Experimental Validation of Novel Methods for Access Recirculation Measurement in Hemodialysis

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Introduction

The occurrence of access recirculation during a dialysis therapy has its own negative impact on the efficiency of the therapy and on the patency of the vascular access. Early detection and preemptive intervention is necessary to improve the e ciency of the treatment and prevent the access from irreversible malfunction. [1, 2] We developed methods for the online determination of access recirculation based on an optical sensor which is already installed on the dialysate side of the hemodialysis machine.

Methods

The intensity signal measured with the optical sensor is highly dependent on the amount of access recirculation present. Based on this, we developed methods for periodically monitoring of access recirculation. To investigate the methods we implemented an experimental setup with a pump to simulate the vascular access and to mimic defined levels of access recirculation. To assess the performance of the methods, we performed measurements for which we used different test solutions, such as watery solution and Bovine Blood, and the specialized test stands adapted for the use with these solutions. The use of different test solutions created the necessity to use different reference methods. Thus, used a spectroscopical method for watery solution whereas the Transonic HD03 served as reference device for Bovine Blood. In all measurements, we used a blood flow of $300\,\mathrm{ml\,min^{-1}}$ and dialysate fluid flow of $500\,\mathrm{ml\,min^{-1}}$ in conjuction with a midsurface dialyzer of $1.5\,\mathrm{m^2}$ surface because these are common settings for dialysis therapies and thus a realistic use case.

Results and Discussion

It has been shown that one the methods investigated worked for both test solutions, watery solution and Bovine Blood, with sufficient accuracy. However, we experienced some systematical errors which might originate from flow tolerances. The limits of these errors need further investigation to make sure they do not affect the over all accuracy of the method negatively. For the second method we also found sufficient accuracy in the experiments performed with watery solution. However, we were unable to validate these results with Bovine Blood. This effect might not be due to the method itself. We hypothesize that it is an effect of aging of the Bovine Blood and thus a limitation of the experimental setup and procedure. However, this hypothesis needs further investigation and prove.

References

[1] USRDS: The United States Renal Data System: Overall hospitalization and mortality. Am J Kidney Dis 2003; 42: S136-40.

[2] Murphy, SW, Foley, RN, Barrett, BJ. Comparative mortality of hemodialysis and peritoneal dialysis in Canada. Kidney Int 2000; 57: 1720-6.