COMPUTER ASSISTED CONTROL OF DIALYSIS THERAPY

S Stiller, H Mann, W Gürich

Department of Internal Medicine of the Technical University of Aachen

Dialysis necessarily causes fluctuations in solute concentrations. Variable dialysis-free intervals and changeable feeding lead to different plasma concentrations prior to each dialysis. Using a standard treatment with the same clearance and the same duration the concentration changes and the ultrafiltration rates differ from one dialysis to the other, as does the well-being of the patient.

A computer could help us to control these fluctuations in order to protect the patient. We start with the assumption that every patient has a certain tolerance to changes in electrolyte concentrations and to changes in osmolarity, pH, urea and body weight, and that he tolerates dialysis well if electrolytes, urea and water are eliminated sufficiently slowly. On the other hand sufficient solutes and water must be removed during every session, i.e. certain amounts of potassium, urea, middle molecules and water have to be eliminated. Urea and potassium are representative of small molecular solutes; the dialysis index as defined by Scribner can serve as a measure for the elimination of middle molecules. [1]

To ensure that every treatment remains within the individual tolerance range and is adequate, solute and water exchange is simulated with a mathematical model (Stiller et al) [2] at the beginning of each session. From the input data (pre dialysis sodium, potassium and urea concentration, body weight, dialyser and dialysate) the computer calculates blood flow rate, dialysate flow rate, transmembrane pressure and dialysis duration, observing the restrictions for concentration changes and the requirements for solute removal. Supplementary data such as the normal body weight of the patient, residual clearance, dialysate composition and dialyser clearance data are stored in the computer (Figure 1).

The limits for the decrease and decrease rates of the sodium and potassium concentration, osmolarity and body weight must be derived from experience. The amounts of potassium and urea which must be eliminated are calculated from their concentration prior to dialysis. If not all conditions can be met with reasonable parameters in a reasonable time, the computer gives an

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alarm and a proposal as to what should be changed.

For the practical application of the described procedure it is necessary to take 2 ml of plasma from the patient immediately after connection of the arterial line. One ml serves for the determination of the sodium and potassium concentration and 1 ml for urea. We hope that future measurements will be possible without withdrawing blood from the patient. The evaluation of the plasma sodium and potassium concentration requires only 1 to 2 minutes. We are still looking for a technique for rapid determination of urea.

After the measurement the values, together with the patient’s body weight and the dialyser and dialysate code, are typed on the keyboard of a computer terminal.

By consecutive calculations of the time course of the concentrations for increasing blood and dialysate flow rate, the computer finds the maximum elimination rate within the given tolerance limits. In a subsequent step the time necessary to eliminate the required quantities of solutes and water and to keep the dialysis index greater than one, is calculated. The results of the calculation, i.e. blood flow rate, dialysate flow rate, transmembrane pressure and dialysis duration are displayed and dialysis can be conducted accordingly.

A protocol of the dialysis parameters and the pre and post dialysis concentrations and the eliminated quantities, together with the maximum change rates of the concentrations and the body weight are stored after every dialysis.
A strict record of the clinical symptoms during dialysis together with the dialysis parameters and results provide a secure basis for the definition of the individual tolerance limits.

In conclusion: The quality of dialysis can be improved by observing individual needs and restrictions during every session.

Acknowledgments


References

1 Babb, AL, Scribner, BH, Strand, MJ, Milutinovich, J, Schmitt, C and Follette, WC, *8th Annual Contractors’ Conference NIAMDD, DHEW Publication No.(NIH) 76-248*