World Journal of Research and Review (WJRR)
ISSN:2455-3956, Volume-5, Issue-5, November 2017 Pages 09-23

The Relevance of Diuresis on Nutrition Studied in 26 Patients Undergoing Peritoneal Dialysis

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***Abstract*— Recently, clinicians have questioned the advisability to save the diuresis in patients come to the need of a substitutive treatment. This interest drove us to look at the strategy of incremental dialysis, based on progressively increasing dialytic treatment, with the purpose of delaying the loss of diuresis for as long a time as possible. This work aimed to study the importance of residual diuresis, analyzing the differences of nutritional data in a population of 26 patients undergoing peritoneal dialysis. Of the 26 patients, 18 of them had diuresis and 8 of them were anuric. The nutritional data of patients with diuresis were compared with those without diuresis. The same was performed between patients with diuresis of greater than the average of diuresis versus those with a significantly lower diuresis. The relationships between the total clearances and nutritional data were analyzed, as well as between nutritional data and the attained creatinine clearance/volume of creatinine (KT/V), this also to state the need of a predefined KT/V value to maintain adequate nutritional conditions. It was shown that, in the studied population, no significant differences of nutrition resulted between patients with and without diuresis and in patients with diuresis when separating them in two groups having significant difference of diuresis, nor were significant differences found in nutrition data and the attained KT/V. The final conclusion is that the value of residual glomerular filtration rate (GFR) to signal the start of incremental dialysis treatment should not be based on a predefined value in all patients, but should be tailored according to the specific needs of each patient.**

***Index Terms*— residual diuresis, peritoneal dialysis, nutrition.**

I. Introduction

In the late stage of renal insufficiency, a residual renal function maintaining a residual diuresis is considered a very relevant value to be saved for as a long time as possible to for two important reasons: the residual function allows a small discharge of molecules that would be poorly eliminated by dialytic treatments, and a better maintaining of the correct body water volume, with beneficial effects on blood pressure and cardiovascular conditions. The strategy of incremental dialysis has the aim to gradually increase treatment to the full substitutive treatment, but at same time to save the residual function, and for this it is known as increasing adoption, in both the case of peritoneal dialysis (PD) as well as hemodialysis. The progression of this strategy in Italy was reported by Viglino [1], who related a percentage of 29.2% in 2005, 38.5% in 2008, and 50% in 2012, the year of his publication. In a following report in 2017 on behalf of the Peritoneal Dialysis Study Group of the Italian Society of Nephrology [2], Neri, Viglino et al. reported that in 2014, 1655 patients started peritoneal dialysis treatment, 27.5% of whom by incremental PD, 82.5% as continuous ambulatory peritoneal dialysis (CAPD) and the remaining as automated peritoneal dialysis (APD). Similar experiences are reported by a Spanish group, Borràs, Sans et al., and by Sandrin M. Vizzardi V. et al. [3,4], particularly pointing out the prolonged maintenance of residual diuresis, in comparison with the standard starting of PD treatment (3-4 exchanges per day). In the paper entitled "The importance of residual function in peritoneal dialysis" by Sikorska D. et al. [5], the authors studied 44 patients undergoing PD, divided into three groups according to the size of the residual diuresis. The values of cholesterol, albumin, and hemoglobin were assumed as indexes of general conditions and nutrition. Many measures of heart and of the cardiac ejection percentage were studied, comparing the values according to the groups by diuresis, fundamentally concluding that the amount of diuresis influences the probability and the relevance of overhydration and the conditions of nutrition. Notwithstanding the many different fields of interest evaluated in the article, some criticisms have to be raised about the findings**.** First, it has to be pointed out that the tables included in the text and concerning the data on which the article is based lack many basal informations, including height and weight, which are somatic dimensions whose absence should be considered inadmissible. The only reference concerning height and weight were the body mass index (BMI) values, which were practically the same in the three groups, but evidently the same BMI may result by different reciprocal variation of weight and height. The values of the creatinine clearances/week are shown in terms of means and standard deviations, but without specifying the percentage that is due to residual renal function and the percentage due to peritoneal dialysis. No correlations were performed between the clearances and the data concerning the general and nutritional conditions, in order to evaluate the degree of effectiveness of the treatment and to define which variables were fundamentally dependent on the clearances. In addition, no tables reported in figures the data used to state the conditions of patients, of whom the only specification concerned albumin and hemoglobin. Whereas, calcium, phosphate, glucose, urea, creatinine, uric acid, and total protein were not specified by their values but only named to specify which were the basal variables used to evaluate the conditions of the patients, whose satisfactory conditions were not shown in figures but simply claimed. Therefore, it seemed useful to analyze some of the results whose values were defined, to better understand in a tangible way the difference within the three groups. The results of this evaluation are summarized in Table 1.

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Table1. Grouping on the Basis of Diuresis

	A		B		C	
Number of Patients	12		14		18	
Diuresis ml/day	Mean	SD	Mean	SD	Mean	SD
	154	194	1314	207	2572	353

Comparison by T Test

Diuresis	A vs B	T-Value = -14.74 P-Value = 0.000 DF = 23
	A vs C	T-Value = -24.11 P-Value = 0.000 DF = 27
	B vs C	T-Value = -12.59 P-Value = 0.000 DF = 28

Groups	A		B		C	
	Mean	SD	Mean	SD	Mean	SD
LBM	50.48	20.34	47.87	12.34	48.85	12.21
Body fat	32.61	14.7	36.75	9.46	36.39	8.86
Albumin	3.55	0.56	4.07	0.41	4.02	0.38

Comparison by T Test

LBM	A vs B	T-Value = 0.39 P-Value = 0.703 DF = 17
	A vs C	T-Value = 0.25 P-Value = 0.806 DF = 16
	B vs C	T-Value = -0.22 P-Value = 0.828 DF = 27
Body fat	A vs B	T-Value = -0.84 P-Value = 0.413 DF = 18
	A vs C	T-Value = -0.80 P-Value = 0.436 DF = 16
	B vs C	T-Value = -0.01 P-Value = 0.990 DF = 27
Albumin	A vs B	**T-Value = -2.66 P-Value = 0.015 DF = 19**
	A vs C	**T-Value = -2.54 P-Value = 0.021 DF = 17**
	B vs C	T-Value = 0.35 P-Value = 0.727 DF = 26

Tab. 1 – Comparison by T test

Haemoglobin	A		C	
	Mean	SD	Mean	SD
	11.05	2	12.63	1.21
A vs C: **T Value = -2.45 P value = 0.026 DF =16**				

From the data provided in Table 1, it is clear that the only significant difference between the groups on the basis of diuresis concerns albumin and hemoglobin. Further, it has to be noted that this difference does not concern the comparison between B versus C, the two most different degrees of diuresis. It is important to emphasize that the lean body mass and the fat mass, evaluated by body impedance analysis (BIA), and representing the fundamental components of body composition, does not differ within the three groups, an observation made also by the authors, but without drawing from it the evident conclusion, which is that the differences of diuresis not influenced the body composition. A similar procedure of analysis was also performed for the cardiologic data, in this case directly comparing the group A versus C, the groups with the greatest difference of diuresis (Table 2).

