GREEN NEPHROLOGY: RETRO-FIT OF HEAT EXCHANGERS TO HAEMODIALYSIS MACHINES – CASE STUDY AND HOW-TO GUIDE

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Renal technicians at the Maidstone dialysis unit have investigated the potential costs and benefits of retro-fitting heat exchangers to their existing Braun Dialog+ haemodialysis machines.

The team selected five machines at random and ran simulated dialysis treatments before and after fitting the machines with heat-exchangers. They found that the average reduction in power required for each treatment session was 0.86kWh, representing an 18% increase in efficiency.

The team went on to calculate that an investment of £15,687 to fit heat exchangers to all 83 machines across the Kent and Canterbury renal service would deliver an annual saving of £3988.15 from reduced electricity consumption, with an annual reduction in greenhouse gas emissions of 22.6 Tonnes of CO_2 equivalents.

> *"I recommend all units should consider the financial and carbon savings to made by fitting heat exchangers to those dialysis machines without them, but I would also urge manufacturers to take the initiative and fit them as standard"*
>
> (Fraser Campbell, Renal Technician, Maidstone Dialysis Unit.)

INTRODUCTION

Haemodialysis forms the cornerstone of most renal replacement therapy programmes. Unfortunately, haemodialysis has a considerable environmental impact, as it usually requires frequent patient travel, consumes large amounts of electricity and mains water, and produces significant plastic and packaging waste. It is therefore important that opportunities to reduce this environmental impact are identified. The use of heat exchangers in dialysis machines offers one such opportunity.

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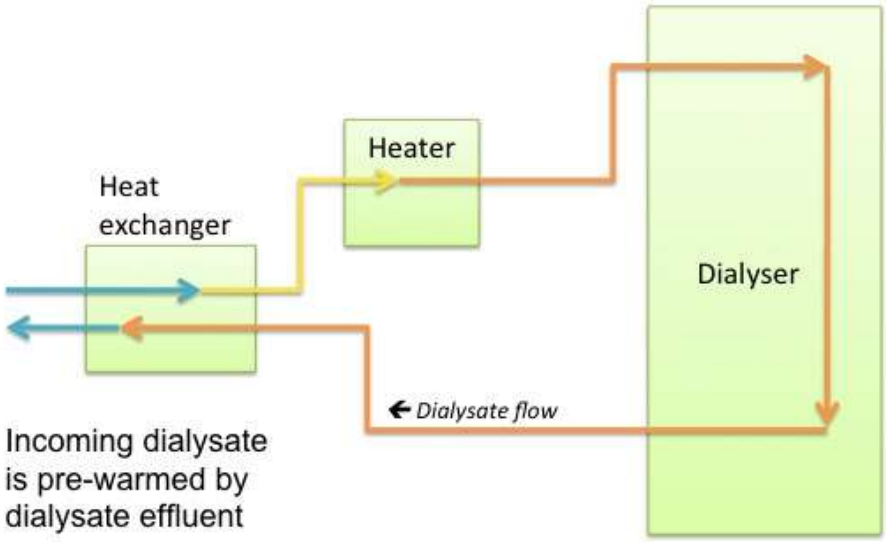
During haemodialysis, blood is removed from the patient and pumped through a dialyser, before being returned to the patient. Inside the dialyser, waste products in the blood diffuse across a membrane into the 'dialysate' fluid, a blend of treated water and chemicals. However, if the dialysate is too cool, the patient may become uncomfortably cold. Cool dialysate also reduces the rate of diffusion, making the treatment less efficient. For these reasons, the dialysate is usually warmed to just below body temperature. The way this warming is done varies. Most machines use a heater controlled by a thermostat to warm the dialysate. However, some machines will also have a heat exchanger incorporated into the system before this heater. In these machines, heat is recaptured from the dialysis effluent ('used' dialysate) and transferred to the incoming dialysate, warming it up before it enters the heater and thereby saving energy and reducing the environmental impact of a haemodialysis treatment.



CASE STUDY: MAIDSTONE DIALYSIS UNIT

The Kent and Canterbury renal service has predominantly purchased Braun Dialog+ haemodialysis machines, and these have been supplied without heat exchangers. However, the purchase of newer haemodiafiltration machines with built-in heat exchangers highlighted the potential financial and environmental savings that heat exchangers can offer. The renal technicians at the Maidstone dialysis unit decided to investigate the possibility of retro-fitting heat exchangers to their existing machines.

