UNIVERSITY OF NIŠ
The scientific journal **FACTA UNIVERSITATIS**
Series: **Medicine and Biology** Vol.6, No 1, 1999 pp. 107 – 111
Editor of Series: Vladisav Stefanović, e-mail: factacivil@medfak.medfak.ni.ac.yu
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http://ni.ac.yu/Facta

UC 616.38

ADEQUACY OF HEMODIALYSIS IN A LARGE UNIVERSITY - AFFILIATED DIALYSIS CENTRE IN SERBIA

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Summary. *Adequacy of hemodialysis was analyzed in an outpatient university-affiliated dialysis facility in South Serbia. In 1998 181 patient was on maintenance hemodialysis (average age, 54.5 years; 47.5 women, 52.5 men; interstitial nephritis 28%, glomerulonephritis 27%). A Kt/V delivered <0,8 was recorded in 6.7% of patients (group I), 0.8-1.2 in 43% (group II), and >1.2 in 50.3% of patients (group III). Patients of group III had a lower body weight and, since a dialysis session of 4h was offered to all patients, this could account for a significantly higher Kt/V and URR. A better rehabilitation in groups III and II than in group I was demonstrated. Thirty-two patients were hospitalized in 1998, but the only difference between these and 149 patients without hospitalizations was a significantly higher number of erythrocytes and hemoglobin.*
This analysis has revealed an insufficient dialysis time given to patients with the large body weight. Severe anemia was associated with increased hospitalizations. The degree of rehabilitation was extremely low in patients with Kt/V <0.8.

Key words. *Hemodialysis, adequacy, Kt/V, urea reduction rate, hospitalization, rehabilitation*

Introduction

Numerous studies have demonstrated a correlation between the delivered dose of hemodialysis and patient mortality and morbidity (1-3). Kt/V is an index of dialysis adequacy. Values of < 1.0 have been associated with higher rates of morbidity and mortality than values >1.0 (4). Recent data, however, suggest that values greater than 1.0 has been an underestimate, and that a Kt/V>1.2 or 1.3 is ideal (5). In 1993 Renal Physicians Association developed practice guidelines for hemodialysis (6). The PPA recommended that delivered Kt/V should be at least 1.2, and when the Kt/V falls below this level, corrective action should be undertaken. Because many end-stage renal disease (ESRD) patients do not receive an adequate dose of hemodialysis, the National Kidney Foundation (NKF) Dialysis Outcomes Quality Initiative (DOQI) decided to reevaluate the issue of hemodialysis adequacy. The NKF-DOQI clinical practice guidelines, published in 1997, have set the minimum of delivered dialysis dose (7). The minimum dose of hemodialysis delivered to each ESRD patient, as measured monthly, must achieve at least a Kt/V of 1.2 or an average URR>65%. However, the optimum dose of delivered hemodialysis could not be defined, since there was not compelling or convincing evidence for recommending a higher minimum dose of delivered hemodialysis. However, dialysis care teams are not discouraged from establishing greater minimum hemodialysis dose for their patients.

Thus more sensitive indicators must be studied to optimize dialysis treatment (8). In this regard measures about quality of life appear to be valuable. Health related quality of life was found to be an independent measure of patient problems otherwise undetected by traditional objective parameter (9). Quality of life adjusted for life expectancy was directly related to dialysis dose (Kt/V range 0.4-2.0) (10,11). In older patients beyond Kt/V>1.3 the increment of costs was very steep, while the increment in quality adjusted life expectancy was rather minuscule. In this study the threshold of Kt/V 1.3 was dictated by economical reasons rather than by the outcome.

In this study, dialysis adequacy was analyzed in a large university-affiliated dialysis facility.

Materials and Methods

One hundred eighty-one patient, from the university-affiliated hospital in Niš, Serbia, participated in the study of dialysis adequacy. Inclusion criteria for the study included maintenance hemodialysis (HD) treatment for at least 3 months. Patients underwent

dialysis three times weekly for approximately 4 hours, using a 1.0 to 1.3 m^2 surface area hollow fiber dialyzer. Most of the patients (about 85%) were using cuprophan, and only 15% polysulfone membranes. Blood flow was 250 to 300 ml/min, and dialysate flow was 500 ml/min.

Delivered dialysis dose was calculated from pre- and post-dialysis blood urea and weight. Blood sample for post-dialysis urea measurement was drawn at the completion of dialysis, after a decrease of blood flow to 50 ml/min for 15 seconds, from the arterial sampling port closest to the patient.

All blood and urine chemistries were measured using Synchron CX-3 autoanalyser (Beckman, USA). Serum albumin was measured by the bromcresol green method.

Kt/V urea was calculated from natural logarithm formula [12]:

$Kt/V_{urea} = -Ln (R - 0.008 \times t) + (4 - 3.5 \times R) \times UF/W$

In which Ln is the natural logarithm; R is the post-dialysis BUN : pre-dialysis BUN: t is the dialysis session length in hours; UF is the ultrafiltration volume in liters; and W is the patients post-dialysis weight in kg.

$Kt/V_{double\ pool}$ was calculated from formula:

$Kt/V_{double\ pool} = Kt/V_{single\ pool} \times [1 - (0.6/T)] + 0.03$

Urea reduction rate (URR) was calculated [13]:

URR = 100 x (1 - Ct/Co) in which Ct is the post-dialysis BUN, and Co is the pre-dialysis BUN.

Results

The mean age of 191 patients on hemodialysis was 54.5 years. Only 2% of patients were up to 20 years, and most of the patients (46.2%) were over 60 years (Fig.1). There were 86 (47.5%) women and 95 (52.5%) men.