Table 2. Cardiologic Data for Group A vs. Group C			
Ejection fraction %			
A		C	
Mean	SD	Mean	SD
47.56	11.56	57.29	13.61
T-Value = -2.10 P-Value = 0.045 DF = 26			
septal thickness at diastole			
A		C	
Mean	SD	Mean	SD
13.67	1.94	13.07	2.79
T-Value = 0.69 P-Value = 0.493 DF = 27			
left ventricular end-systolic diameter			
A		C	
Mean	SD	Mean	SD
40.33	10.5	37.3	11.91
T-Value = 0.73 P-Value = 0.470 DF = 25			
aortic bulb			
A		C	
Mean	SD	Mean	SD
28.33	6.95	27.31	3.09
T-Value = 0.48 P-Value = 0.641 DF = 13			

Tab. 2 - left atrium			
A		C	
Mean	SD	Mean	SD
39.63	7.67	41.43	4.83
T-Value = -0.72 P-Value = 0.480 DF = 16			

All the cardiologic parameters in Table 2 were selected to be compared based on the greatest differences. However, no differences are found between groups A and C, except for the ejection fraction %, p = 0.,045. These results well agree with the observation of the authors on the lack of differences of blood pressure within the three groups. In conclusion, the difference of diuresis seems to significantly influence the body conditions for only some of the considered body parameters, including body hydration, a parameter strongly linked to residual diuresis.

This unusually in-depth citation of an article was done to emphasize the great interest and attention that should be paid to the importance of residual diuresis for certain patients who are selected to start a dialysis treatment. The aim of the present article is to explore the benefits of a residual diuresis for patients in end-stage renal disease, in terms of general conditions, particularly in patients who have already started substitutive treatment, and compare them with anuric patents, beyond the evident result of maintaining the correct level of hydration.

Materials and methods

This research is based on the data of 26 patients undergoing chronic PD. Of these, 18 patients had a residual diuresis, and the remaining 8 patients were anuric. The subjects with diuresis included 12 females and 6 males; the anuric patients included 4 females and 4 males. The data of female and male subjects were analyzed together and then independently by gender. This grouping was evaluated suitable on basis of the comparison by t test of the patients' basal data, with no resulting significant differences, as follows: dialysis volume, p = 0.300; weight/height, p = 0.076; age, p = 0.808; serum creatinine (CtS), p = 0.185; blood urea nitrogen (BUN), p = 0,551; protidemia, p = 0.181; creatinine clearance (CtCl)/min, p = 0.231; excreted Ct by dialysis, p = 0.171. During data analysis, if variables based on formulae differentiated by gender, the appropriate formula was used, because the gender was constantly shown beside the files of data in the Excel spreadsheets.

Considering the importance of defining the volumes of diffusion of urea and of creatinine to calculate the total mass of urea and creatinine and their relationships to the parameters concerning the clearances and the body conditions, these volumes were calculated according to the work of Daugirdas and Depner [6]. The evaluation of the volumes of diffusion of urea and creatinine in the 26 studied patients was based on the kinetic modeled values of the urea and of the creatinine volumes in that article. The models reported there were regressed based on the corresponding available volumes according to Watson [7], and the obtained equations have been used to calculate the values of the volumes of the 26 studied patients, using their Watson volumes. The equations were obtained by the data of Daugirdas and Depner [6], by cubic regressions of modeled volumes versus the corresponding Watson volumes and are here reported as follows: males: Ct volume = 89.8 + 7.547 x Watson volume -0.1601 x Watson volume^2 + 0.001285 x Watson volume^3; females: Ct volume = 380.9 - 37.44 x Watson volume + 1.255 x Watson volume^2 - 0.001327 x Watson volume^3. A similar procedure was used for urea volume, with the resulting equations: males: urea volume = -88.69 + 7.168 x Watson volume -0.1431 x Watson volume^2 + 0.001095 x Watson volume^3 ; females: urea volume = 50.32 -2.190 x Watson volume + 0.09459 x Watson volume^2 - 0.001180 x Watson volume ^3. The possible relevance of the diuresis was first studied by evaluating the difference of the corresponding variables between the 18 patients with diuresis and the 6 patients without diuresis. The same comparison was performed, separating the patients with diuresis into two subgroups, considering the large range of residual diuresis, 960.28 ± 52.24 ml/day**;** in other words, a range indicatively comprised between 1064.76 ml/day and 855.8 ml/day, as calculated on the basis of its mean ± two standard deviations (SDs). The division into two subgroups of the residual diuresis, greater and lower than 960.28 ml/day, generated two very different degrees of diuresis: 1355.56 ± 332.1 and 565 ± 339.9 (t test: t -value = 4.99, p value = 0.000, degrees of freedom (DF) = 15, whose comparison was then performed. The results are shown in Tables 4, 5, and 6. Each of the two subgroups was compared successively with the variables of the anuric patients (Tables 7 and 8). KT/V values were also analyzed, their values being calculated assuming K as the creatinine clearance and not the urea clearance, as usually done (for details, see following in section K/TV).

Results

Elaboration of basal data

The basal data of the elaboration are shown in Table 3. Table 3A and 3B report the values of three different volumes of water, of which the first is Watson TBW [7], and the second and third are the volumes of diffusion of urea and of creatinine, respectively, on which was calculated the values of total body nitrogen and Ct, included in the same tables. Note in Table 3C that the considered basal variables do not statistically differ between the patients with diuresis versus those without diuresis.

Table 3 A. Comparison of basal data between patients with residual diuresis and anuric patients								
Patients with diuresis								
Patients n =18	CtCl	Height	Weight	Age	TBW by Watson	Volume of Urea	Volume of Ct	Weight/ height
Mean	4.15	165.6	69.15	50.72	34.92	35.76	35.07	42
SD	1.32	10.05	12.87	16.33	9.44	7.19	6.66	7.47
Coeff var	0.32	0.061	0.19	0.32	0.27	0.2	0.19	0.34

Table 3 A - Following data

Patients n =18	Total nitrogen mass	Total Ct mass	Estimated muscle mass	CtS	BUN	Total Protidemia	Albuminemia	Excreted Ct by Dialysis
Mean	28567	3547.95	16.71	9.88	80.43	6.92	3.92	568
SD	10045	1203.5	4.76	2.16	16.78	0.8	0.54	227.7
Coeff var	0.28	0.22	0.21	11	0.138	0.37	0.138	0.4

Table 3B. Patients without diuresis

Patients n = **8**	CtCl	Height	Weight	Age	Water Volume by Watson	Volume of Urea	Volume of Ct	Weight/ height
Mean	4.9	161.25	67.17	52.87	39.95	33.45	33.24	41
SD	1.04	13.3	13.62	11.14	12.86	8.47	8.57	6.7
Coeff var	0.21	0.08	0.203	0.211	0.32	0.253	0.258	0.163
Patients n = 8	Total nitrogen mass	Total creatinine mass	Estimated Muscle mass	CtS	BUN	Total Protidemia	Albuminemia	excreted Ct by Dyalisis
Mean	28166.61	4659.74	20.06	11.12	70	6.69	3.86	794.41
SD	13743.7	2680.13	5.54	3.2	22.93	0.244	0.41	322.15
Coeff var	0.49	0.57	0.276	0.29	0.327	0.036	0.105	0.41

Table 3C. T test between basal data of Table 3A: Patients with diuresis versus without diuresis

variables	T Test for two variables results
CtCl	T-Value = -1.56 P-Value = 0.138 DF = 17
Height	T-Value = 0.83 P-Value = 0.428 DF = 10
Weight	T-Value = 0.35 P-Value = 0.734 DF = 12
Age	T-Value = -0.39 P-Value = 0.701 DF = 19
Water Volume by Watson	T-Value = -0.97 P-Value = 0.353 DF = 10
Weight/height	T-Value = 0.34 P-Value = 0.740 DF = 14
Total nitrogen	T-Value = 0.07 P-Value = 0.942 DF = 10
Total Ct	T-Value = -1.12 P-Value = 0.294 DF = 8

Table 3C. T test between basal data of Table 3B: Patients with diuresis versus without diuresis

Excreted Ct by dialysis	T-Value = -1.64 P-Value = 0.132 DF = 10
Estimated muscle mass	T-Value = -1.48 P-Value = 0.166 DF = 11
CtS	T-Value = -1.00 P-Value = 0.344 DF = 9
BUN	T-Value = 1.15 P-Value = 0.275 DF = 10
Total Protidemia	T-Value = 1.11 P-Value = 0.279 DF = 22
Albuminemia	T-Value = 0.31 P-Value = 0.760 DF = 17
Table 3C. T test between basal data of Table 3B:- Following data	
Excreted Ct by dialysis + urine versus excreted Ct by dialysis	T-Value = -1.28 P-Value = 0.228 DF = 10
Volume of Ct diffusion	T-Value = 0.54 P-Value = 0.603 DF = 10
Volume of urea diffusion	T-Value = 0.96 P-Value = 0.357 DF = 11

The basal variables of the group with diuresis were compared with the resulting corresponding variables in the anuric group, by means of T test for two variables. The results of comparison are reported in Table. 3C. Note that no significant differences were found.

