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ORIGINAL PC PROGRAM FOR DETERMINATION OF THE DIALYSIS DOSE AND NUTRITIONAL STATUS OF PATIENTS ON CHRONIC HAEMODIALYSIS

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ABSTRACT

An original PC program created in the Centre for Haemodialysis, Clinic of Nephrology, Haemodialysis and Toxicology, Medical University of Varna, and designed for determination of the dialysis dose and nutritional status of patients on periodic haemodialysis (PHD) was presented. The study covered 58 patients on PHD, 24 females and 34 males monitored at 3-month intervals for one year. Using a PC software and this program the following parameters were estimated: single pool model - KT/Vsp, urea reduction rate (URR), and nutrition status (nPCR). The mean KT/Vsp value (single pool) of 1,13 ± 0,14 was close to that recommended by the Dialysis Outcomes Quality Initiative of the National Kidney Foundation. However, a further optimization of dialysis procedures was required. The mean value of protein intake in these patients during the period of observation was of 1,04 ± 0,13 g/kg/d. It should be emphasized that despite the acceptable mean nPCR value the protein intake remained insufficient in 49 per cent of the cases. There was a positive correlation between KT/V and PCR ($r = 0,63$; $p < 0,05$). There was no statistically significant difference between the parameters' values from the urea-kinetic modelling (UKM) and those calculated using authors' PC program that testified to the reliability of the results. This program allowed the prognostication of the necessary dialysis dose by rendering an account of the individual patient's parameters and the ultrafiltration required and then by choosing the optimal values of dialysis duration and blood flow.

Key words: dialysis adequacy, dialysis dose, protein intake, urea, chronic haemodialysis

INTRODUCTION

There are two aspects of the necessary determination of individual dialysis dose in patients on periodic haemodialysis (PHD). First comes the wish to achieve a maximal blood clearance resulting in reduced morbidity and mortality rates. On the other hand, however, emerge the economic realities influencing upon the duration and quality of HD taking into consideration its high expenses. The calculation of Kt/Vsp parameter (single pool model) where K (ml/min) is the urea clearance of the dialyser registered by the manufacturer; t is the dialysis duration in hours, and V (ml) is the volume of urea distribution of the corresponding patient represents a widely used method for dialysis adequacy evaluation (9). The Dialysis Outcomes Quality Initiative (DOQI) of the National Kidney Foundation (NKF) of the USA recommends the achievement of Kt/Vsp values i 1,2 (7). Similar clinical practical guidelines are elaborated in Bulgaria within the National program for improvement of dialysis quality (1).

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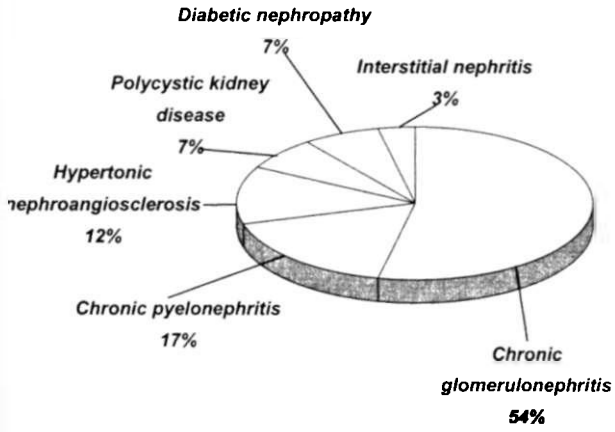
The urea reduction rate (URR) is another, easy to calculate and commonly used parameter of the delivered dialysis dose (6,8). Its inaccurate estimation due to absent ultrafiltration assessment is considered a main disadvantage of this method. The recommended URR values are i 65 %. Protein and energetic malnutrition is common in PHD patients. The protein catabolic rate (PCR) parameter provides excellent information about the protein intake in these patients. The analysis of the results from the National Cooperative Dialysis Study in the USA (3) demonstrates a combination between PCR < 0,8 and increased mortality rate of the PHD patients. It is accepted that nPCR should be greater than 1 g/kg/d. The calculation of the parameters of dialysis adequacy and nutritional status is carried out in two ways - by a software for urea-kinetic modelling and by using more elementary PC programs with definite formulae.

