OPTIMIZING DIALYSATE BICARBONATE CONCENTRATION DURING HEMODIALYSIS BY MATHEMATICAL MODELING

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Approximately 2 million people worldwide receive routine, thrice-weekly treatments by hemodialysis to stay alive. Treatment of such kidney failure patients allows the administration of bicarbonate buffer via the dialysis solution to control body fluid pH in these patients; however, the optimal amount and method for prescribing the bicarbonate concentration in the dialysis solution is unclear.

The main objective of this project is to explore potential new approaches for optimizing the amount and method for prescribing the bicarbonate concentration-time profile in the dialysis solution to better control body fluid pH in hemodialysis patients using a mathematical model.

The project will develop a comprehensive model of acid-base and bicarbonate biochemistry in the blood and whole body of kidney failure patients treated by hemodialysis. The model is necessarily complex and requires knowledge of chemistry, biomedical transport phenomena, and numerical mathematics. Once developed, the mathematical model will be compared with clinical kinetic data collected from hemodialysis patients. The comparison of model predictions with clinical data will allow optimization of physiological parameters and suggest novel methods for bicarbonate administration. The developed integrative model may also be applied in other biomedical engineering applications in medicine, mechanical ventilation and extracorporeal carbon dioxide removal and contribute to the design of virtual human physiology for medical purposes.

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