



REVERSE OSMOSIS (RO) UNIT OPERATION TIME & HEAT DISINFECTION

PRACTICAL ASSESSMENT
FOR REDUCING
ENVIRONMENTAL IMPACT

Australian and New Zealand
Society of Nephrology

RO Unit operation time

Reducing the length of time that reverse osmosis (RO) units are operating will save water and power, thereby reducing the environmental impact of haemodialysis and cost of treatments. Reviewing and aligning RO operation time with dialysis machine treatment schedule & disinfection process could result in an overall reduction in running time of an RO unit.

Prior to being used for haemodialysis, source water must be extensively treated to remove contaminants and inorganic ions and reduce hardness. A core step in this process is reverse osmosis water filtration, which involves using hydrostatic pressure to force water across a semi-permeable membrane.

Reverse osmosis results in the production of clean water (permeate or product water), which in turn is used to:

- Flush the plumbing loop that supplies the dialysis machines;
- Prime, rinse and disinfect the dialysis machines; and
- Produce the dialysate required for treatments.

Whenever an RO unit is operating, large amounts of water and power are used. It also results in the production of high volume 'reject water'. In contrast, when in standby mode, the RO unit is not functioning and therefore power consumption and water waste is minimised.

The RO unit is required to operate:

1. Before dialysis treatments begin to flush water through the carbon filters and plumbing loop and for the time needed to prime the dialysis machines +/- to rinse or disinfect the dialysis machines;
2. Throughout dialysis to provide a steady flow of permeate for dialysate production; and
3. After dialysis concludes, for the duration of the heat disinfection of the dialysis machines.

If an RO unit is operating outside these times, there is likely unnecessary water and power wastage.

ANZSN acknowledges the Traditional Custodians of Country throughout Australia, recognises their unique cultural and spiritual relationships to the land, waters and seas and their immense contributions to society, and pays respects to Ancestors and Elders, past and present. ANZSN acknowledges and respects iwi and hapū as tangata whenua of Aotearoa and is committed to upholding the principles of Te Tiriti o Waitangi (the Treaty of Waitangi). To read our statement on Indigenous Health [click here](#).

CASE STUDY



RO Unit Operation time

At a dialysis unit in QLD, the (RO) unit supplies permeate for dialysis treatments scheduled between 7am-7:30pm Monday-Saturday and to supply water for dialysis machine disinfections. Outside of treatment hours, the dialysis machines complete a heat disinfection on Mondays at 5:30am, a bleach disinfection on Thursdays at 5:30am, and heat disinfection following every treatment every day. A heat or bleach disinfection of the dialysis machines in use takes approximately 45 minutes.

Currently, the RO operates from 4am-9:30pm Monday-Saturday.

Intervention and results

The RO unit operation time was altered to reflect the needs of the dialysis unit. The RO unit now begins at 5am on Mondays and Thursdays for the automated heat and bleach disinfection of dialysis machines, respectively. The RO unit begins at 6am on all other days. This allows plenty of time for flushing of the plumbing loop, any necessary machine rinsing, and priming of machines before patient treatments begin. The RO unit ceases operation at 8:30pm, allowing adequate time for heat disinfection of the dialysis machines following the final treatment. Altering the RO unit schedule has reduced its operation time by 11 hours every week, avoiding unnecessary power and water consumption.

Conclusion

By mapping when patient treatments occur and when disinfection of dialysis machines occur, it's clear when RO units are operating outside of need. Ensuring the RO is only operating when required will save power and water.

See Appendix 1 for a worksheet to simplify data entry and assessment of the RO unit program.

RO Unit heat disinfection

Heat disinfection of the RO unit consumes the majority of the power required for RO operation for dialysis. Minimising the frequency and duration of disinfections will save power.

The RO membrane and the plumbing loop that delivers permeate (clean water or product water) to the dialysis machines require regular disinfection with heat to prevent bacterial contamination. The hot permeate used for disinfection can be provided by a hot water tank system or flow through heating (where the permeate within the plumbing loop is heated and circulated). Flow through loop heating consumes less water and power compared to tank systems.(1)

The duration required for the RO membrane heat disinfection is dependent on the make and model of the RO unit.

Disinfection of the RO membrane is typically completed weekly to reduce scale and bacterial contamination. Regular heat disinfection of the plumbing loop is crucial to avoid bacterial contamination and biofilm development. The 'dose' of disinfection is dependent on the temperature of the water flowing through the plumbing loop and the amount of time that the hot water is in contact with the plumbing loop.(2) The optimum 'dose' is not known.

Most older units heat the water to a certain temperature and circulate that hot water for a set period of time. Many modern units have a live calculation of the disinfection 'dose' achieved and will discontinue the disinfection program once the target 'dose' is met. Disinfection of the plumbing loop is commonly completed every night that the RO unit is not operating for dialysis, but this frequency is not mandated. International guidelines for the preparation of water for dialysis simply state that the chosen disinfection program must be verified effective through water testing.(3) Less frequent disinfection may be adequate to achieve acceptable water testing results. Despite dialysis units evolving over time, the RO unit programs are rarely reassessed to ensure they remain fit for purpose. Whilst modern RO units' disinfection time and duration is now commonly automated, older RO units allow for greater variation in disinfection programming and need to be assessed in collaboration with the biomedical technician to ensure the programming is appropriate.