The group of patients with residual diuresis
The mean and the SD of diuresis resulted in 960.28 ± 52.24 ml/day. The 18 patients with diuresis were divided in two groups of 9 patients, the first having diuresis greater than the average of diuresis, 960.28 ml/day, and the second with diuresis less than the average value. The statistics of diuresis of the two subgroups are reported in the Materials and Methods section. The results of the comparison of the two subgroups are reported in Tables 4, 5, and 6.
Table 4 shows significant differences among the following variables : the muscle mass by Wang [8], the muscle mass by Wang/weight, and diuresis/minute, per default criteria. In Table 5, no significant differences were found. In Table .6, : the following variables were found to be significantly different: CtCl indexed on weight, Ct excreted by dialysis, Ct excreted by dialysis and by the urine, Ct excreted by dialysis and by the urine, Ct indexed on weight, and Ct excreted by dialysis and by the urine, and Ct indexed on height. Seven of all the aforementioned heights with significant differences by T test have negative values because the comparison was performed according to the sequence : variables of subgroup with diuresis greater than 960.28 versus the variables of subgroup with diuresis less than 960.28. Therefore, the seven negative values are due to the significantly greater size of values in the second subgroup. Conversely, the t test resulted in a positive sign for only a variable (Table 4), diuresis/min. It important to emphasize that the significant differences concern variables consistent with a greater effectiveness of CtCl/kg in the subgroup with diuresis less than 960.28 ml/min, and concerning the muscle mass, that is evaluated by the formula of Wang [8], which is based on Ct excretion, that is significantly greater in the same subgroup according to different profiles of evaluation (Table 6 files 10,11,12,13).

Table 4. T Test of variables of diuresis greater than 960.28 ml/day versus variables of diuresis less than 960.28 ml/day

	diuresis > 960.28			diuresis < 960.28			T test for two variables
Variables	mean	SD	Coeff var	mean	SD	Coeff var	T values and p values
Dialisate/min	7.51	3.92	0.52	9.26	5.23	0.56	T-Value = -0.80 P-Value = 0.435 DF = 14
Age	47.9	15.38	0.32	53.56	17.66	0.33	T-Value = -0.73 P-Value = 0.479 DF = 15
Height	169.2	9.58	0.057	162	9.68	0.06	T-Value = 1.59 P-Value = 0.133 DF = 15
Weight	71.87	9.66	0.13	66.4	15.5	0.23	T-Value = 0.89 P-Value = 0.389 DF = 13
Weight/height	0.427	0.067	0.16	0.41	0.082	0.2	T-Value = 0.07 P-Value = 0.949 DF = 8
Weight/age	1.62	0.472	0.29	1.37	0.496	0.36	T-Value = 1.10 P-Value = 0.291 DF = 15
Muscle mass by Wang	13.55	2.41	0.18	18.55	4.62	0.25	T-Value = -2.88 P-Value = 0.014 DF = 12
Muscle mass by Wang/weight	0.19	0.033	0.17	0.29	0.073	0.26	T-Value = -3.59 P-Value = 0.004 DF = 11
Muscle mass by Wang/age	0.311	0.109	0.35	0.39	0.165	0.42	T-Value = -1.20 P-Value = 0.252 DF = 13
Volume By Watson	37.38	4.85	0.13	33.6	6.85	0.2	T-Value = 1.81 P-Value = 0.090 DF = 15
Volume By Watson/weight	0.524	0.07	0.13	0.51	0.049	0.095	T-Value = 0.42 P-Value = 0.680 DF = 14
Volume of urea diffusion	38.91	4.49	0.115	49.96	40.46	0.81	T-Value = -0.81 P-Value = 0.439 DF = 8
Volume of Ct diffusion	37.94	4.51	0.119	62.68	81.32	1.3	T-Value = -0.91 P-Value = 0.389 DF = 8
Total nitrogen	31597.8	8910	0.282	26871	11833	0.440	T-Value = -0.96 P-Value = 0.355 DF = 14
Tab.4 – following data							
Total Ct	3458.9	909.3	0.263	5193.8	3439.9	0.662	T-Value = -1.46 P-Value = 0.178 DF = 9
Total nitrogen/kg	437.37	101.8	0.22	413.43	99.98	0.242	T-Value = 0.13 P-Value = 0.900 DF = 15
Total Ct/kg	48.06	11.61	0.242	84.69	71.57	0.845	T-Value = -1.52 P-Value = 0.168 DF = 8
Total nitrogen/age	713.36	269.1	0.377	571.7	292.5	0.511	T-Value = -1.07 P-Value = 0.302 DF = 15
Total Ct/age	82.18	42.18	0.513	102.96	52.55	0.51	T-Value = -0.93 P-Value = 0.370 DF = 15
Diuresis/min	0.93	0.23	0.248	0.359	0.236	0.66	T-Value = 4.80 P-Value = 0.000 DF = 13

Table 5. T Test variables of diuresis greater than 960.28 ml/day versus variables of diuresis less than 960.28 ml/day

	diuresis > 960.28			diuresis < 960.28			T test for two variables
Variables	mean	SD	Coeff var	mean	SD	Coeff var	T values and p values
Protidemia totale	6.93	0.666	0.01	6.91	0.95	0.14	T-Value = 0.05 P-Value = 0.959 DF = 14
Protidemia totale/kg	0.161	0.063	0.39	0.11	0.019	0.18	T-Value = 0.81 P-Value = 0.439 DF = 9
Protidemia/height	4.096	0.376	0.09	4.26	0.486	0.11	T-Value = -0.80 P-Value = 0.436 DF = 15
Protidemia/age	0.214	0.103	0.48	0.15	0.062	0.42	T-Value = 1.70 P-Value = 0.114 DF = 13
Albuminemia	3.98	0.617	0.15	3.86	0.48	0.125	T-Value = 0.46 P-Value = 0.652 DF = 15

Protidemia/albuminemia	1.76	0.194	0.11	1.8	0.186	0.104	T-Value = -0.45 P-Value = 0.662 DF = 15
Volume of dialisys	10822.2	5641.3	0.52	13333	7527	0.56	T-Value = -0.80 P-Value = 0.437 DF = 14
Urea	63.44	25.99	0.41	63.2	28.78	0.46	T-Value = 0.02 P-Value = 0.985 DF = 15
Ct	4.56	1.86	0.41	5.89	2.99	0.51	T-Value = -1.13 P-Value = 0.278 DF = 13
Urine + dialysis volume	12177.8	5612.7	0.46	13898	7669	0.55	T-Value = -0.54 P-Value = 0.596 DF = 14
Volume/100	121.78	56.13	0.46	139	76.7	0.55	T-Value = -0.54 P-Value = 0.597 DF = 14
Volume/min	8.46	3.9	0.46	9.65	5.33	0.55	T-Value = -0.54 P-Value = 0.597 DF = 14
Total CtCl	3.86	1.37	0.36	4.44	1.28	0.29	T-Value = -0.93 P-Value = 0.368 DF = 15
Residual GFR/min	0.365	0.135	0.37	0.57	0.37	0.65	T-Value = -1.55 P-Value = 0.151 DF = 10

