OPTIMISING DIALYSIS ACID CONCENTRATE CONSUMPTION

Australian and New Zealand
Society of Nephrology

BACKGROUND

Optimising dialysis acid concentrate consumption

Minimising waste of acid concentrate will save money and carbon emissions through reduced production and transportation requirements**.**

Background

Acid concentrate is mixed with clean water (permeate) and bicarbonate to produce dialysate for online priming of dialysis machines, dialysis treatments, and post-dialysis flushing of blood lines.

In Australia and New Zealand, individual acid concentrate bags or containers are typically used for each dialysis treatment. Any acid not used during the treatment is discarded. The price of acid concentrate is currently approximately $2 per litre. Purchasing acid volume in excess of that required for dialysis treatments is costly and wasteful, as well as having implications for storage space and manual handling of the bags or containers.

Acetate concentrates currently available in Australia and New Zealand (2023)

Product	Volume (L)	Dialysate produced (L)
Baxter SoftPak	3.5	157
	5	225
Braun container	4.7	211
Braun Sol-Can A	4.7	211
Fresenius SmartBag	4.5	202
Nipro Niprosol bags	3.8	171
	4.7	211
Nipro Niprosol containers	3.9	175
	5	225

Assumes acid concentrate 1:44 dilution.

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.

Citrate concentrates available in Australia and New Zealand

Product	Volume (L)	Dialysate produced (L)
Baxter Selectbag*	1	200
Baxter SoftPak Citrate**	3.5	157
	5	225

*Selectbag requires 1:200 dilution. **SoftPak requires 1:44 dilution.

OPTIMISING ACID CONCENTRATE CONSUMPTION

Reduce dialysate volume requirements

Dialysate flow is commonly set to 500mL/min regardless of blood flow, dialyser size and patient body weight. This is despite no apparent benefit on Kt/V from increasing the dialysate flow to blood flow ratio beyond 1.5:1 and studies showing minimal impact on Kt/V in haemodialysis when comparing dialysate flows of 700mL/min, 500mL/min and 400mL/min when blood flow is 300mL/min.(1,2,3) Even lower ratios may be effective in haemodiafiltration (HDF).(4)

On some dialysis machines an Autoflow function is available which automatically adjusts the dialysate flow to blood flow, with variable ratios of dialysate flow to blood flow available. Use of Autoflow significantly reduces both water and acid concentrate usage compared with standardised dialysate flows.(4) Dialysis machines without Autoflow can be manually set to a lower dialysate flow rate to achieve a ratio to prescribed blood flow of 1.5:1.

To note, there are no long-term data on the effects of different dialysate flow rates on patient outcomes. Study of this is needed.

Estimates of acid concentrate volumes required for treatments of varying duration and Q_D

	Q_D 500mL/min		Q_D 450mL/min (or AutoFlow with Q_B 300ml/min)		Q_D 375mL/min (or AutoFlow with Q_B 250ml/min)	
Treatment duration	Dialysate (L)	Acid conc (L)	Dialysate (L)	Acid conc (L)	Dialysate (L)	Acid conc (L)
4 hours	120	2.67	108	2.4	90	2
4.5 hours	135	3	121.5	2.7	101.25	2.25
5 hours	150	3.34	135	3.0	112.5	2.5

Q_D: dialysate flow rate. Q_B: blood flow rate. Autoflow assumes a Q_D:Q_B ratio 1.5:1

Assumes acid concentrate 1:44 dilution.

Above table does not include volume required for priming of dialysis machine or flushing of blood lines following conclusion of treatment (estimated to require an additional 2L of dialysate or 45mL of acid concentrate).

OPTIMISING ACID CONCENTRATE CONSUMPTION

Post-dilution haemodiafiltration (HDF) increases dialysate and acid concentrate use by approximately 15% per treatment. Given this additional resource usage, it is crucial to review a patient's treatment outcomes following prescription of HDF to ensure target substitution volumes are being achieved, or alternatively, that HDF is improving the symptom for which it was prescribed. If not, a return to prescribing haemodialysis should be considered to reduce acid concentrate requirements. Pre-dilution HDF is commonly prescribed to enable anticoagulant-free dialysis as an alternative to repeated saline flushing of the dialysis lines. This practise increases dialysate and acid concentrate use by approximately 30% (assuming a substitution volume 50% of blood flow) and its use should be avoided when not clinically indicated. Automated substitution volume calculation using transmembrane pressure monitoring available on modern haemodialysis machines must be disabled when pre-dilution HDF is completed, or excessive haemofiltration will occur. This can consume up to 65% more dialysate and acid concentrate, significantly impact on clearances achieved during dialysis treatments, and may even result in water-soluble vitamin deficiencies.

