Laboratory
   - C R D Water Services Laboratory
   - Caro Analytical Services
   - Exova Canada Inc.
   - IG Micromed Environmental Inc.
   - Maxxam Analytics - Burnaby, Victoria
   - MB Laboratories Ltd.
   - Metro Vancouver Water Laboratory
   - North Island Laboratories
   - Northern Laboratories (2010) Ltd.
   - Passmore Laboratory Ltd.

Chlorine Sampling

1. Method used to measure chlorine levels must have sufficient sensitivity and specificity to detect levels of 0.05 mg/L and higher (i.e., action level).
2. Collect samples when the system is operating under stable conditions representing normal operation.
   - The RO must have been operating for at least 15 minutes.
   - There must be flow through the carbon filtration system during this 15 minute period.
3. Collect the sample after the first carbon tank or carbon filter.
   - Rinse the sample container at least once before taking the sample.

- Follow the collection procedure as per the manufacturer's guideline.
- Test the sample immediately after collection as per the manufacturer's guideline.

4. Record test results on the appropriate daily testing log sheet.

5.2 Follow-up on Sample Results

Chemical Sampling

1. If the chemicals are within the maximum acceptable concentrations (refer to Table 2), resume routine sampling of dialysis water annually.
   - Suggest comparing results year on year to proactively identify changes in the membrane. Consider changes in the feed water composition in making year on year comparisons.
2. If the concentrations exceed the maximum acceptable concentration, take corrective action.
   a) If this is the 1st round of positive samples, retake system or portable RO sample as soon as possible.
   b) If this is the 2nd round of positive samples:
      - Notify the area renal manager, nephrologist, biomedical &/or technical lead, risk management/quality and equipment vendor.
      - Area renal manager and nephrologist to determine suitability of water to continue treatment. Complete PSLS report.
      - Assess membrane and replace as needed.
        - If membrane requires replacement, replace it and retake sample.
        - If membrane does not require replacement, initiative troubleshooting protocol:
          - Collect and test samples from other parts of the distribution loop (applicable to RO systems only).
          - Evaluate/correct sample collection technique.
          - Evaluate/correct water system components.
        - Retake system or portable RO sample.

Refer to algorithm in Table 3a: Chemical Sampling of Dialysis Water.

Chlorine Sampling

1. If the total chlorine concentration is under the action level (less than 0.05 mg/L), resume routine chlorine sampling the following day. Note: 1 PPM is equivalent to 1.0 mg/L.
2. If the concentration exceeds the action level (greater than 0.05 mg/L), notify biomed or a renal dialysis technician. Biomed or renal dialysis technician takes the following corrective action:

Dual tanks:

- If this is the 1st positive sample, retake sample as soon as possible using a different lot of test strips.
- If this is the 2nd positive sample:
  - Draw sample after carbon tank 2.
  - Test sample. Record results.
  - If the concentration is below the action level (less than 0.05 mg/L):
    - Continue with dialysis and notify the area renal manager, nephrologist and risk management/quality.
    - Install new carbon tanks as soon as possible. Measure chlorine levels every 3 hours while waiting for new tanks to be installed and ensure level stays below 0.05 mg/L.
  - If the concentration exceeds the action level

(greater than 0.05 mg/L):
  - Notify the area renal manager and nephrologist. Determine next steps (e.g., shut renal unit until issue resolved).
  - Complete PSLS.
- Record corrective actions and complete PSLS report.

Portable ROs:
- If this is the 1st (or more) positive sample, replace all carbon filters.
- Retake sample. Test. Record results.
- Notify the area renal manager, risk management/ quality and nephrologist.
- If the concentration is below the action level (less than 0.05 mg/L), continue with dialysis.
- If the concentration exceeds the action level (greater than 0.05 mg/L), the area renal manager and nephrologist will advise re next steps (e.g., discontinue use of portable ROs until issue resolved).
- Record corrective actions and complete PSLS report.

Refer to algorithm in Table 3b: Chlorine Sampling of Dialysis Water.