Retro-fit heat exchanger kits for Braun Dialog+ machines can be fitted by most renal technicians in less than half an hour. The technical team selected five machines at random and ran simulated dialysis treatments before and after fitting the machines with heat-exchangers. When they measured the electrical energy used by the machines on each run using a power monitor fitted between the wall socket and the machine plug, they found that the average reduction in power

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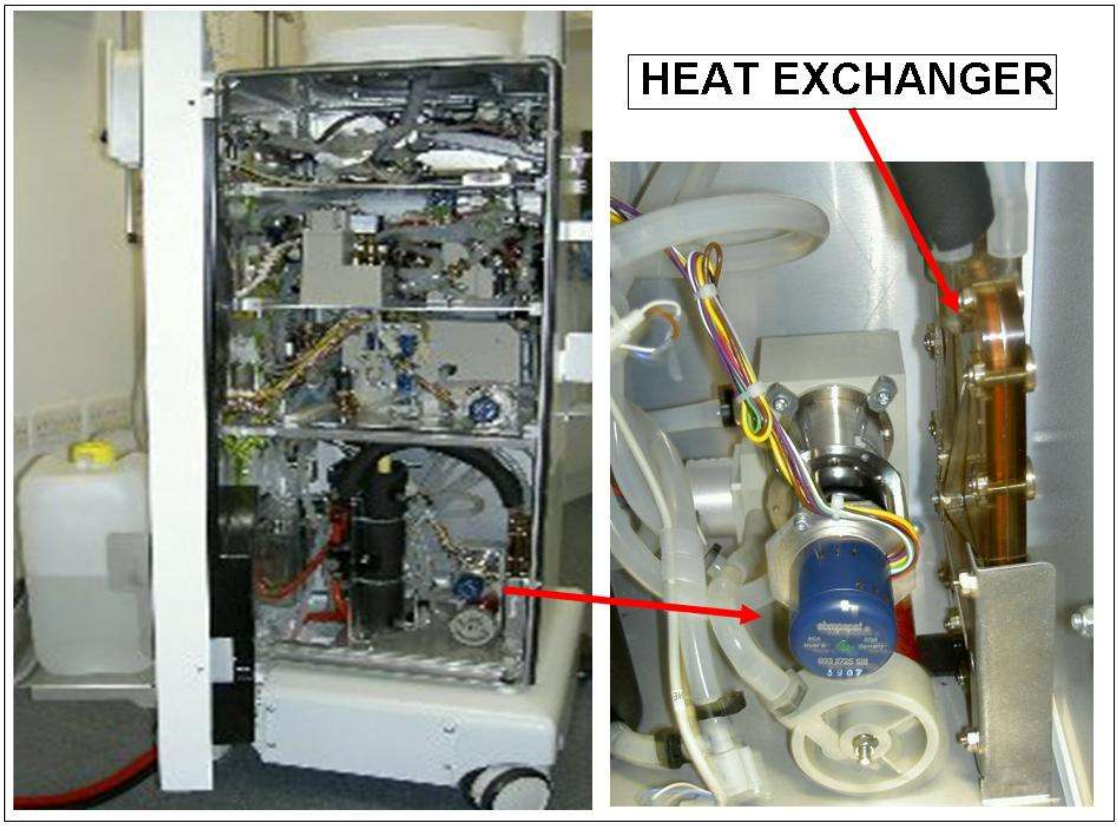
required for each treatment session was 0.86kWh, representing an 18% increase in efficiency (the full results are listed at the end of this case study).



The heat exchanger located inside the haemodialysis machine.

Environmental Savings

Assuming each machine is used twice daily, six days a week for 52 weeks of the year, an annual power saving of 536.64 kWh per machine (2 * 6 * 52 * 0.86) is predicted. Applying a conversion factor of 0.50748 kg CO_2 equivalents per kWh, this in turn equates to an annual saving of 272.33 kg (0.272 Tonnes) of CO_2 equivalents per machine per year. For the 83 machines across the Kent and Canterbury renal service, this equates to an annual power saving of 44,541 kWh and an annual carbon saving of 22.6 Tonnes of CO_2 equivalents.