Table 6. Comparison of data of patients with diuresis greater than 920.28 ml/day versus patients with diuresis less than 920.28 ml/day

	diuresis > 920.28			diuresis < 920.28			T test for two variables
Variables	Mean	SD	Coeff var	mean	SD	Coeff var	T values and p values
1 - Dialysis CtCl	3.49	1.44	0.41	3.87	1.41	0.36	T-Value = -0.57 P-Value = 0.575 DF = 15
2 - Dialysis excreted Ct/ /t/Dialysate/min	71.83	32.09	0.45	86.8	42.3	0.49	T-Value = -0.85 P-Value = 0.412 DF = 14
3 - Dialysis CtCl/weight	0.049	0.019	0.39	0.059	0.02	0.31	T-Value = -1.15 P-Value = 0.270 DF = 15
4 - BSA DuBois	1.82	0.109	0.06	1.7	0.23	0.13	T-Value = 1.41 P-Value = 0.185 DF = 11
5 - Coeff DuBois	0.95	0.57	0.06	1.03	0.15	0.14	T-Value = -0.41 P-Value = 0.693 DF = 9
6 - CtCl indexed DuBois	3.68	1.29	0.35	4.49	1.05	0.23	T-Value = -1.46 P-Value = 0.165 DF = 15
7 - CtCl indexed weight	0.05	0.018	0.34	0.07	0.02	0.24	T-Value = -2.42 P-Value = 0.028 DF = 15
8 - CtCl indexed height	2.23	0.86	0.39	2.65	0.66	0.25	T-Value = -1.16 P-Value = 0.265 DF = 14
9 - CtCl indexed age	0.085	0.031	0.37	0.09	0.03	0.37	T-Value = -0.33 P-Value = 0.749 DF = 15
10 - Ct excreted by Dialysis	452.8	142.04	0.31	683.2	245	0.36	T-Value = -2.44 P-Value = 0.031 DF = 12
11 - Ct excreted by dialysis + by the urine	499.8	127.79	0.26	764.4	245	0.32	T-Value = -2.88 P-Value = 0.014 DF = 12
12 - Ct excreted by dialysis + by the urine CT/kg	7	1.66	0.24	11.68	3.65	0.31	T-Value = -3.50 P-Value = 0.005 DF = 11
13 - Ct excreted by dialysis + by the urine CT/height	296	75.57	0.26	467.8	139	0.3	T-Value = -3.26 P-Value = 0.007 DF = 12
14 - Difference total excreted Ct- Excreted Ct by dialysis	46.98	18.26	0.39	81.27	48.3	0.59	T-Value = -1.99 P-Value = 0.074 DF = 10

In Table 5, the difference of diuresis does not give rise to significant differences in the comparison of parameters concerning the body nutrition, protidemia, and protidemia indexed for weight, for height and for age, ,albuminemia, nor for parameters of body depuration, CtCl, and residual GFR.
Table .6 shows that the variables CtCl indexed on weight, Ct excreted by dialysis, Ct excreted by dialysis and by the urine, Ct excreted by dialysis and by urine /kg, and Ct excreted by dialysis and by urine /height are significantly greater in the patients with diuresis lower than 960.28 /ml/day.

In Tables. 7 and 8, the data concerning the subjects with diuresis greater and lower than 960.28 have been compared with the corresponding data of the patients without diuresis. In Table7, significant differences resulted in seven comparisons, where the group of anuric patients had significantly greater values, concerning the following variables: the clearance of Ct by dialysis (line 16) and its indexations by DuBois [9] and by height (lines 18,19), the excreted Ct by dialysis (line 20) and its indexation on weight (line 22) and on height (line 23). The t test has a negative value as previously noted, because of the direction of comparison: values of patients with diuresis versus anuric patients. The data

Table 7. Comparison of basal data between patients with diuresis greater than 960.,28 ml/min and patients without diuresis

	Variables	patients with diuresis > 960.28			patients without diuresis			T test results	
		Mean	SD	Coeff var	mean	SD	Coeff var	T value	p
1	Dialysate/min	7.51	3.92	0.52	10.83	4.93	0.45	-1.51	0.155
2	Age	47.9	15.38	0.32	52.87	11.14	0.21	-0.77	0.452
3	Height	169.22	9.58	0.057	161.25	13.3	0.08	1.41	0.185
4	Weight	71.87	9.66	0.13	67.17	13.62	0.2	0.81	0.433
5	Weight/height	0.427	0.067	0.16	0.415	0.067	0.16	0.37	0.718
6	Creatininemia	9.023	1.82	0.2	11.12	3.2	0.29	-0.25	0.806
Table 7 – following data									
7	Azotemia	80.56	18.84	0.23	79	22.93	0.33	1.03	0.32
8	Total protidemia	6.92	0.666	0.01	6.69	0.244	0.04	0.97	0.357
Table 7 – Following data									
9	Albuminemia	3.98	0.617	0.15	3.86	0.407	0.1	0.48	0.641
10	Protidemia/albuminemia	1.76	0.19	0.11	1.75	0.206	0.12	0.1	0.919
11	Dialysis volume	10822	5641	0.52	15600	7092.65	0.45	-1.52	0.151
12	Urea	63.44	25.98	0.41	53.12	33.38	0.63	0.7	0.494
13	Ct	4.56	1.86	0.41	6.46	4.4	0.68	-1.13	0.286
14	V/100	121.8	56.13	0.46	156	1.4	0.45	-1.8	0.11
15	V/min	8.46	3.9	0.46	10.83	4.93	0.45	-1.09	0.296
16	Dialysis CtCl	3.49	1.44	0.41	4.9	1.036	0.21	**-2.34**	**0.035**
17	BSA DuBois	1.82	0.109	0.06	1.71	0.226	0.13	1.25	0.242
18	CtCl indexed DuBois	3.68	1.29	0.35	4.99	1	0.2	**-2.35**	**0.034**
19	CtCl indexed height	2.23	0.865	0.39	2.9	0.539	0.19	**-2.25**	**0.041**
20	Ct excreted by dialysis	452.85	142	0.31	794.4	322.15	0.4	**-2.77**	**0.022**
21	Ct excreted by D + urine CT	499.8	127.8	0.26	794.4	322.15	0.4	**-2.42**	**0.042**
22	Ct excreted by D + urine CT/kg	7	1.66	0.24	11.69	3.1	0.27	**-3.82**	**0.003**
23	Ct excreted by D + urine CT/height	296.03	75.57	0.26	488.11	173.6	0.36	**-2.9**	**0.018**

in Table 8 show that the variables concerning the anuric patients do not significantly differ from those of the patients with diuresis.

Table 8. Comparison of basal data between patients with diuresis less than 960.28 ml/min and patients without diuresis

	Variables	Patients with diuresis < 920.28			Patients without diuresis			T test results	
		Mean	SD	Coeff var	mean	SD	Coeff var	T value	p
1	Dialysate/min	9.26	5.23	0.56	10.8	4.93	0.45	-0.62	0.542
2	Age	53.56	17.66	0.33	52.87	11.14	0.21	0.1	0.924
3	Height	162	9..68	0..06	161..25	13..27	0..08	0..13	0..897
4	Weight	66.43	15.55	0.23	67.17	13.62	0.2	-0.1	0.918
5	Weight/height	0.408	0.082	0.2	0.415	0.067	0.16	-0.19	0.849
6	Creatininemia	10.73	2.23	0.21	11.12	3.2	0.29	-0.29	0.778
7	Azotemia	80.31	15.6	0.19	70	22.9	0.33	1.07	0.305
8	Total protidemia	6.91	0.95	0.14	6.695	0.244	0.04	0.66	0.529
9	Albuminemia	3.86	0.482	0.12	3.86	0.407	0.1	0	1
10	Protidemia./albuminemia	1.8	0.187	0.1	1.75	0.206	0.12	0.52	0.61
11	Dialysis volume	13333.3	7526.6	0.56	15600	7092.6	0.45	-0.64	0.533
12	Urea	63.22	28.78	0.46	53.12	33.38	0.63	0.66	0.519

