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Bulletin de la Dialyse à Domicile

Equipment and water treatment for the daily management of home hemodialysis

(Equipement et traitement d'eau pour la gestion quotidienne de l'hémodialyse à domicile)

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Summary

Home hemodialysis (HD) must remain one technique among many in the treatment of end-stage renal failure. For this reason, everything must be done to ensure that patients, with the help of their health care team, have a choice. The management of accessibility to home water treatment is still difficult today despite the significant progress made in recent decades. The development of (Daily Home Hemodialysis) without having to install water treatment in a patient's home is notable progress that has given the necessary impetus to the development of patient treatment at home. The challenges remain great—particularly in the development of sorbent dialysis, which should be addressed with the help of nanotechnology while working to increase the number of patients treated. There is also a need to create an eco-responsible attitude by reducing the amount and wastage of water used.

Key words: home hemodialyis,water treatment,ecology,-sorbants,nanotechnology,low-flow.

Résumé

L'hémodialyse à domicile doit rester une technique parmi tant d'autres pour traiter l'insuffisance rénale terminale. Pour cela tout doit être mis en place pour que les patients puissent avoir le choix, aidés par leur équipe soignante. La gestion de l'accessibilité à un traitement d'eau à domicile reste encore de nos jours difficile malgré les progrès notables lors des dernières décennies. Le développement de l'HDQD sans avoir à installer un traitement d'eau au domicile des patients est un progrès notable qui a donné un élan nécessaire au développement du traitement du patient au domicile. Les défis restent grands malgré tout, notamment pour le développement de la dialyse à sorbants qui devrait revoir le jour avec l'aide des nanotechnologies cela aidera à augmenter le nombre de patients, mais aussi à avoir une attitude éco responsable, en diminuant les quantités d'eau utilisées et les déchets générés par ce type de traitement.

Mots clés : hémodialyse à domicile, eau, écologie, sorbants, nanotechnologie, bas débit.

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INTRODUCTION

Water is essential for life: there is no debate today about the essential role this precious liquid plays in our lives. Its application in the field of health has become indispensable. Dialysis is no exception to this rule, which places it at the heart of chronic care for patients with end-stage renal disease.

Much progress has been made in recent years in simplifying water treatments and making them less complex and more reliable, which is essential for their use by patients and their caregivers at home. This, in addition to the use of bags for Daily Home Hemodialysis , has made access to treatment easy for many patients. However, other challenges must be met in the coming years, including finding ways to significantly reduce the amount of water used as well as its wastage. We are beginning to talk about the «green transition in health»; and, in dialysis, there is much to be done.

Water in the hospital

Elements	Dialysis water (mg/l)	Drinking water (mg/l)
Chlorinated elements	0.1	-
Chlorides	50	250
Fluorides	0.2	1.5
Nitrates	2	50
Nitrites	0.005	0.1
Phosphates	5	5
Sulfates	50	250
Total aluminum	0.01	0.2
Ammonium	0.2	0.5
Calcium	2	-
Tin	0.1	-
Magnesium	2	50
Mercury	0.001	0.001
Sodium	50	150
Potassium	2	12
Zinc	0.1	5
Heavy metals	<0.1	0.05
Cadmium	<0.1	0.005
Lead	<0.1	0.05
Copper	<0.1	1

🠅 *Table I Cf. – Circular DGS/38/DH/4D of 1986 relating to water treatment. Comparisons of element concentrations. International Organization for Standardization. ISO 13959:2014. [2]*

There are strict standards and frequent controls to ensure the quality of water for care and to avoid nosocomial infections. In France, the Conseil supérieur d'hygiène de France [1] was in charge of regulating this subject.

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Objectives that relate to the quality of water that is used in dialysis are clear and precise; they include:
• Maintaining the physico-chemical consistency of the diluted solution
• Imparting no toxicity to the patient
• Good bacteriological and pyrogenic standards
• Elimination of bacteria present in water
• Avoid bacterial recontamination of the system
• Inhibit bacterial growth
• Production of water of bacteriological quality compatible with the final application

At home

There are no water quality exemptions for the home: all hospital standards must be applied, which is sometimes difficult to achieve.

This is one of the reasons why the development of hemodialysis (HD) for home use has been stagnating or even declining over the past few decades.

We had to rethink our model, through a significant collaboration with industry, to support our research.

Low flow systems

The arrival of systems with a cycler for HDQD has created a new boom for this type of technique. Simple machines and the use of dialysate bags with «ready-to-use» lactate or bicarbonate as a buffer have led to a renewed interest in home dialysis.