Table 3a:
Chemical Sampling of Dialysis Water

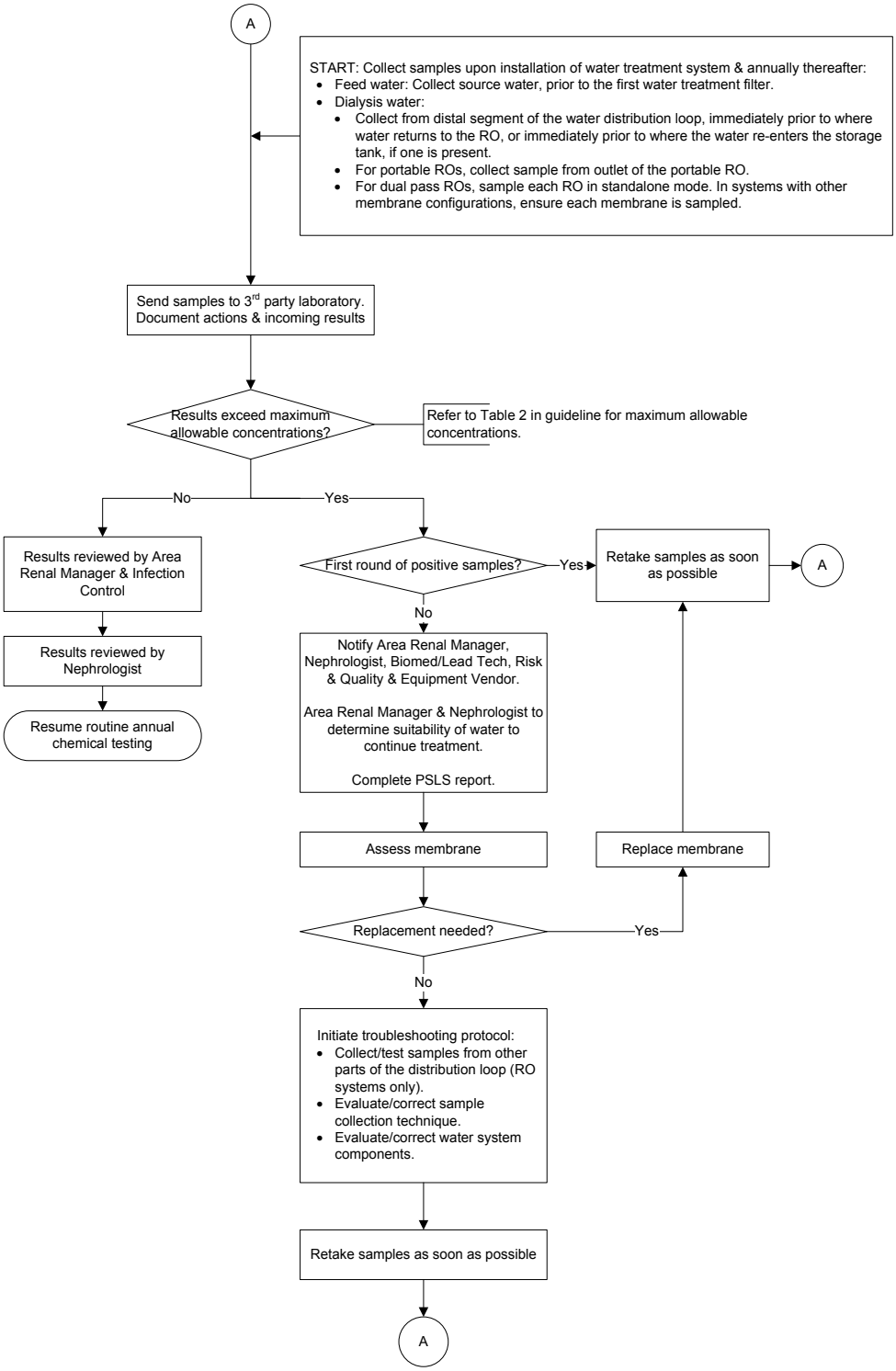
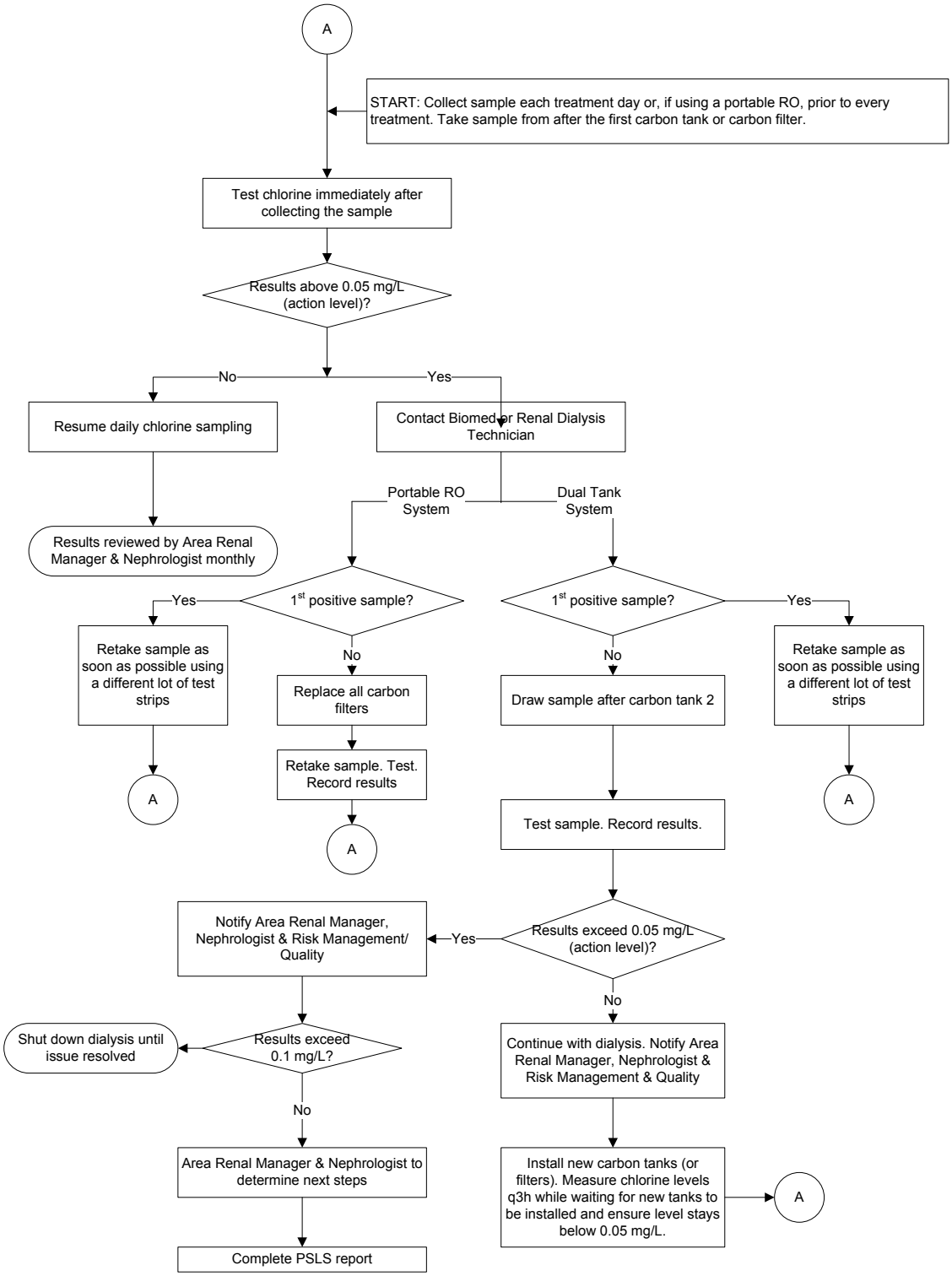