MATERIAL AND METHODS

The trial covered 58 patients on PHD, 24 females and 34 males. Mean patients' age was 45,0 ± 12,3 years and their dialysis onset was at an average of 8,2 ± 3,4 years ago. Patients' distribution according to the primary kidney disease having lead to terminal chronic renal failure was the following: chronic glomerulonephritis - 31 cases; chronic pyelonephritis - 10; primary nephroangiosclerosis - 7; dia-

betic nephropathy and polycystic kidney disease - 4 each, and interstitial nephritis - 2 cases (Fig. 1).



ig. 1. Patients' distribution according to the primary idney disease (n=58)

ialysis was carried out using Fresenius 2008 and 4008 se-es, with acetate and bicarbonate buffer, dalysis quantity)d) of 500 ml/min, three times weekly, mean dialysis time 10,42 ± 1,25 hours weekly, vascular access with two edles. Disposable capillary dialysers such as Hemaflow 3, Nephral 1,2, FB110, FB 130T, FB 150, F6, and F7 ere used. The following parameters were determined to imate patients' status and dialysis adequacy according to methods listed in Table 1.

ble 1. Methods for estimation of the main parameters

Parameter	Method	Laboratory equipment
Urea	enzymic (urease) Berthleto "Spinnact"	Secomam S250P
Creatinine	Jaffe with "Biocon" deproteinization	Secomam S250P
K. Na	flame photometry	Radiometer FLM 3
, serum Fe	atomic absorption	AASF 3030 B "Perkin Elmer"
P	Molybden blue with "Biocon" deproteinization	Secomam S250P
al protein	Biuret "Biocon"	Secomam S250P
lbumin	Bromcresolgrun "Biocon"	Secomam S250P

d samples were taken every third month for one year, to the beginning of the PHD from the arterial line and the termination of the procedure according to the lled "Stop pump sampling technique" (7). The calcu- of the parameters of dialysis adequacy and nutritional was carried out in two ways - by a MEDISC 1994 software for urea-kinetic modelling and by using our own PC program. The latter enabled after indicating the desired dialysis dose (Kt/V or URR), to individually calculate the necessary dialysis time (t) depending on preliminarily entered parameters such as "dry" body weight, height, required ultrafiltration, dialyser's clearance (K), blood flow (Qb) according to the peculiarities of patient's AV fistula. After the dialysis procedure and registration of the urea values measured prior to and after PHD, the factually achieved dialysis dose and nPCR (i. e., PCR normalized according to patient's body weight). Comparing the desired and really obtained dialysis dose enabled the analysis and elimination of the undesired factors leading to reduced dialysis effectivity. nPCR helped patients' protein-intake monitoring.

The formulae shown in Table 2 are used in the PC program.

Table 2
Formulae for calculation of parameters for dialysis adequacy and nutrition status

Parameter	Method or formula for calculation	
Kt/Vsp	$\frac{Kt}{Vsp} = -Ln(\frac{C}{Co} - 0{,}008t) + (4 - 3{,}5\frac{C}{Co})\frac{UF}{W}$	(2)
URR %	$URR = 100(1 - \frac{C}{Co})$	(8)
TBW males l	$TBW = 2{,}447 - 0{,}09156A + 0{,}1074\,ht + 0{,}3362wt$	(10)
TBW females l	$TBW = -2{,}097 + 0{,}1069ht + 0{,}2466wt$	(10)
nPCR g/kg/d	$nPCR = \frac{0{,}036(Cn - C)24}{ID}$	

where
A is age in years
ht is height in cm
wt is optimal weight in kg
W is postdialysis weight in kg
V is volume of urea distribution in litres
C is urea nitrogen after haemodialysis
Co is urea nitrogen in mg% prior to haemodialysis
Cn is urea nitrogen prior to the next haemodialysis
t is dialysis time in hours
UF is volume of ultrafiltration in litres
TBW is total body water, and
ID is interdialysis time in hours.

The data obtained by the two methods of calculation mentioned above were compared in order to assess the reliability of the calculations. By each method, a total of 232 estimations of the parameters were carried out. The PC program is functioning with any PC with installed Access 97 or higher versions. Both variation analysis (x ± SD, Student Fisher's *t*-criterion and statistical reliability at $p < 0{,}05$) and linear correlation analysis were used for data processing.