13	Creatinina	5.89	2.99	0.51	6.46	4.4	0.68	-0.31	0.763
14	V/100	138.98	76.69	0.55	156	70.93	0.45	-0.53	0.604
15	V/min	9.62	5.33	0.55	10.83	4.93	0.45	-0.49	0.634
16	Dialysis CtCl	4.44	1.28	0.29	4.9	1.04	0.21	-0.82	0.428
17	BSA DuBois	1.7	0.23	0.13	1.707	0.226	0.13	-0.06	0.95
18	CtCl indexed DuBois	4.49	1.05	0.23	4.99	1	0.2	-1.01	0.332
Table 8 – Following data									
19	CtCl indexed Height	2.65	0.659	0.25	2.9	0.54	0.19	-0.86	0.405
20	Ct excreted by D	683.18	245.3	0.36	794.41	322.15	0.4	-0.79	0.442
21	Ct excreted by D + urine CT	764.45	244.67	0.32	794.4	322.1	0..4	-0.21	0.834
22	Ct excreted by D + urine CT/kg	11.68	3.65	0.31	11.69	3.1	0.26	-0.01	0.995
23	Ct excreted by D + urine CT/height	467.8	139.04	0.3	488.1	173.6	0.36	-0.26	0.796

In Table .7, some cases of significant difference occurred, due to prevalent values in anuric patents , which is different from that of Table 6, where no significant difference was shown between patients with and without diuresis. The results in Tables 7 and 8 very clearly demonstrate that if the presence of diuresis in patients could cause significant differences of some variables versus those of anuric patients, this could happen only if the diuresis is corresponding to an effective level of GFR able to induce a significant difference of total CtCl, what seems to not be in this case, taking into account that no significant differences have been generated between the data of patients with diuresis greater and less than 960.28 ml/day. and those of the anuric patients. Conversely, as shown in Table 7, in terms of clearance of Ct, better results may be attained by anuric patients.

In practical terms, returning to what is fundamentally shown in the tables, at least for the variables 1taken into account, in the 26 studied patients, the residual diuresis results in no influence to the general conditions of patients. The presence of a residual diuresis could be evaluated as an effective component of the treatment until its value could correspond to a residual GFR that, added to a moderate dialytic treatment, could attain an effective KT/V (see following), allowing a reduced weekly dialysis prescription, which is the exact strategy of incremental treatment. However, a residual diuresis increasing an ineffective GFR will, however, have a positive effect on the condition of body hydration, as mentioned in the premise.

Regressions

The existence of correlations between variables selected concerning body composition, general conditions, degree of nutrition, and the clearances due to dialysis and to diuresis was ascertained by linear regression for patients with diuresis and anuric patients. The performed regressions and their results are shown in Table 9 for patients with diuresis and in Table 10 for anuric patients.

Table 9. Regressions for patients with diuresis

number of order	Predictor	Responder	R	R^2	p	absolute residuals %
1	Renal CtCl % of total CtCl/weight	protidemia/kg	0.459	0.211	0.055	21.25±13.7
2	Proteinuria/ml/min	Protidemia	0.613	0.377	0.0067	7.13±3.15
3	Azoturia/azotemia per kg	protidemia/kg	0.502	0.252	0.034	10.06±7.42
4	total nitrogen	Protidemia	0.518	0.268	0.027	7.89±5.18
5	total nitrogen/total creatinine	Protidemia	***0.205***	***0.042***	***0.41***	
6	total nitrogen/total creatinine	protidemia/kg	***0.217***	***0.047***	***0.39***	
7	weight/height	protidemia/kg	0.791	0.624	0.000	8.12±5.78
8	total creatinine	Protidemia	0.705	0.497	0.001	6.58±4.67
9	muscle mass/kg	protidemia/kg	0.583	0.34	0.011	10.8/6.84
10	muscle mass/age	protidemia/age	0.849	0.722	0.000	18.8±28.2
11	total nitrogen/age	protidemia/age	0.849	0.722	0.000	18.8±28.2
12	total creatinine/age	protidemia/age	0.865	0.748	0.000	14.17±12.06
13	weight/height	Protidemia	0.547	0.298	0.019	7.89±5.6
14	renal CtCl	Azoturia	0.545	0.297	0.019	31.14±20.5
15	Renal CtCl % of total CtCl	excreted Ct by dialysis	0.545	0.297	0.019	31.14±20.5
16	CtCl	excreted Ct by dialysis + urine	0.795	0.732	0.001	21.19±14.5
17	CTCl - renal CtCl	excreted Ct by dialysis + urine	0.829	0.688	0.000	21.2±13.66

18	azotemia/CtCl	excreted Ct by dialysis + urine	0.579	0.335	0.012	27.2±27.4
19	azoturia/azotemia/ per mL of CtCl	excreted Ct by dialysis + urine	0.517	0.267	0.028	29.7±14.2
20	CtCl/age	excreted Ct by dialysis + urine/age	0.877	0.769	0.000	21.18/13.57
21	Renal CtCl % of total CtCl	Creatininuria	0.708	0.501	0.001	34±23.6
22	total creatinine/age	muscle mass/age	0.74	0.549	0.0004	23.7±21.5
23	protidemia/age	muscle mass/age	0.819	0.671	0.000	18.4±16.9
24	excreted creatinine/volume	muscle mass	***0.06***	***0.004***	***0.813***	
25	azotemia/CtCl	Protidemia	***0.211***	***0.044***	***0.4***	
Table 9 – Following data						
26	CtCl/kg	muscle mass/kg	0.778	0.606	0.0001	0.56±0.38
27	excreted Ct/CtCl	muscle mass	0.459	0.211	0.055	17.5±12.3

In Table 9, the protidemia results significantly correlated with Ct mass and nitrogen mass, with the estimated muscle mass indexed on age and on weight, with the ratio weight/height, whereas the estimated muscle mass is also correlated with excreted Ct indexed on CtCl milliliters. Of note is that CtCl is better correlated with the Ct excreted by dialysis and urine if the renal clearance. is subtracted from its value. (R 0.829, R^2 0.688 versus. R 0.795 R^2 0.732), and that in file 1 of Table 9, the protidemia indexed on weight does not correlate with the prevalence of renal CtCl on total CtCl. These observations both further evidence the poor relevance of residual diuresis in the studied population and underline the correlation of age in the significance of the relationship of many variables (lines 10, 11, 12, 20, 23), that is to say the close relationship of size of many variables with age.

	Table 10. Regressions of patients without diuresis					
number of order	Predictor	Responder	R	R	P	absolute residuals %
1	weight/height	protidemia/kg	0.859	0.737	0.0063	8.87±5.13
2	total nitrogen/total Ct	Protidemia	0.861	0.742	0.006	1.1±1.47
3	protidemia/age	muscle mass/age	0.685	0.47	0.06	20.4±16.9
4	excreted Ct/volume	muscle mass	0.794	0.631	0.018	13.12±7.73
5	azotemia/CtCl	protidemia	0.807	0.65	0.016	1.68±1.1
6	CtCl/age	excreted Ct/age	0.8	0.64	0.017	17.5±14.2
7	CtCl/kg	muscle mass/kg	0.711	0.505	0.048	8.8±6.9

Table 11. Comparison of regressions		Patients with diuresis				Patients without diuresis			
Predictor	responder	R	R^2	P	absolute residuals %	R	R^2	P	absolute residuals %
weight/height	protidemia/kg	0.791	0.624	0.000	8.12±5.78	0.859	0.737	0.0063	8.87±5.13
protidemia/age	muscle mass/age	0.819	0.671	0.000	18.4±16.9	0.685	0.47	0.06	20.4±16.9
CtCl/age	excreted Ct/age	0.877	0.769	0.000	21.18±13.6	0.8	0.64	0.017	17.5±14.2
CtCl/kg	muscle mass/kg	0.778	0.606	0.00014	0.56±0.38	0.711	0.505	0.048	8.8±6.9
excreted Ct/CtCl	muscle mass	0.459	0.211	0.055	17.5±12.3	0.884	0.781	0.0036	8.58±10.6

The regressions of the patients without diuresis reported In Table10 had significant correlations that differ from the similar regression in Table .9. The regressions that were more significant in patients with diuresis are as follows: 1) protidemia/age versus muscle mass/age, 2) excreted Ct/age versus CtCl/age, and 3) CtCl/kg versus muscle mass/kg. The regressions that were more significant in patients without diuresis were as follows: 1) protidemia/kg versus total nitrogen/total creatinine and 2) muscle mass versus excreted Ct/CtCl. The remaining regressions concerning patients without diuresis resulted in being not significant in patients with diuresis. In Table 11, data of regressions concerning patients with and without diuresis were comparable.

