

Analysis of Dialysis Performance by an Asymptotic Model

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EXTENDED ABSTRACT

Dialysis is commonly used in medical facilities to aid filtration of the blood when the kidney fails in the human body. New methods are needed in order to advance efforts in achieving an implantable kidney. The dialyzer today only performs outside the body in a large apparatus. One of the best filtration devices is the so-called “capillary membrane-based dialyzer” where the filter action can take place through a cylindrical semi-porous membrane, while the blood flows through the cylinders by a pump. The outside shell is used to flow a relatively high Reynolds cleaning solution that takes the waste out from the blood stream. The concentration of the waste in the blood, within the cylindrical capillary dialyzer, can be modeled mathematically through mass balances leading to a differential model in terms of partial differential equations. In general, this model is quite mathematical intensive to solve and illustrate the dialyzer behavior.

In this contribution, instead, we focus on obtaining an asymptotic solution of this system that will be presented as the model of the description of the concentration of waste profile inside the cylindrical capillary. The motion is due to convective-diffusive transport typically found in a dialyzer device. The solution to this model is obtained on the basis of steady state assumptions and the results will illustrate various parametrical situations within the device. For example, several illustrative concentration profiles showing potential practical protocols will be presented. In addition, the optimal performance parameters for the dialyzer will be described for this system. We believe that this method for modeling could lead to a reduction of the current size of the dialyzer device leading to, potentially, an implantable type of device in the future.