However, there is still a long way to go: the amount of water used in dialysis, even at home, as well as the production of waste is still an extremely important factor. We are just beginning to talk about an eco-responsible attitude in the hospital environment, and we are already behind. [3, 4]

Dialysis and ecology

In 2025, there will be more than 4 million dialysis patients in the world, which is equivalent to 600 million sessions per year.

It is clear that today we are facing climate change and especially its consequences that we can already see. Our attitude must be responsible in the face of what is probably the greatest challenge that humanity has ever had to face.

Several initiatives are already underway to reuse dialysis water in hospitals, but these initiatives remain fairly marginal.

The Centre for Sustainable Healthcare (https://sustainablehealthcare.org.uk/green-nephrology) in the UK is an example of an initiative that aims to improve our care while respecting the environment by trying to make us carbon-neutral in our activities.

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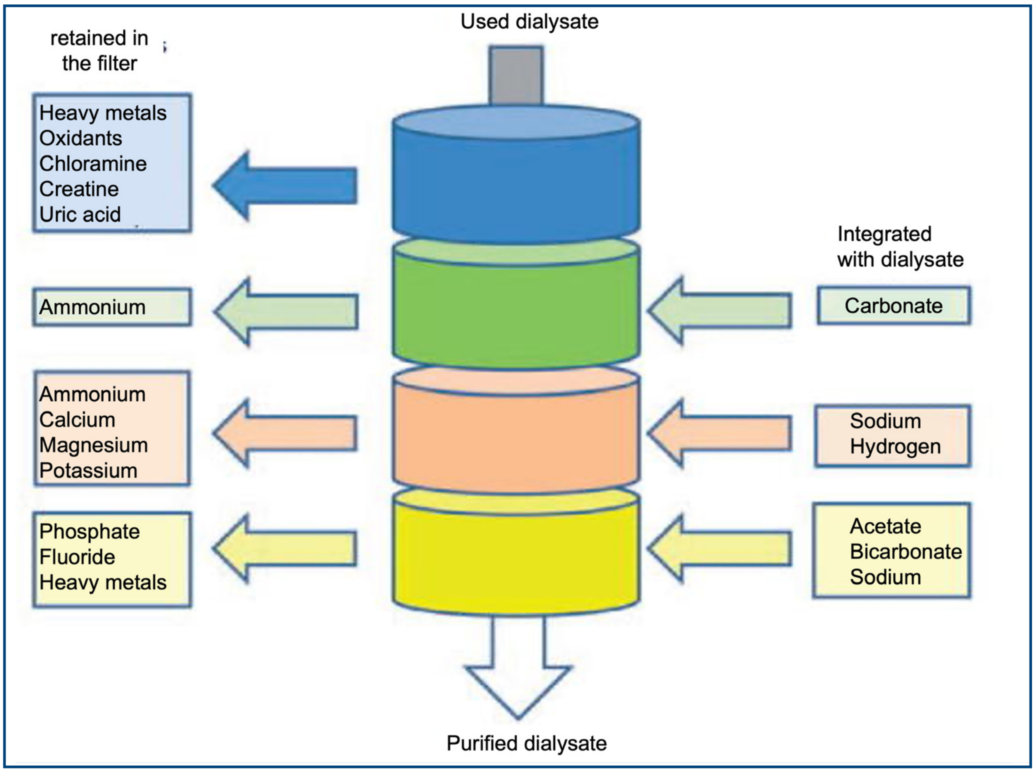
⬆ *Figure 1. Examples of waste produced by dialysis Rev Med Suisse 2013 ; 9 : 468-72*

Sorbent dialysis

Sorbent dialysis is based on the principle of passing used dialysate through a filter consisting of four layers placed close to each other in order to obtain a purified solution that returns to the patient. The filter also has the ability to eliminate bacteria and cytokines. This results in ultra-pure water. A sorbent filter must be used in conjunction with a conventional semi-permeable HD filter, which will allow the semi-permeable filter to purify the blood while the sorbent filter will allow the dialysate to be recycled. Sorbent dialysis requires only 6 L of water in a closed circuit versus the 400 to 500 L required in HD. To date, studies have only been done on small groups of patients. Large-scale studies will have to be carried out to better evaluate the effectiveness, risks, and management of such devices. [5]



⬆ *Figure 2. Diagram of a sorbent filter*

The first layer is made of activated carbon. This has the property of being very porous with a large absorption surface. Heavy metals, oxidants, chloramines, creatinine, uric acid and other organic particles are absorbed there. The second layer is composed of urease, an enzyme whose role is to catalyze the transformation of urea ($(NH_2)_2CO$) into carbon dioxide (CO_2) and ammo-

