Prize Winning Team!

REVIEW OF THE HAEMODIALYSIS PROCESSES IN A SINGLE SATELLITE DIALYSIS UNIT WITH THE AIM TO REDUCE CARBON AND WASTE.

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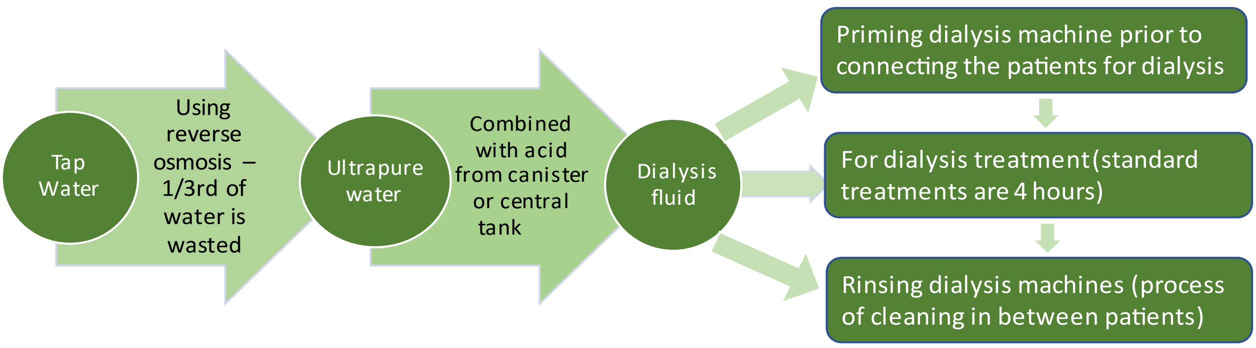
Project Aims:

1. Reducing the number of disinfections of the dialysis machines to once in 24 hrs in staggered manner and replacing the others with rinsing process
2. Once the initial priming process of the dialysis machines is complete, placing them standby mode whilst waiting to connect patients to the machine
3. Reducing the number of pharmacy deliveries from weekly to biweekly to the satellite dialysis unit
4. Reviewing the processes to enable usage of wastewater generated during the process of water purification for dialysis
5. Identifying potential ways of reduction in wastage of canister acid
6. Recycling of the empty acid canisters

Background: Haemodialysis is lifesaving therapy for patients with kidney failure. However, it comes with huge environmental costs, including usage of vast amount of medical consumables, water, and electricity. It is estimated that 3.8 tonnes of carbon-dioxide equivalent emissions are produced by one patient's dialysis treatment per year[1].

Studying the system: We started by creating a process map of the steps from the production of dialysis fluid to use of dialysis machine, with major steps outlined below.



Of approximately 350-400 litres of water utilised during each dialysis session, a significant part (1/3rd to 2/3rd depending on the system) is wasted during the process of purification. In the satellite unit under review (1 of 8 in LTHT), we provide services to our patients in two different shifts per day. This means that a single dialysis machine is routinely used for provision of two dialysis treatments in a 24 hour period. As per the standard practice of the unit, the dialysis machine gets three heat disinfections (the beginning of the day, in between patients and at the end of the day). As a part of the routine, dialysis machines are primed and turned on at the beginning of the day, and dialysis fluid runs continuously whilst waiting for the patients to be connected. The process of dialysis requires several consumables like lines, dressing kits, pharmaceutical products which are currently delivered from the central hospital services weekly.

Changes implemented:

The proposed plans for aims 1 and 2 were discussed with the staff on the unit during daily handovers to seek their views and encourage staff engagement. Staff were enthusiastic to try the suggested changes. The whole unit (and all dialysis machines) are visible at the same time, which helped us to successfully remind the team of the changes in the initial stages of implementation.

A similar approach was adopted with aim 3 with seeking staff opinions regarding the sustainability of fortnightly deliveries by exploring the availability of the storage space, rearranging few storage cupboards to improve the utilisation of the available space, and relabelling of the cupboards as per the new agreed storage arrangements.

Measurement:

Aim 1: We measured the electricity and water usage with each episode of disinfection and rinse during 24 hour periods for one dialysis machine. We then projected the electricity and water use over one year.