In addition to reducing acid concentrate usage, reducing the volume of dialysate required for each dialysis treatment through prescription of lower dialysate flow rates and minimising ineffective HDF prescriptions will reduce reverse osmosis (RO) unit power and water consumption, pre-treatment water and salt requirements, and reject water generation. While the reductions might appear small on an individual patient basis, the potential for savings is large when broader haemodialysis populations are considered.

Individualise the acid concentrate package size used for the patient treatment

The volume of dialysate required for an individual haemodialysis treatment can be estimated from the duration of the treatment and dialysate flow rate. From this information, an appropriately sized bag or cannister of acid concentrate can be chosen for that treatment to reduce waste. Switching between brands of concentrate may be possible, although a once-off small modification to the dialysis machine may be required.

CENTRAL ACID DELIVERY

Central acid delivery involves a central holding tank that delivers acid concentrate via a plumbing system to outlets at the dialysis machines, much like permeate from the plumbing loop. This ensures only the volume of acid required for a treatment is used and no acid is discarded. In addition to avoiding waste of acid, this reduces packaging, manual handling, carbon emissions from production and transportation, and cost.

The acid concentrate for central delivery can be:

1. Mixed on-site from a dry powder or slurry and stored in a central holding tank
2. Delivered via tanker truck to a central holding tank
3. Delivered in large packages

On-site mixing of concentrate is widely undertaken throughout Asia and the Pacific. A dry powder mix with an automated mixing device (ECOMix Revolution) is available through Braun in Australia and New Zealand. This form of acid delivery leads to the greatest reduction in packaging and transportation costs and should be preferenced where recycling of the acid container is possible.

Tanker truck delivery of acid concentrate for central delivery is being increasingly utilised in the UK and Europe. However, distribution distances make this delivery mode uneconomical for most dialysis units in Australia and New Zealand. Large packages of acid concentrate that can be used for central acid delivery will likely be available in the near future. This will not avoid all packaging, but will be the preferred option where recycling of dry powder acid containers is not available by reducing the volume of packaging directed to landfill.

The cost of the infrastructure required for central acid delivery is neutralised over time due to the savings from reduced acid concentrate and waste disposal costs, however the speed of this will be dependent on the size of the unit and number of treatments per week.(5) Given retrofitting existing dialysis centres will incur added expense compared with incorporating the required infrastructure into new builds, the design of new large dialysis centres in Australia and New Zealand should consider the emerging option of acid concentrate delivery to enable its use once it is available.

Other considerations

The move to soft plastic packaging from hard plastic canisters minimises waste volume, however many sites do not have access to soft plastics recycling. This results in increased landfill volume, even if the plastic bag is marketed as recyclable. Sites should explore local options for recycling acid concentrate packaging and consider this at the time of procurement contract negotiations.

To note, the triangle formed by 3 circling arrows found on plastic products does not indicate that a product is recyclable. Instead, the number in the triangle simply denotes the type of plastic the product is made of. While plastic types 1-6 may be recyclable in some instances, plastic with the code 7 can never be recycled.

CASE STUDY

A kidney care service providing treatment to 100 haemodialysis patients switched the QD from 500mL/min to a ratio of 1.5:1 to the prescribed QB. This had no impact on monthly blood testing results but resulted in an average reduction in dialysate volume of 25.5 L per treatment and RO water savings of approximately 300,000 L per year.

The reduced dialysate requirements prompted a switch to purchasing a smaller acid concentrate bag (3.5 L compared with 4.5 L), suitable for 92% of the patient treatments. This change would save approximately $43,000 annually

and avoid the waste of 14,350 L of acid concentrate per year (equivalent to almost 3,200 4.5 L bags of concentrate).

References

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