The Litre—Kilogramme Concept: Use of a Total Flowmeter as a Monitor for Adequate Dialysis Control

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Adequate dialysis involves many factors. However, this determination is usually expressed in terms of hours on the machine. The adequacy of dialysis treatment can be more precisely related to the total volume of blood dialysed. However, the rate of blood flow is often changed during dialysis, thus making calculation of the quantity of blood dialysed impractical. These variations in flow are difficult to estimate. Dialyses of equal duration, therefore, are not always equally effective and the routine assignment of a standard dialysis time subjects the patient to the risk of inadequate dialysis.

We now decide the duration of a dialysis by the total amount of blood circulated through the dialyser. This total volume is recorded by a counter which provides a continuous digital readout of the number of revolutions performed by the blood pump (Figure 1). This is based upon calibration of the blood pump for volume per revolution. The reading is easily converted by a nomogram into the volume of blood (expressed in litres) circulated through the artificial kidney (Figure 2). Constancy of calibration is best assured by a negative pressure monitor on the arterial line.

Studies based on computerised data provide guide lines by which the number of revolutions per dialysis, relating the patient's body weight to the volume of blood dialysed, may be prescribed.

Parameters used in the computer analysis were:

Pre-dialysis plasma and tissue concentrations of BUN in the range of 50 to 120 mg/100 ml.
Pre-dialysis plasma and tissue concentrations of creatinine in the range of 5 to 12 mg/100 ml.
The removal rates for BUN and creatinine for blood flows in the range of 150 to 200 ml/min for dialysers with a surface area of 0.85 to 1 m².
Patient body weight in the range of 30 to 90 kg.
Figure 1. Total Flowmeter quantitative indicator for volume of blood pumped

Figure 2. Nomogram showing number of revolutions to move desired number of litres of blood
Figure 3. Computer predicted change for BUN, pre- and post-dialysis versus observed change

Figure 4. Computer predicted change for creatinine, pre- to post-dialysis versus observed change
The computer graphs showed the decrease in plasma and tissue concentrations of BUN and creatinine in relation to the number of revolutions, i.e. litres of blood dialysed, for all possible combinations of pre-dialysis values and body weights. Selection of the endpoint of a dialysis was determined according to the drop in plasma concentrations beyond which further significant removal of waste products would not occur within reasonable time limits.

For a three times per week dialysis schedule, the following index was established:

during each treatment the total blood volume (in litres) to be dialysed should be equal to the patient's body weight (in kilogrammes)

The decrease between pre- and post-dialysis values was found to average 50% for BUN and 40% for creatinine (Figures 3 and 4). In practice, the number of revolutions for a particular patient is determined when he comes on the programme. It is changed only if gross weight changes occur. The patient dialyses until the assigned number of revolutions is completed. This figure is attached by a label to his Total Flowmeter*.

Dialysis records, in terms of flow rates and time are reduced to a single precise number. The litre-kilogramme concept offers an exact basis for the prescription of dialysis for each individual patient and various dialysis schedules. As a means to accomplish this the Total Flowmeter* introduces a simple and reliable means to compare and evaluate the adequacy of haemodialysis.

ACKNOWLEDGMENTS

This book was supported in part by the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Contract PH-43-68-1027, with Dr W J Kolf as Principal Investigator; Kidney Disease Control Center, Public Health Services, Contract PH-86-67-232, with Dr W J Kolf as Principal Investigator; and Division of Research Resources, National Institutes of Health, Contract RR-54-07, with Dr Frank H Tyler as Principal Investigator; and by Lifemed Corporation, 2107 Del Amo Boulevard, Compton, California 90220.

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