Table 3b:
Chlorine Sampling of Dialysis Water



5.3 Documentation

All chemical analyses test results for feed and dialysis water received from the third party laboratory and all daily chlorine testing results are documented. Processes are in place within the Health Authority for designated individuals to review the results and take action, if required.

6.0 References

CSA Standards (CSA)

CAN/CSA-ISO 13959-11-Water for haemodialysis and related therapies (Adopted ISO 13959: 2009, 2nd edition, 2009-04-15), *Canadian Standards Association*, 2011.

CAN/CSA-ISO 26722-11–Water treatment equipment for hemodialysis applications and related therapies (Adopted ISO 26722:2009, First edition, 2009-04-15), *Canadian Standards Association*, 2011.

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Centers for Disease Control and Prevention (CDC), Guidelines for Environmental Infection Control in Health Care Facilities. http://www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf (pages 59 - 65). Accessed Feb 24, 2016.

Laboratories Approved by BC Provincial Health Officer for Drinking Water Microbiology Testing, *Enhanced Water Quality Assurance, BC Centre for Disease Control*, June 30, 2015. Available online: http://lmlabs.phsa.ca/NR/rdonlyres/33521F8F-576A-4570-BAB6-F9F6D4D377A6/0/PHOApprovedLaboratoryList.pdf.

Articles

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Layman-Amato, R, Curtis, J and Payne, G (2013). Nephrology Nursing Journal, 40:5 (September-October 2013), p. 383. https://tinyurl.com/yc9thcqu. Accessed Sept 10, 2015

7.0 Sponsors

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Developed by:

- a working group of biomedical/renal technicians from across BC (one per health authority)

Approved by:

- BCPRA Hemodialysis Committee
- BCPRA Medical Advisory Committee

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