

Haemodialysis to Online Haemodiafiltration – Concerns on Clinical Implications

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Abstract: Switching from Haemodialysis to online Haemodiafiltration is a trend today. There is literature available for differentiating the merits and demerits of both HD and online HDF. In this paper, we just try to point out our opinion about the concern of patient safety while applying these advanced extracorporeal therapies without having a feasible applicability of quality and standard guidelines for the water used for it. This paper may help future aspirants to do more research on the gaps in quality and standard guidelines of these treatments.

Keywords: Haemodialysis, Haemodiafiltration, Online Haemodiafiltration, Water Soluble Vitamins, Patient Safety, Water Quality.

1. Introduction

Haemodialysis (HD) and online Haemodiafiltration (HDF) are the two popular therapies helpful for chronic kidney disease (CKD) stage five patients to sustain their lives.

A. The Procedure of Haemodialysis (HD)

HD is a procedure in which the blood of a person is processed with the help of an extracorporeal circuit containing a dialyzer (Dialyzer). Nowadays cylindrical shaped hollow fibre kidney (HFK) is used for HD procedure. Based on the characteristics of the HFK the Haemodialysis can be classified into conventional (Low water removal and solute removal capacity HFK is using), High flux (High Water removal capacity HFK is used) and High efficiency (High solute transport capacity HFK). In HFK two compartments are there. Blood is passed through hollow fibres, that is blood compartment and the hollow fibres are dipped in the Dialysate bath compartment. In haemodialysis solute/toxin removal is achieved mostly by diffusion. The solvent removal is achieved in HD by Ultrafiltration. All the toxins, solutes and extra water removed are exiting from the dialyser along with spend dialysate.

Table 1

Concentrate proportioning ratios [1]

Acid part	Water	Bicarbonate part
1	34	1.83
1	42.28	1.72
1	32.775	1.225
1	34	1.1

The usual dialysate flow rate is 500-800ml/minute in a

dialysis treatment. The dialysate is prepared inside the machine with three components.

- 1) Acid part (Acid concentrate)
- 2) Bicarbonate part (Bicarbonate concentrate)
- 3) Water

Every machine manufacturer provides their concentrate proportioning ratios for the preparation of dialysate inside the machine. The most used proportioning ratios are below. (See Table 1). One four-hour HD session will use a dialysate of 120 litres if the dialysate flow rate is 500ml/min (500mlx60minx4 Hours) and a minimum of 120 litres of dialysate comes in contact with blood. As per the concentrate proportioning ratio, more than 90% of the dialysate is water only. From this, it is very clear that the prominence of water in the dialysate. This is the reason why the Quality of Water Used for HD is having high importance. The dialysis water quality for conventional HD is different from High flux HD in terms of microbiological purity as per current practice. The guidelines for the limits of chemical contaminants and microbiological contaminants are mentioned in the Association for the Advancement of Medical Instrumentation (AAMI). (See Table 2 and Table 3)

B. The Process of Haemodiafiltration

Haemodiafiltration (HDF) is one of the extracorporeal treatments for removing toxins and extra water present in the human body due to renal insufficiency. which will help to maintain electrolyte balance among renal failure patients. The difference between haemodialysis (HD) and HDF is the infusion of replacement fluid for extra filtration which will help to remove more water-soluble middle molecular toxins from the blood.

There are standards for water quality to be maintained for conventional haemodialysis. In conventional HD, the water permeability and solute clearance of the dialyser will be low and the pore size of the dialyser also will be low.

Globally new updates are happening in HDF, one of which is online HDF. In online HDF the dialysate produced by the machine is directly infused into the patient's body and the same amount of fluid is filtered from the patient's blood. Some studies proposing 18-20L filtration are needed for the effective survival of the patient while using HDF. Replacement fluids used for HDF manufactured by companies may be based on quality and

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standards, But in online HDF the machine is prepared with the help of processed water in the dialysis centre mainly used for conventional HD or even High flux HD.