Table 1: *Comparison of the differences in the power and water consumption in the Satellite dialysis unit with Standard vs Changed practice*

Table 1	**Standard practice**		**Changed practice**	
Number of actions/ day	3 disinfections	0 Rinse	1 disinfection	2 Rinses
Number of stations in dialysis unit	10	0	10	10
Working days/ week in dialysis unit	6	0	6	6
Number of action/ week in dialysis unit	180		60	120
Number of action/ year in dialysis unit	9360	0	3120	6240
Power Consumption/action (Kwh)	0.75	0	0.75	0.1
Power Consumption/year (Kwh)	7020	0	2340	624
Total Power per year (Kwh)	7020		2964	
Water Consumption/action (L)	14.6	0	14.6	4.4
Water consumption/year (L)	136656	0	45552	27456
Total water per year (L)	136656		73008	

**Action refers to disinfection or a rinse process; Kwh- kilo watt per hour; L- litres.*

Aim 2: We collected data regarding the waiting times between the dialysis machined being primed and turned on, to when a patient was connected, over a period of one week. This data was utilised to calculate the average time per dialysis station per day. We then measured the consumption of electricity, water and central acid usage during this waiting time per minute and projected it over a one year period. There is a scope for further savings from this change by reduced number of central acid deliveries, however it is not possible to precisely calculate at this stage.

Table 2: *Summary of the power, water and acid consumption during the standard practice of allowing continuous flow of dialysis fluid whilst waiting for patients*

Table 2	**Standard Practice (Continuous flow of dialysis fluid whilst waiting)**
Average waiting time/machine/day (minutes)	135
Number of stations in dialysis unit	10
Working days/week in dialysis unit	6
Total average waiting time/week (minutes)	8100
Total waiting time/year (minutes)	421200
Power consumption kwh/minute	0.004
Total power consumption/year (kwh)	1684.8
Water consumption/minute	0.12
Total water consumption/year (L)	50544
Acid consumption/min (ml)	8.33
Acid consumption/year (L)	3508.596

**Kwh- kilo watt per hour; L- litres; ml- millilitres*

Aim 3: Reducing pharmacy deliveries from weekly to biweekly will lead to an average saving of 104 miles in transportation per year. We are liaising with the teams at the other satellite units within the Trust to investigate if the same change is feasible in their setting. This would yield higher milage savings.

Aim 4: We measured the water wastage from the purification system at the satellite unit and it comes to 1,337,000 litres/ year. We are liaising with appropriate teams to enable redirection of this water to grey water systems of our healthcare setting. Significant progress has been made in one of our other satellite dialysis units and we are looking forward to continuing this work to maximise the benefit of water preservation.

Aim 5: As demonstrated in flow chart 1, we use acid supplied in 6 litre plastic canisters and our standard practice is to use one canister for each patient/ treatment. The leftover acid goes down the drain systems. On measurement of the wastage of the acid, the cumulative wastage of acid comes down to 18.75 Litres over 10 dialysis treatments. We are currently exploring the feasibility of avoiding this wastage, by liaising with the infection control team regarding potential safety issues if we were to use a cannister for multiple patients.

Aim 6: Currently we do not recycle the plastic acid canisters. We are in discussion with the hospital wastage management team regarding recycling potential of these canisters by using existing steri-melt facilities.

Results:

Our data enabled to calculate the impact of changes made for aims 1, 2 and 3. For travel, water and energy conversion factors from the UK government BEIS 2021 database were used. Pharmaceutical carbon factors were taken from the Greener NHS Team 2020-21. In total, changes implemented from our aims 1, 2 and 3 will save **1,914.4 kgCO2e** and **£2,837.05.** The rest of the projects have been excluded from analysis at this stage as they are still work in progress.

Table 3: *Summary of the environmental and financial impact from Aims 1, 2 and 3 from proposed changed practice in the satellite dialysis unit*

Table 3	**Savings per year**	**Environmental impact**		**Financial Impact**	
		kgCO2e/ unit	**Total kgCO2e**	**Pence/ unit**	**Total (£)**
Electricity (Kwh)	5740.8	0.2913	**1672.29504**	22.4	**1285.9392**
Water (m3)	114.192	0.3666	**41.8627872**	232	**264.92544**
Travel (miles)	104	0.09489	**9.86856**	56	**58.24**
Acid savings (L)	3508.596	0.155	**190.341333**	35	**1228.0086**

**Kwh- kilo watt per hour; m^3- cubic meters; L- litres and kgCO2e -Carbon Dioxide Equivalent in kg*

This satellite unit is a part of Leeds Haemodialysis services which currently provides care provision for 550 incentre dialysis patients in 8 different dialysis units. After taking into consideration of the shift patterns in each unit, if we implement the above changes across our haemodialysis services, the estimated annual savings will be much higher.

