MIXED MATRIX MEMBRANES WITH SUPERIOR REMOVAL OF PROTEIN-BOUND TOXINS FROM HUMAN PLASMA

INTRODUCTION

Protein-bound toxins (PBT) accumulate in uremic patients due to their poor removal by conventional hemodialysis[1]. Previously, we have shown that their removal can be improved by a mixed matrix membrane (MMM)[1], which combines adsorption and diffusion. However, the first generation MMM had relatively large dimensions and suboptimal mass transfer characteristics. In this work, we develop a new generation of MMM suitable for dialysis treatment. The membranes have smaller diameter with no albumin leakage, thereby meeting the characteristics of low-flux dialyzers used in the clinic [2].

EXPERIMENTAL METHODS

The inner and outer layers of hollow fiber MMM were produced from a polyethersulfone/ polyvinyl-pyrrolidone polymer blend. Activated carbon was loaded in the outer polymer matrix layer for adsorption of PBTs. The membranes were characterized by scanning electron microscopy (SEM) and clean water flux and dialysis/adsorption experiments with plasma spiked with uremic concentrations of the PBTs indoxyl sulfate (IS) and p-cresyl sulfate (pCS), and ultrapure water dialysate.

RESULTS AND DISCUSSION

By optimizing spinning conditions, we produced fibers with inner diameter of 450µm and inner membrane layer thickness of 21 µm (Figure 1C and 1D), which is markedly smaller than previously reported MMM fibers (Figure 1A and 1B). Their permeability is comparable to that of conventional low flux dialysis membranes. Figure 2 shows that the new MMM have superior performance concerning the removal of IS and pCS in comparison to a dialyser F8HPS currently used in the clinic.

CONCLUSION - OUTLOOK

We developed MMMs with optimal characteristics offering superior ability in removing PBT in comparison to commercial dialysis membrane. In the future new membranes will be developed with sorbent particles with dual porosity [3], to achieve removal of broader range of uremic toxins.

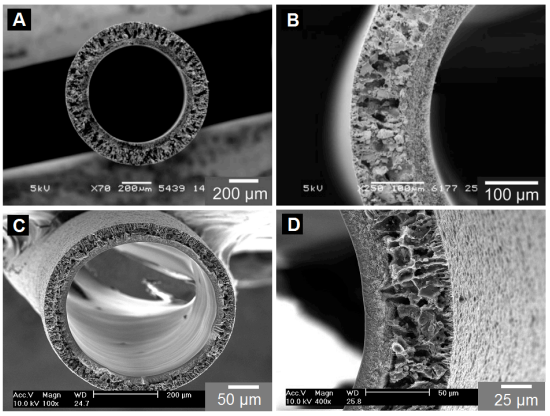


Figure 1. A and B show first generation MMM.
C and D show new fibers with smaller diameter.

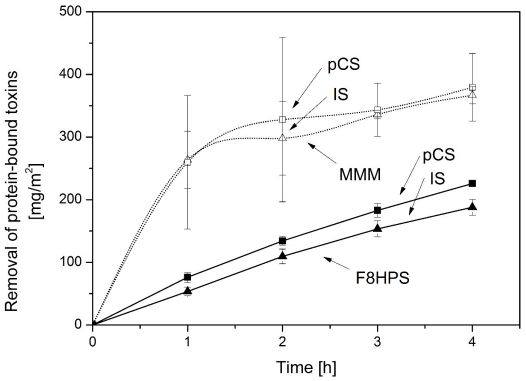


Figure 2. Removal of protein-bound toxins by MMM and the F8HPS commercial membrane over time.

REFERENCES

[1] Tijink M. *et al.*, Biomaterials. 34 (2013) 7819-28.

[2] Pavlenko et al, Scientific Reports, 6 (2016) 34429.

[3] Pavlenko et al, Scientific Reports 7 (2017) 14914

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