RESULTS AND DISCUSSION

During the one-year period the mean dialysis dose obtained through UKM is Kt/Vsp = 1,13 ± 0,14 and Kt/Vsp_2 = 1,13 ± 0,12 as calculated using our PC program. There does not exist any statistically significant difference between the values obtained by the two methods. Patients' percentage distribution according to the calculated values of the obtained dialysis dose is demonstrated on Fig. 2.

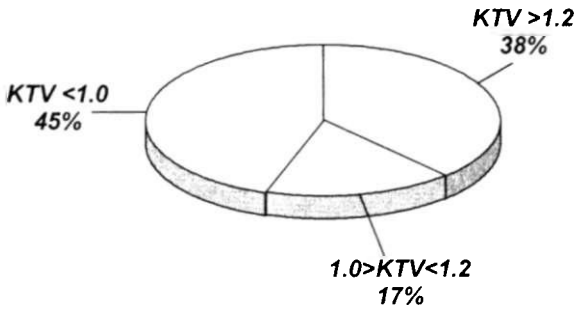


Fig. 2. Percentage distribution of patients on PHD (n=58) according to the calculated values of the received dialysis dose (Kt/Vsp)

This value is close to the recommended one of Kt/V > 1,2 (NKF-DOQI) (7). Despite the favourable results, however, it is obvious that most patients do not receive a sufficient dialysis dose. The mean value of URR is 64 ± 2,5 %.
The protein catabolic rate during the period of observation is $nPCR_1$ = 1,04 ± 0,13 g/kg/d as calculated using UKM and $nPCR_2$ = 1,04 ± 0,11 g/kg/d as calculated using our PC program. There is no statistical difference between the values obtained by means of both methods.

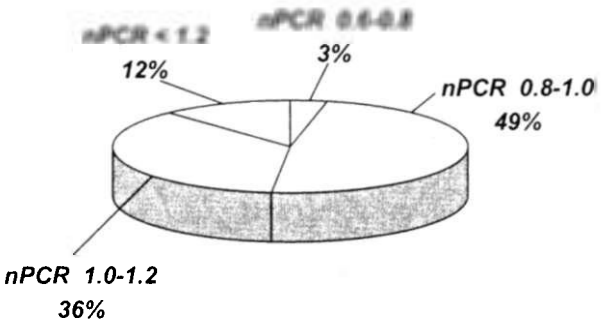


Fig. 3. Percentage distribution of patients on PHD according to the nPCR (in g/kg/d)

In 49 per cent of the patients (Fig. 3) an unsatisfactory nutrition status is observed. It could be due, on the one hand, to the insufficient dialysis dose, and, on the other hand, to certain socio-economic factors reflecting on the manner of nutrition such as inadequate diet and consumption of low-protein, mainly carbohydratic food.

Our results demonstrate a strongly positive correlation (r = 0,63; p < 0,05) between Kt/V and PCR. This finding is confirmed by the investigations of other authors, too (10). The dependence between these two parameters remains linear until Kt/V = 1,8. Over this value the correlation becomes insignificant, i. e, no influence upon the protein intake could be expected with further increasing of the dialysis dose.

CONCLUSIONS

1. There is no statistically significant difference between the values of the parameters obtained by using UKM and those calculated by means of our PC program that testifies to the reliability of our results.
2. Our PC program for determination of dialysis adequacy and the parameters of nutrition status of the patients on PHD shows the following advantages:
   a) it enables the real calculation of the received dialysis dose (presented as Kt/V or URR) after performing the dialysis procedure and introducing the predialysis and postdialysis urea values;
   b) it enables a sufficiently precise prescription of the necessary dialysis dose (either as Kt/V, or as URR) taking into consideration patient's individual parameters and the necessary ultrafiltration. In this way, the optimal values of dialysis duration and blood flow can be selected;
   c) it enables to calculate the PCR that characterizes the nutrition status of the dialyzed patients;
   d) it can be used on every PC with installed Access 97 or later versions. It occupies a limited space on the hard disk;
   e) the creation of an own software eliminates the necessity to purchase an analogous software.
3. The mean dialysis dose is close to that recommended in DOQI.
4. There is an unsatisfactory protein intake in 52 per cent of our patients on PHD.
5. The strongly positive correlation between the dialysis dose and protein consumption is confirmed.

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