See Appendix 1 for a worksheet to simplify data entry and assessment of the RO unit program.



CASE STUDY

Reverse osmosis (RO) unit heat disinfection

On review of a dialysis unit's RO unit program, it was discovered that the RO membrane was disinfected twice each week (instead of once) and the plumbing loop was disinfected whenever the RO unit was not operating for dialysis (total loop disinfection time: 60 hours each week including 21 hours on Sundays). This schedule was developed many years ago when the dialysis unit only performed treatment three days each week, therefore the RO unit was not functioning four days each week and the risk of bacterial contamination was felt to be high. The dialysis unit now performs dialysis treatments Monday-Saturday and water testing results are pristine.

Intervention and results

The disinfection program was altered to minimise unnecessary disinfection in a stepwise fashion. The RO membrane disinfection was reduced to once weekly and the 21-hour long disinfection of the plumbing loop on Sundays was reduced to resemble the nightly disinfection completed Monday-Saturday. Bacterial and endotoxin testing of the water continued monthly. Every three months following receipt of clear water testing results, the duration of the heat disinfection was slowly reduced to 4 hours Monday-Sunday (total disinfection time: 28 hours). This time was chosen as it was deemed sufficient to achieve a target disinfection dose.⁽²⁾ This has more than halved the duration of time the hot water tank system maintains a high temperature of 90 degrees, significantly impacting on power use.

Conclusions

Avoiding an excessive frequency and duration of disinfection of the RO membrane and plumbing loop will save significant power without adversely affecting water testing results.

References

- (1) Green excellence in dialysis: recommendations for sustainable kidney care [Internet]. EDTNA/ERCA & B Braun; September 2022 [cited 13 December 2023]. Available from: https://www.edtnaerca.org/resource/edtna/files/pdf/education/2022-09-08-Online-Broschure_Green_Dialysis-RZ-ehe.pdf
- (2) Rosenberg U, "Thermal disinfection – the A0 concept and the biological background", *Central Service*, 2003;11:118-20.
- (3) ISO 23500-1:2019, Preparation and quality management of fluids for haemodialysis and related therapies – part 1: general requirements [Internet]. ISO. International Organization for Standardization; 2019 [cited 20 December 2023]. Available for purchase from: <https://www.iso.org/standard/67610.html>

APPENDIX 1

DIALYSIS UNIT:							
DIALYSIS MACHINE MAKE AND MODEL:							
RO UNIT MAKE AND MODEL:							WATER RECOVERY:
	TREATMENT TIMES	DISINFECTION	BLEACH	RO OPERATION	RO DISINFECTION	LOOP DISINFECTION	HIGH HEAT
MONDAY							
TUESDAY							
WEDNESDAY							
THURSDAY							
FRIDAY							
SATURDAY							
SUNDAY							

Water recovery: what percentage of RO feedwater is set for conversion to clean water OR what conductivity results in discard?

Treatment times: what time do the first patients start dialysis and what time do the final patients complete dialysis each day?

Disinfection: does the unit complete an automated heat disinfection of every dialysis machine? What time does this occur?

Bleach: does the unit complete an automated bleach disinfection of every dialysis machines? What time does this occur?

RO operation: what time does the RO operation start and end each day?

RO disinfection: when does the RO membrane undergo disinfection?

Loop disinfection: when does the plumbing loop undergo disinfection?

High heat: is the hot water service operation manually programmed separate to the disinfection times of the RO and loop?

EXAMPLE

DIALYSIS UNIT:		NAMBOUR, QLD						
DIALYSIS MACHINE MAKE AND MODEL:		FRESENIUS 5008						
RO UNIT MAKE AND MODEL:		HERCOPUR			WATER RECOVERY:		800 µS/CM	
	TREATMENT TIMES	DISINFECTION	BLEACH	RO OPERATION	RO DISINFECTION	LOOP DISINFECTION	HIGH HEAT	
MONDAY	07:00 - 21:00	05:30		05:00 - 22:00		01:30-03:00	N/A	
TUESDAY	07:00 - 14:30	10:30		06:00 - 15:30		01:30-03:00	N/A	
WEDNESDAY	07:00 - 21:00	10:30		06:00 - 22:00		01:30-03:00	N/A	
THURSDAY	07:00 - 14:30	10:30	05:30	05:00 - 15:30		01:30-03:00	N/A	
FRIDAY	07:00 - 21:00	10:30		06:00 - 22:00		01:30-03:00	N/A	
SATURDAY	07:00 - 14:30	10:30		06:00 - 15:30		01:30-03:00	N/A	
SUNDAY	-	-		-	04:00-06:30	04:00-06:30	N/A	