Table 2
The acceptable limits of chemical contaminants in HD water [2]

Contaminants	Maximum allowable limits(mg/L) of Chemical contaminants for HD water as per AAMI RD52 guidelines
Calcium	2
Magnesium	4
Potassium	8
Sodium	70
Antimony	0.006
Arsenic	0.005
Barium	0.10
Beryllium	0.0004
Cadmium	0.001
Chromium	0.014
Lead	0.005
Mercury	0.0002
Selenium	0.09
Silver	0.005
Aluminum	0.01
Chloramines	0.10
Free chlorine	0.50
Copper	0.10
Fluoride	0.20
Nitrate (as N)	2.0
Sulfate	100
Thallium	0.002
Zinc	0.10

There are microbiological standards available to be maintained for the infusion of fluids into the human body. Ultrapure dialysate, generally considered to have a bacterial count <0.1 CFU/mL and an endotoxin level <0.03 endotoxin units (EU)/mL, is required for online convective therapies, such as online hemodiafiltration, and its use has been recommended for all haemodialysis therapies [3]. (See Table 4)

Some of the usual questions to be addressed about online HDF are below.

1. Do we need attention to the water quality used for Online HDF when compared to HD?

Yes, we just need to pay more attention to the water quality because the infusion of large amounts of fluids is present in online HDF and the Dialyzer used is High pore sized (High flux).

- As per the literature, companies are claiming that online HDF is efficient in removing inflammatory mediators because of high filtration(convection) [4]-

Table 3
The acceptable limits of bacteria and endotoxin present in water used for HD [2]

Microbiological contaminants	Maximum allowable limits of microbiological contaminants as per ANSI/AAMI/ISO 13959:2009* and 23500:2011 and ANSI/AAMI RD 23500:2014
Bacteria (water and dialysate)	<100 CFU/ml (Action limit is more than or equal to 50CFU/ml)
Endotoxin (water)	<0.25 EU/ml (Action limit is more than or equal to 0.125 EU/ml)

Table 4
Quality and Standards for the water used for HD and online HDF

Water quality standards	HD	Online HDF
Guidelines for chemical contaminants	Available (AAMI standards)	Not available (trend to use the same as that of HD)
Guidelines for microbiological contaminants	<100 CFU/ml <0.25 EU/ml	<0.1 CFU/ml <0.03 EU/ml
Exposure of Water as an infusion	No	Yes (18-20L for an effective treatment)
Total exposure of water with Blood for 4hours treatment with 500ml/min dialysate flow	Aproximate 120L	Approximate 140L

[6]. There are standard chemical contaminations allowed for HD as mentioned above table by AAMI. Online HDF follows the same method for allowable chemical contaminants in water used for HD. The procedure of Online HDF involves more amount of infusion fluids compared to HD (7,8)

- The major concern here is, the major principle of online HDF is convection (Removal of toxins with high filtration) and regarding HD, limited convection due to limited ultrafiltration. The inflammatory mediators may be removed well in online HDF and there may be the occurrence of severe inflammation due to the impurities present in water used for the treatment. In this case we feel that appropriate studies should be conducted on the impact of online HDF.
- What are the consequences the patients face, related to poor water quality used for online HDF?
Complications due to the use of poor-quality water for HD are available in the literature, including anaemia, seizures, Haemolysis, Abdominal pain, neuropathy, infections etc. In the case of online HDF, the complications can be more severe and may have new complications like deficiency of water-soluble vitamins due to heavy filtration.
 - Does it need a separate standard for online HDF when compared with the standards and quality of Conventional HD?

It may help maintain patient safety because of the heavy infusion of fluids to the bloodstream compared to HD. The chemical impurities may accumulate in the patient's body.

4. Can we use the same allowable limits for chemicals in water used for HD in Online HDF?

It may be better to redefine because of the heavy infusion of fluids.

5. Can we make it available a new standard for the water quality used for online HDF?

New researchers should come front to study the effect of water impurities on people on HDF to understand more about it and to make optimum water quality guidelines only for online HDF treatment.

6. Is there any chance of severe Water-soluble vitamin deficiency in online HDF when compared to normal HD?

It may have an impact because a large volume of filtration is happening in online HDF and the water-soluble vitamins, as well as water-soluble ions, may be lost in excess due to this

treatment mode.

2. Conclusion

Clearly, we are still lacking the feasible criteria which can apply for improving patient safety in advanced extracorporeal treatment modalities like online HDF. It is very important to think about this and act for further improvement for the chronic kidney disease population.

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