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nium (NH3). The third layer consists of zirconium phosphate containing on its surface sodium (Na+) and hydrogen (H+) which are exchanged for potassium (K+), calcium (Ca++), magnesium (Mg++), metals heavy and ammonium (NH3). Finally, the fourth layer contains carbonate and zirconium oxide which adsorb phosphate (PO4-), fluorine and heavy metals in exchange for sodium (Na+), bicarbonate (HCO3-) and a small amount of 'acetate. The purified dialysate thus obtained containing Na+, H+ and HCO3- is brought into contact with a dialysis bath containing K+, Ca++, Mg++ and is recirculated to the patient for a new cycle. The filter also contains the ability to filter out bacteria and cytokines. This makes it possible to obtain ultra-pure water. The sorbent filter must be used in conjunction with a conventional semi-permeable hemodialysis filter: thus, the semi-permeable filter will purify the blood, and the sorbent filter will recycle the dialysate

Rev Med Suisse 2015 ; 11 : 514-20

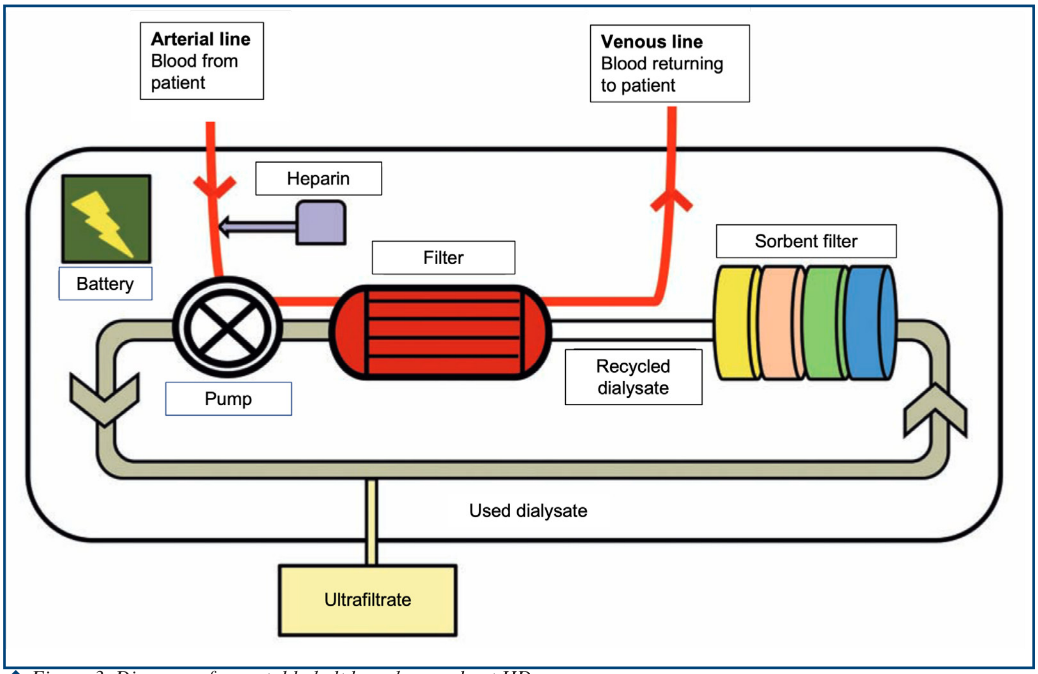

Figure 3. Diagram of a portable belt based on sorbent HD

Rev Med Suisse 2015 ; 11 : 514-20

Nanodialysis

Some nanodialysis systems already exist and are beginning to prove their worth, notably in the Netherlands which has the WEAKID system in peritoneal dialysis DP that is subsidized in large part by the European Union. The WEAKID system (Wearable Artificial Kidney) is promising. [6] There is still room for improvement in the following areas:
• Ergonomics
• Battery life
• Security
• Test of its applicability on a large scale

CONCLUSION

Although major advances in techniques that allow us to treat patients at home have been made and have thus enabled us to advance slightly in the objective of increasing the number of patients reached, the challenges that we must face at the beginning of the twenty-first century make the task somewhat difficult. It is essential that all proponents of home dialysis work hand in hand to advance our common goals while maintaining an eco-responsible attitude in any future innovation: we do not have a choice anymore.

CONFLICT OF INTEREST

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