Table 4: *Estimated impact from proposed changed practice on implementation across the Leeds Haemodialysis services*

Savings per year	**Changing to 1 heat disinfection + 2 rinses per day**	**Dialysis fluid flow off during the standby for patient**
Total reduction in power consumption (Kwh)	41353.2	38
Total reduction in water consumption (m3)	509.3868	3236
Power kgCO2e	12046.19	11
Water kgCO2e	186.7412	1186
Acid kgCO2e	NA	2398.284
Total reduction in kgCO2e	**12232.93**	**3595.284**
Power (£)	9263.296	8.512
Water (£)	1183.2	7507.52
Acid (£)	NA	15472.8
Total cost savings(£)	**10446.5**	**22988.83**

**Kwh- kilo watt per hour; m^3- cubic meters; L- litres, £- pounds and kgCO2e -Carbon Dioxide Equivalent in kg*

Based on the above calculations, a reduction of 0.1845 kgCO2e/patient/dialysis session can be achieved with the implementation of the above proposed changes. If the same small changes were possible for all 24,365 people receiving dialysis in the UK[2] and energy consumption of all dialysis equipment was similar across the 70 renal centres in the UK, the national reduction in CO2 emissions could be in the region of 4,495kg per treatment session. If everyone was having dialysis thrice per week, that would reduce CO2 emissions by approximately 700 tonnes per year.

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Social sustainability and clinical outcomes: The proposed changes may not directly impact individual patient experience but may contribute to an improvement in the turnaround of the patients in the dialysis unit, for example from saving time by replacement of disinfection (40 minutes) with rinse (9 minutes) of the machine in between patients. The unit is planning to move from a 2 shift to 3 shift cycle. Our new system will support in reduce staff workload.

Barriers encountered:

Measuring energy and water consumption on site was difficult as the relevant meters aren't in place, so this was dealt with in a test setting in the main workshop. Reuse of water, maximising the benefits of reduced acid consumption and improving recycling has been more difficult to achieve as we need input from other departments and discussions about various policies. These discussions are ongoing.

Steps taken to ensure lasting change and conclusion:

We learnt a lot from this project and were pleasantly surprised by how much we could reduce our central acid consumption, as well as save water and electricity with relatively simple changes. We are proud to work with an enthusiastic team who were all willing to take part to support changes to everyday practice. Meeting with colleagues regularly and tackling a different sort of problem to usual was really uplifting and motivating, especially when we realised how much potential benefit there would be when we roll out across the service. Our next steps are to spread this enthusiasm by sharing our project aims and finding at an upcoming departmental meeting, and to explore if the other satellite units would consider a reduction in their pharmacy deliveries.

We are continuing to explore options for projects 3-6 as we could have even further savings

- Aim 4: Water wastage from the purification process was measured as 1,337,000 litres/ year. Across the service equates to approximately 16,848,000L of water wasted per year, equivalent to 6 Olympic sized swimming pools. We are liaising with appropriate teams to enable redirection of this water to grey water systems of our healthcare setting. Significant progress has been made in one of our other satellite dialysis units and we are looking forward to continuing this work to maximise the benefit of water preservation.
- Aim 5: We use acid supplied in 6L plastic canisters and our standard practice is to use one canister for each patient/ treatment. The leftover acid goes down the drain systems. On measurement of the wastage of the acid, the cumulative wastage of acid comes down to 18.75L over 10 dialysis treatments. We are currently exploring the feasibility of avoiding this wastage, by liaising with the infection control team.
- Aim 6: Currently we do not recycle the plastic acid canisters. We are in discussion with the hospital wastage management team regarding recycling potential of these canisters by using existing steri-melt facilities.

References:

1. Connor A, Lillywhite R, Cooke MW. The carbon footprints of home and in-center maintenance hemodialysis in the United Kingdom. Hemodial Int. 2011 Jan;15(1):39-51. doi: 10.1111/j.1542-4758.2010.00523.x. Epub 2011 Jan 14. PMID: 21231998.
2. UK Renal Registry (2021) 23rd Annual Report- data to 31/12/2019, Bristol, UK. Available from renal.org/audit-research/annual-report.