# In vitro characterization of High-Flux and High Cut-off membranes.

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## INTRODUCTION

Dialysis membranes are designed to accomplish the removal of uremic toxins and excess water from the blood of patients with chronic renal failure while balancing the electrolyte content in the blood with the dialysis fluid. The patophysiology of the uremic syndrome is still not clearly understood; most important than urea and beta 2 microglobulin are middle and high molecular weight toxins and protein bound solutes (molecules like cytokines, free light chains, phenols, etc.). But while the removal of small molecules takes place mainly by diffusion due to concentration differences between the blood stream and the dialysis fluid flow, the removal of middle molecules is mainly achieved by convection through ultrafiltration. The degree of diffusion and convection depends on the treatment mode (hemodialysis, hemofiltration or hemodiafiltration) as well as on the membrane type (low-flux, high-flux, protein leaking, or high cut-off membranes).

Since dextrans are linear chains, its size does not correspond to that of a protein with similar molecular weight. However, the sieving curve determined with a dextrans solution mixture can be considered a standard characterization technique for a membrane, and a number of recent publications have analyzed this methodology.

In this work we characterize a new class of membrane with high permeability whit the purpose to demonstrate the possibility to increase the depuration spectrum of high molecular and protein bound toxins.

## METHODS

Dextrans (Sigma-Aldrich; Average Molecular weight (MW): 17.9, 35.6 and 73.4 kDa) solutions were prepared in distilled water at concentration of 1 g/L for each Dextran.

The Dextran solution was recirculated at 300 ml/min flow rate and 30, 40 and 60 ml/min as ultrafiltration flow.

Feed (blood side entrance), retentate (blood side exit), and filtrate (dialysate exit) samples were taken at 15, 30 and 60 min. The scheme of the experimental setup is shown in figure 1.

Relative concentration of the samples were analysed by spectrophotometer

The sieving coefficient SC was calculated according to the equation:

$$SC = \frac{2 \cdot C_F}{C_P + C_R}$$

where CF is the concentration of the solute in the filtrate, CP its concentration in the permeate and CR its concentration in the retentate.

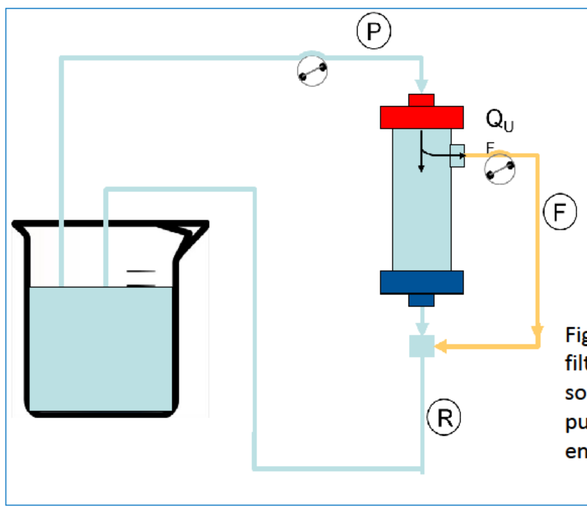


Fig 1: Scheme of the experimental setup for the filtration experiments, showing: poll with Dextrans solution, feed pump (300 ml/min), ultrafiltrate pump (30, 40 and 60 ml/min), permeate, filtrate end retentate sample points

Table 1: Devices employed for the classification of dialysis membranes.

| Device | Inner diameter/wall thickness [µm] | UFC [mL/mmHg/h] | Fibre type | Manufact | Dialyzer type |
|---|---|---|---|---|---|
| Phylther HF 17 G | 200/30 | 53 | PUREMA | Bellco Italy | High-Flux |
| BK-1.6F | 200/n.a. | n.a. | PMMA | Toray Japan | Protein leaking |
| Theralite | 215/50 | 52 | PAES/PVP | Gambro Sweden | High cut-off |
| Supra 17 | 200/35 | 38 | Synclear 0,2 | Bellco Italy | Hyper high flux |
| KIDNEY 17 | 200/35 | 40 | Synclear 0,5 | Bellco Italy | High cut-off |