Note in Table 11 that three of five regressions had a better result in patients with diuresis, whereas the remaining two regressions were better in patients without diuresis, which were the relationships between body structure and excreted Ct versus variables concerning body nutrition. The three regressions by patients with diuresis have similar relationships.

Evaluation and relationships of KT/V

In a well-known article from US National Cooperative Dialysis Study (NCDS), from 1985 [10], according to a "mechanistic analysis," a new variable was introduced to appreciate the degree of depuration; the formula would no longer be based only on the calculation of urea clearance or Ct clearance, but on the clearance of a selected substance normalized on its volume of distribution, that was stated to be the urea clearance according to the formula KT/V, as follows: (clearance of urea/min x time of clearance)/ volume of distribution of urea. Notwithstanding the light molecular weight of urea, the volume of urea distribution does not correspond to the body water estimates based on the Watson formula [7], that in its turn should underestimate the total body water (TBW), for an average percentage of 2.3% ± 13%, as measured by antipirine distribution volume according to the study of .de Fijter W:M: et al in 1995 [11].

On the basis of the KT/V formula , the value of KTV based on urea clearance should have to be 1 for a sufficient adequacy of treatment, but the following clinical results showed direct that the values of KT/V should have to be greater than 1 to attain suitable physical conditions of the patients. An adequate KT/V value was stated in values of 1.70 or greater. However, KT/V based on urea clearance should be considered an uncertain index of dialyisis adequacy because the value of urea can strongly vary in renal insufficiency within a few days, considering its close dependence on the proteinic and caloric intake followed in the period in which KT/V was measured, whereas the volume of urea diffusion could remain the same. For this reason, in this work, it is proposed and consequently practiced that KT/V could be more usefully evaluated based on CtCl and on the volume of Ct diffusion. KT/V value based on CtCl and on Ct volume of diffusion depends on the achieved clearance by dialysis or by the sum of dialytic and renal CtCl and only on renal CtCl in pre-dialysis renal. failure. All variables directed to evaluate the degree of depuration should be more stable in time than that based on urea clearance, to minimize the effects of acute adverse events.. Tables 12 and 13 A,B,C show the resulting KT/Vs, and their relationships with Ct clearances and with variables concerning nutrition and bodily composition.

Table 12. Comparison of KT/V values on the basis of diuresis									
Patients with residual diuresis				Patients without residual diuresis				T Test	Means
number	KTV	Mean	SD	number	KTV	Mean	SD	p	difference %
8	Males	1.56	0.65	4	Males	1.86	0.31	0.307	-19.23
10	Females	1.82	0.39	4	Females	2.28	0.56	0.207	-25.27
Patients with diuresis > 960.28 ml/day				Patients with diuresis < 960.28 ml/day				T Test	Means
number	KTV	Mean	SD	number	KTV	Mean	SD	p	difference %
5	Males	1.25	0.55	3	Males	2.09	0.38	0.051	-67.2
Table 12 – Following data									
4	Females	1.87	0.54	6	Females	1.8	0.32	0.827	3.74
Patients with residual diuresis				Patients without residual diuresis				T Test	Means
number	KTV	Mean	SD	number	KTV	Mean	SD	p	difference %
18	all patients	1.7	0.52	8	all patients	2.07	0.48	0.099	-21.76
Tabl12 – Following data									
Patients with diuresis > 960.28 ml/day				Patients with diuresis < 960.28 ml/day				T Test	Means
number	KTV	Mean	SD	number	KTV	Mean	SD	p	difference %
9	all patients	1.52	0.6	9	all patients	1.9	0.35	0.127	-25

Table.12 reports the values of KT/V based on Ct clearance for the patients with and without diuresis. The patients with diuresis are differentiated according to the amount of diuresis, greater or less than 960.28 ml/day, and each of them further differentiated by gender. Note that no statistically significant differences were found between any of the compared KT/V groups, which is different from the results of the comparison based on the percentage difference of the means, where the values of differences are comprised within 3.74% (females, difference between subjects with diuresis > 960.28 vs. subjects with diuresis < 960.28). This is the only positive difference, whereas the remaining differences are only negative, comprised between -19.23% and -67.2%; in other words, in five of six comparisons, the KT/V values resulted in percentage greater in subjects without diuresis or with diuresis less than the average value of 960.28 ml/day. This result is the same result observed in Tables. 4, 5, and 6, where the greater values with a significant difference were attained by the subjects with lower diuresis.

Table 13 A. Regressions of CtCl versus KT/V		Statistics			
predicting variables	responding variables	R	R²	P	scores
KT/V - patients with diuresis	corresponding CtCl	0.904	0.817	0.000	5
KT/V - patients without diuresis	corresponding CtCl	0.39	0.15	0.34	1
KT/V per kg - patients without diuresis	corresponding CtCl/kg	0.854	0.731	0.007	3
KT/V -patients with diuresis > 960.28	corresponding CtCl	0.943	0.889	0.00014	4
KT/V -patients with diuresis < 960.28	corresponding CtCl	0.641	0.411	0.06	1

Table 13 B. Regressions of estimated muscle mass versus KT/V		Statistics			
predicting variables	responding variables	R	R²	P	scores
KT/V - patients with diuresis	estimated muscle mass	0.47	0.221	0.049	2
KT/V per kg - patients with diuresis	estimated muscle mass /kg	0.672	0.447	0.0022	3
Table 13 B – Following data					
KT/V per kg - patients with diuresis > 960.28	estimated muscle mass /kg	0.0509	0.0026	0.896	1
KT/V per kg - patients with diuresis < 960.28	estimated muscle mass/kg	0.834	0.695	0.005	3
KT/V per kg - patients without diuresis	estimated muscle mass/kg	0.536	0.287	0.171	1
KT/V - patients with diuresis	Protidemia	0.289	0.083	0.245	1
KT/V per kg - patients with diuresis	protidemia/kg	0.521	0.271	0.027	2

Table 13 C. Regressions of protidemia, albuminemia versus KT/V		Statistics			
predicting variables	responding variables	R	R²	P	scores
KT/V per kg - patients with diuresis > 960.28	Protidemia	0.739	0.546	0.023	2
KT/V per kg - patients with diuresis > 960.28	albuminemia/kg	0.209	0.044	0.589	1
KT/V per kg - patients with diuresis < 960,.28	protidemia/kg	0.774	0.599	0.014	2
KT/V per kg - patients with diuresis < 960,.28	albuminemia/kg	0.892	0.796	0.0012	3
KT/V per kg - patients without diuresis	protidemia/kg	0.892	0.796	0.0012	3
KT/V per kg - patients without diuresis	albuminemia/kg	0.63	0.397	0.094	1