Environmental Saving [in tonnes of CO_2 equivalents] per yr	=	Total power saving per treatment (0.86 kWh for Braun Dialog+)	*	Number of treatments run per yr	*	Conversion Factor (0.50748)

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There are approximately 1150 Braun Dialog+ machines in operation in the UK at present. If each of these were to be fitted with a heat exchanger, and assuming once again that each machine is used twice daily, six days a week for 52 weeks of the year, an annual saving of 313 tonnes CO_2 equivalents would be realised.

Although the manufacture of heat exchangers would incur a carbon cost in itself, this is estimated to amount to less than one percent of the carbon savings derived from the improved energy efficiency in the first year of use alone.

Financial Costs

Retro-fit heat exchanger kits for Braun Dialog+ machines are available at a cost of £189 each. The cost of introducing this change to any unit will therefore be dependent on the number of machines for which retro-fit heat exchanger kits are required. For the 83 machines in use in the East Kent and Canterbury renal service, the investment cost was calculated at £15,687.

Investment Appraisal

Given the local electricity rate of £0.089 per kWh, the lower energy usage translates to financial savings of £0.077 per treatment (0.089 * 0.86), and an annual financial saving of £48.05 per machine (if used twice daily, six days a week, for 52 weeks of the year).

Financial saving per treatment = local electricity rate * energy saving per treatment

(£/kWh) (0.86 kWh for Braun Dialog+)

The unit cost of the device (£189) could be recouped within four years (£189/£48.05) and a profit made thereafter. In the case of Kent and Canterbury, if each of the 83 machines were fitted with heat exchangers, an annual saving of £3988.15 (£48.05 * 83) would be made thereafter.

What barriers might be encountered by units wishing to introduce this change?

Of course, not every unit uses Braun Dialog+ machines, and it may be that heat exchangers are already incorporated into the machines at your unit. Gambro and Fresenius machines, for example, are generally equipped with heat exchangers as standard.

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Major Risks

It is important to consider the longevity of the existing machines and whether there are any plans to upgrade or replace them. The machines must of course be expected to remain in service for longer than the anticipated period over which the investment outlay will be recouped.

HOW-TO GUIDE: GETTING STARTED

The case study and discussion outlined above includes most of the information required to develop a sound business case for a programme to retro-fit heat exchangers to existing dialysis machines. The following guidance will help you explore the practicalities and assess the financial benefits further.

1. Firstly identify whether the machines in your unit are fitted with heat exchangers.
2. If not, identify the make of the machine, whether a retro-fit kit exists and what it costs.
3. Also, clarify any plans to replace or update the machines.
4. Remember that the figure quoted here for the energy saving per treatment (of 0.86 kWh) has been derived from tests using Braun Dialog+ machines. If your unit uses different machines, for which retro-fit heat exchangers are available, you will need to clarify the potential energy saving per treatment (either using the method outlined in this case study, or through correspondence with the manufacturer).
5. Ascertain the number of machines to which you plan to fit heat exchangers, and how frequently they are used.
6. Find out the local rate for electricity.
7. You should now be in a position to follow through the calculations outlined above. This will enable you to determine the potential financial and environmental savings for your unit.
8. Funding for projects of this nature is most commonly sought through the budget of the renal service. However, interest free loans for energy efficiency measures may also be available from Salix Finance - http://www.salixfinance.co.uk/home.html

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PRIMARY DATA

The complete results from the Maidstone Renal Unit analysis:

Machine Type & Number	Before & After Heat Exchanger	Ambient Temp (ºC)	Inlet Temp (ºC)	Av Heater Output (%)	Treatment		Disinfection	
					Power (kWh)	Cost (£)	Time (mins)	Power (kWh)
Dialog 71	**Before**	21	18.7	47	4.94	0.44	32	0.71
	After	21	18.7	37	3.92	0.35	31	0.64
Dialog 72	**Before**	21	18.7	45	4.71	0.42	34	0.69
	After	21	18.7	36	4.05	0.36	33	0.69
Dialog 73	**Before**	22	19.2	44	4.84	0.43	31	0.6
	After	21	18.2	33	3.78	0.34	34	0.77
Dialog 74	**Before**	22	19.2	44	4.58	0.41	31	0.6
	After	21	18.2	35	3.68	0.33	34	0.76
Dialog 75	**Before**	22	20.2	44	4.76	0.42	32	0.79
	After	22	19.2	37	4.08	0.36	30	0.61
87 (HDF)	**Before**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	After	22	19.2	35	3.7	0.33	35	0.81

FURTHER INFORMATION & SUPPORT – PLEASE CONTACT:

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