## RESULTS

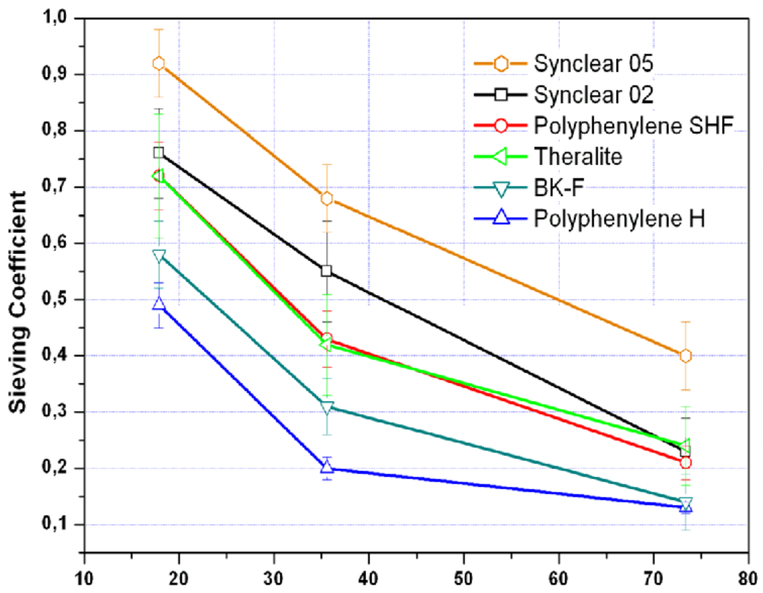


Fig 2: Representation of the sieving curves of different membrane types, is shown in Figure 2.

| | | sieving coefficient | | |
|---|---|---|---|---|
| | MW Destran (kDa) | 17,9 | 35,6 | 73,4 |
| Dialyzer | Sync 0,5 | 0,92 ± 0.06 | 0,68 ± 0.06 | 0,40 ± 0.06 |
| | Sync 0,2 | 0,76 ± 0.08 | 0,55 ± 0.09, | 0,23 ± 0.06 |
| | P SHF | 0,72 ± 0.06 | 0,43 ± 0.05 | 0,21 ± 0.03 |
| | P HF | 0,49 ± 0.04 | 0,20 ± 0.02 | 0,136 ± 0.01 |
| | BK-f | 0,58 ± 0.06 | 0,31 ± 0.05 | 0,14 ± 0.05 |
| | Theralite | 0,72 ± 0.11 | 0,42 ± 0.09 | 0,24 ± 0.07 |

Table 2 The values of sieving coefficients for dextrans with MW of 17.9, 35.6 and 73.4 kDa for different dialyser

The sieving curve or sieving profile of a membrane is a description of the variation of its sieving properties for solutes of different molecular weight, which is assumed to be proportional to its size. The most evident difference among the types of membranes is their position along the molecular weight axis.

Six different commercially available dialyser were characterized throughout sieving coefficient calculation for each dextran solution. As expected, we found an inverse proportionality between dextrans molecular weight and sieving coefficient. The values of sieving coefficients for dextrans with MW of 17.9, 35.6 and 73.4 kDa are shown in table 2 and a representation of the sieving curves of different membrane types, is shown in Figure 2.

## CONCLUSIONS

The new membrane Synclear 0.5 showed encouraging behaviours in term of sieving coefficient, indicating a possible superior performance in the clearance of high molecular weight toxins. Innovative field for blood depuration could be explored due to its high depuration properties. Use of Synclear 0.5 membrane must be coupled with a specific sorbent system that allow reinfusion of albumin and retention of toxins substances.

## REFERENCES

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