In Tables 13A, 13B, and 13C, overall, the variables concerning CtCl, protidemia, albuminemia, and estimated muscle mass were found to have significant correlations with KT/V based on CtCl and on the volume of Ct diffusion and indexed per weight: 11 of 18 regressions (61.11%). The regressions that were not significant (38.9%) concerned the following: 1) patients without diuresis versus a) CtCl, b) estimated muscle mass/kg, and c) albuminemia/kg; 2) patients with diuresis greater than 960.28 ml/day versus a) estimated muscle mass/kg, b) albuminemia/kg; and 3) patients with diuresis less than 960.28 ml/day versus CtCl. The data in Tables 13A, 13B, and 13C seem to verify that the new variable represented by KT/V on the basis of Ct clearance, as proposed, may really be adopted as a suitable measure of patient treatment when normalized on weight . Considering the presence of 7 of 18 regressions that were not found to be significant, the suitability of this assumption could be supported by the relevance of the significant regressions versus the results that were not significant. This was evaluated on the basis of the levels of significance of the 18 regressions, giving them numerical scores on the basis of p values as follows: 5 for p = 0.000, 4 for 0.000*N*, 3 for p = 0.,00*N*, 2 for p = 0.0*N* when ≤ 0.05, and 1 for p greater than 0.05 (see Tables. 3A, 3B, and 3C). The significance of the distribution of scores was evaluated by the text for two proportions, resulting in a high difference for the prevalence of values of significant regressions versus the regressions that were not significant: test and CI for two proportions; test for difference = 0 (vs not = 0); Z = 5.69, P value = 0.,000 ; Fisher exact test: P value = 0.000.

Discussion

The aim of this work was to study a group of 26 patients in end-stage renal disease and undergoing chronic PD to find the tangible relevance of a residual diuresis to attain better conditions of nutrition and body composition. The original available data base did not include data concerning the cardiovascular conditions, but it is easy to believe that the presence of a residual diuresis could facilitate the control of body water volume and, consequently, a better cardiovascular state. The database did not include the exact isotopic measures of body water volume (TBW), and its size was estimated by the Watson formula [7]. These estimates resulted in no difference between patients with and without diuresis (Tables. 3A, 3B), which seemed to exclude in this studied population a differentiating influence of the saved diuresis on body water. TBW is the space of urea and creatinine diffusion, but this space was considered according to two different volumes included in TBW, in other words, a different point of view to define TBW. Their volumes in this article were calculated on the basis of the consistent modeled volumes according to Daugirdas et al. [6], as presented in Materials and Methods.

Protidemia, albuminemia, nitrogen mass, Ct mass, and estimated muscle mass were no different between patients with and without diuresis; these are all variables strongly related to body nutrition. These results are very probably ascribable to the same degree of Ct clearance existing between the two groups of patients, this seeming to exclude also that, at least in these studied patients, the available residual diuresis should add a significant differentiating factor to the final total clearance. Within the results, it was found that the muscle mass evaluated by the formula of Wang [8] and its indexation by weight differ between the two subgroups of diuresis (one with a larger value and one with a lower value), as well as a larger total nitrogen indexed by age. The seemingly unexpected result of a larger muscle mass depends on the values of excreted Ct, which was greater (with high significance) in subjects with lower diuresis and on which the formula by Wang calculates the muscle mass (see Table 6: excreted Ct by dialysis + urine 764.4 ± 244.7 mg vs. 488.8 ± 127.79). Table 5 shows that there are not significant differences between the considered variables. This result is of particular interest, because within the considered variables are included protidemia and its indexations on weight, on height, and on age, albuminemia, protidemia/albuminemia, the data concerning the clearances, and the residual GFR. In other words, the content of Table 5 indicates that the difference of diuresis, at least at the degree in this case, does not significantly influence the nutrition and the renal clearance, notwithstanding the means of the values of the subgroups of diuresis differed from each other by 58.32% and the difference of the average residual GFR is greater in the second subgroup by 35.96%. But, the most relevant observation is that KT/V differs between the two subgroups by only 20%. KT/V signifies, in the present assumption, the clearance of Ct normalized on Ct volume, allowing the inference that the degree of depuration is quite close between the two groups, which well explains the results in Table 5. Table 6 includes a very interesting result: when indexed on weight, CtCl is significantly greater in subjects with less diuresis compared with those with greater diuresis, whereas the not indexed total CtCl are not significantly different from each other (i.e., the respective effectiveness of total CtCl is more evaluable when normalized on body mass). This observation can explain how the comparison in Tables 4 and 6 resulting in significant differences always had greater values in the subgroup with lower diuresis, with an expected exception for diuresis, having greater and lower values because of the amount of their separation. It is of note that even the mean of GFRs is greater than 36% in the subgroup with lower diuresis. The calculated residual GFRs (Table .5) resulted in a difference that was not significant; in fact, a greater diuresis does not necessarily signify a greater GFR, this last due only to the better functional conditions of the kidneys. Based on these findings, it seems reasonable to conclude that the subjects with lower diuresis had better GFRs, a usual observation in renal insufficiency, where the relevant decreasing of GFR is usually concurrent with an increase in diuresis. It is worth reminding that diuresis greater than 960.28 ml/day gives rise to a residual GFR of 0.368 ± 0.135 ml/min, equivalent to 11.6 ± 6.89 % of total clearance, whereas diuresis less than 960.28 ml/day gives rise to a residual GFR of 0.57 ± 0.372 ml/min, equivalent to 14.7% ± 10.94% of total clearance, which is not even a statistically significant difference (T test, T-value = -0.72, P-value = 0.483, DF = 13). Based on the percentage values of participation of renal CtCl to total CtCl, in the first subgroup the substitute treatment represents, more or less, a percentage of CtCl between 74.62% and 92.18%, and in the second subgroup a percentage of CtCl between 63.42% and 92.82%. Applying to these percentage differences between the two subgroups the text of the two proportions, it results that the difference of the percentages of dialytic treatment between the two subgroups is significant, with a lower size of dialytic treatment in the second subgroup: test for difference = 0 (vs. not = 0): Z = 2.18, P value = 0.029; Fisher exact test: P-value = 0.042. That is to say that the residual renal functions, according to the size and functional significance of residual diuresis, could possibly contribute to a lower dialytic prescription, with less or more effectiveness, this depending on their size, as in the case presented previously.

Regressions

In Table 10, 7 of 27 regressions concerned variables related to diuresis, whereas the remaining 20 concerned variables differently related. Twelve of 27 regressions correlated protidemia and its indexations on weight and on age with variables concerning the body mass (weight/height), the nutrition, and the degree depuration (lines 1-13 and line 23, muscle mass vs. protidemia). A following group of variables (lines 12-21) concerns different aspects of the clearances with the excretion of nitrogen and of Ct. Lines 22 to 27 concerned the muscle mass. The most relevant significance (p = 0.000) was attained by the regressions concerning the following: protidemia/kg versus weight/height, protidemia indexed on age versus muscle mass indexed on age, versus total nitrogen, and versus total creatinine indexed on age, all if indexed on age. The same can be noted for the regression of excreted Ct versus CtCl (renal CtCl), similarly indexed on age. The statistical significance of these relationships is a very interesting demonstration of how the variables concerning body composition resulted in correlation only if normalized on age; therefore, in the case of comparison or of regressions, it could be suitable to index on age the variables concerning the body composition, particularly taking into account that the change of these variables generally depends on aging.

KT/V

This variable defines the scheduled target of treatment, in this case, clearance/min of Ct for time of treatment (K)/volume of diffusion of Ct, in which is also included K due to the eventual residual GFR. Its calculation in the patient data evaluates the achieved target. In Table 12, male patients with diuresis present an average KT/V that is not adequate (<1.70), and adequate (1.86) in male patients without diuresis, with similar conditions for males and females in patients with diuresis greater than 960.28 ml/day versus those with diuresis less than 960.28 ml/day. The patients with diuresis and the anuric patients both show adequate KT/V (>1.70), whereas all patients with diuresis greater than 960.28 ml/day have inadequate average KT/V (1.52 ± 0.6) versus those with diuresis less than 960.28 ml/day, a difference that is not statistically significant; however, the statistical significance can be considered irrelevant when the value of KT/V is 1.70 or greater. This value should be considered a pre- defined target. It was interesting to analyze the consequences on body composition and on variables concerning nutrition depending on a greater or a lower KT/V. For this aim, the KT/V of each the two groups of patients having diuresis greater and less than 960.28 ml/day was separated in two groups of greater and lowers than the average value of KTV, each including the corresponding muscle mass, total protidemia, protidemia depending on weight, and, albuminemia depending on weight. The results are shown in the Tables. 14 and 15.

Table 14. Patients > 960.28

variables	KT/V > average of KT/V			KT/V < average of KT/V			
statistics	mean	SD	Coeff var	mean	SD	Coeff var.	T test for two variables
KT/V of all patients	1.91	0.327	0.171	1.029	0.322	0.313	T-Value = 4.04 P-Value = 0.007 DF = 6
KT/V of all patients by kg	0.042	0.174	0.413	0.028	0.0073	0.263	T-Value = 1.66 P-Value = 0.158 DF = 5
Muscle mass	13.9	4.79	0.345	13.85	1.51	0.109	T-Value = 0.02 P-Value = 0.983 DF = 4
Total Protidemia	6.62	0.606	0.92	7.31	0.585	0.08	T-Value = -1.74 P-Value = 0.133 DF = 6
Protidemia/kg	0.096	0.014	0.146	0.099	0.011	0.111	T-Value = -0.36 P-Value = 0.731 DF = 6
Albuminemia	3.77	0.722	0.192	4.25	0.378	0.888	T-Value = -1.31 P-Value = 0.238 DF = 6
Weight	69.5	8.3	0.119	74.88	11.62	0.155	T-Value = -0.79 P-Value = 0.467 DF = 5

Table 15. Patients < 960.28 ml/min

Variables	KT/V > average of KT/V			KTV < average of KT/V			
Statistics	mean	SD	Coeff var	mean	SD	Coeff var.	T test for two variables
Table 15 – Following data							
KT/V all patients	2.35	0.104	0.044	167	0.29	0.174	**T-Value = 4.88 P-Value = 0.005 DF = 5**
KT/V all patients by kg	0.03	0.003	0.098	0.025	0.005	0.2	T-Value = 0.04 P-Value = 0.969 DF = 3
Muscle mass	22.81	1.77	0.078	16.94	3.73	0.22	**T-Value = 3.11 P-Value = 0.027 DF = 5**
Total Protidemia	7	0.46	0.066	6.84	1.28	0.187	T-Value = 0.26 P-Value = 0.806 DF = 5
Protidemia/kg	0.11	0.022	0.195	0.104	0.02	0.192	T-Value = 0.71 P-Value = 0.507 DF = 6
Albuminemia	4.09	0.338	0.083	3.68	0.536	0.146	T-Value = 1.40 P-Value = 0.212 DF = 6
Weight	64.5	9.57	0.148	68.02	20.2	0.297	T-Value = -0.35 P-Value = 0.741 DF = 5

As shown in Tables 14 and 15, it is possible to observe that the operated separation in two groups of KT/V caused relevant and significant differences of KT/V values : in Table 14,191 ± 0.327 versus 1.029 ± 0.322, and in Table 15, 2.35 ± 0,104 versus 1.67 ± 0.29, which corresponds to a percentage difference of the means of KT/V, respectively, of 46.13% and 28.9%. But, this very significant difference of KT/V values between the two groups of patients did not correspond to a statistically significant difference between the correlated muscle mass, protidemia, and protidemia indexed on weight, albuminemia, with the only exception where the lower KT/V coupled with a lower muscle mass. The data in Tables 14 and 15 seem to question the mandatory need of KT/V ≥ 1.70 to attain adequate results of body maintenance. All the above information should be cautiously evaluated, because the golden target of KT/V, which was based on urea clearance and having the best results when KT/V ≥ 1.70, could have a different value when based on Ct clearance, and even very marginally the volumes of diffusion of urea and Ct differ from each other, with a lower value for Ct volume.

Conclusions and final considerations

The amount of diuresis per se does not represent a sufficient base for a better bodily condition and nutrition, whereas it certainly influences the control of total body water. The assertion of a better nutrition of subjects with a larger amount of diuresis in the article by Sikorska D. et al [5]. broadly commented in premise, in fact concerns only hemoglobin, albumin, and cholesterol, whereas the lean body mass and the fat mass did not differ within the three diuresis volumes. Thus, what our findings emphasize is that the amount of diuresis does not necessarily correspond to a proportional GFR, and the same conditions of nutrition were shown in this article, when comparing the data concerning the body structure and nutrition between patients with diuresis versus the anuric patients. The same relationship resulted when comparing the data related to nutrition of patients having diuresis greater than 960.28 ml/day versus those having diuresis less than 960.28 ml/day, with the only exception for estimated muscle mass, which is due only to the method used to calculate this variable, based on Ct excretion, which has a significantly larger size in subjects with lower diuresis (signifying that this group has a greater effectiveness of total clearance). The amount of diuresis has significant influence on patients' conditions only when consistent with an effective GFR. In these patients, the group with a larger amount of diuresis had residual GFR values between 0.635 ml/min and 0.095 ml/min representing the 11.6% ± 6.89% of total clearance, when in the group with a lower amount of diuresis the residual GFR values were between 1.31 ml/min and 0.17 ml/min, attaining the 14.7 ± 10.94% of total clearance, very marginal contributions to total CtCl. Therefore, it is correct to assume that for all the patients considered in this article, the conditions in terms of body composition and nutrition were actually based only on PD. This assumption is confirmed by the comparison of data of patients with diuresis greater than 960.28 ml/day with those of anuric patients, by which significant differences in favor of anuric patients in terms of total clearance are demonstrated. On the basis of what is shown in the discussion concerning KT/V, and particularly the results of the analysis based on the separation of its values into two groups greater and lower than its average, the assumption that KT/V values should mandatorily be stated to be ≥ 1.70 to have adequate physical conditions seems to be uncertain, for the described strong variability of urea, in cases of KT/V based on urea clearance and for the possibility of a different target of KT/V if defined on the basis of Ct clearance. The final conclusion is that a residual diuresis in the course of a started dialytic treatment, beyond its usefulness in maintaining TBW, can be the basis for a better general condition only when corresponding to a GFR value significantly contributing to total clearance, i.e., very probably when this contribution to total clearance is greater than the percentage evaluated in the patients of this work. An effective percentage value should not be defined on a theoretical basis in a pre-defined range; rather, it has to be stated according to the widely different conditions of each patent, and particularly for the age of the patient. In practical terms, all the findings herein signify that, for each patient, his/her specific value of GFR is needed to start an incremental dialysis.

Final considerations on the attained results

The results of the statistical calculations in this elaboration were characterized by a high significance of probability (p values). In 112 comparisons, no comparison had marginal significance nor was any comparison marginally not significant; that is to say, p values being between 0.049 and 0.06. In 45 performed regressions. 30 had significant results (66.67%), with the following p values: 7 regressions (23.33%), p ≤ 0.049; 4 regressions (13.33%), p = 0.00*N*, 19 regressions (63.33%), p = 0,000 or 0,000*N*. Therefore, is rationally arguable that the small number of the studied sample (26 subjects) did not significantly influence the results of the research. Notwithstanding this consideration, by considering the relevance of the studied topic, and the relevance of diuresis in advanced renal failure, it seems suitable to think that the obtained results would be confirmed by applying this study to an adequately wider sample of patients.

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