The primary kidney disease leading to ESRF was interstitial nephritis in 28% of patients, mostly chronic pyelonephritis. Glomerulonephritis was the second most common cause, with 27% of patients (Fig.2). Women predominated in interstitial nephritis, men in glomerulonephritis. Unknown cause of ESRF was in 17.5% of patients.

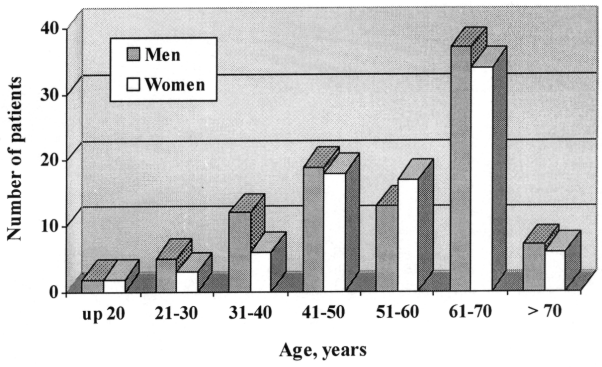

Fig. 1. Age and sex distribution of patients on maintenance HD.

Mean age at the start of hemodialysis was 37.3 years in glomerulonephritis but 54.1 in chronic tubulointerstitial disease, and 54.8 in polycystic kidney disease (Table 1).

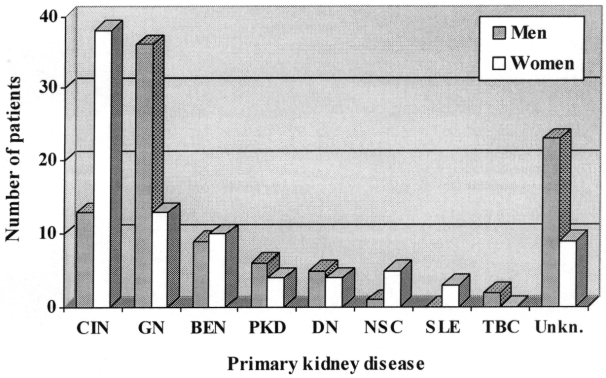

Fig.2. Primary kidney disease leading to dialysis.
CIN - chronic interstitial nephritis, GN - glomerulonephritis, BEN - Balkan endemic nephropathy, PKD - polycystic kidney disease, DN - diabetic nephropathy, NSC – nephroagniosclerosis, SLE – systemic lupus erythematosus, TBC - tuberculosis.

Table 1. Mean age of patients at the start of hemodialysis

Kidney disease	Age, years
Renal tuberculosis	61.0
Unknown	59.9
BEN	56.1
Polycystic kidney disease	54.8
Chronic tubulointerstitial disease	54.1
Nephroangiosclerosis	43.7
Diabetic nephropathy	42.6
Lupus nephritis	37.5
Chronic glomerulonephritis	37.3

At the time of study, 38.1% of patients were on dialysis longer than 5 years (Fig.3). There were 17 (9.4%) patients on hemodialysis over 10 years, and 7 (3.9%) on dialysis over 15 years. Only one patient was over 20 years on dialysis.

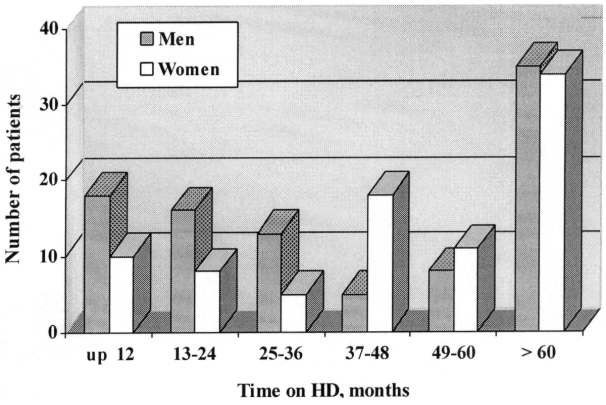

Fig. 3. Duration of hemodialysis.

General data of patients, in the groups, according to the Kt/V, are presented in Table 2. Patients with the Kt/V>1.2 (group 3) are younger, have started dialysis treatment earlier in the life, with a longer dialysis treatment than patients in the group I, and have a lower body mass than patients in the groups I and II.

Table 2. General data of patients on maintenance HD in three groups with different Kt/V*

	Group I	Group II	Group III
Age, years	57.7	55.0	50.7
Body height, cm	167.0	166.5	162.0
Body weight, kg	64.9	63.0	58.3
HD duration, months	45.9	61.2	72.6
Age at the start of HD, years	53.8	49.8	44.6
S-Urea before HD, mmol/L	29.8	32.0	35.7
S-Creatinine before HD, μmol/L	894.1	925.0	883.1
$Kt/V_{double\text{-}pool}$	0.710	1.021	1.328
URR (%)	47.8	61.6	71.6

* Kt/V: group I: <0.8; group II: 0.8-1.2; group III: >1.2

Body length and body weight of patients in the group III is significantly lower than in groups II and III (Table 3). Alkaline phosphatase was significantly higher in group III. Mean duration of each hemodialysis session was shorter in group I than in the two other groups.

All other parameters studied were not different between these three groups of patients.

Stages of rehabilitation according to the EDTA criteria are:

1. Working full time, including household work
2. Working partial time
3. Able to work but not working, no suitable work
4. Able to work but not working, drawing pensions
5. Not able to work, but living at home and taking care of themselves
6. Not able to work, and not able to take care of themselves.

Patients with Kt/V<0.8 had the lowest rehabilitation (Table 4). Only 3.2% of these were working full time, however, 16.1% cannot care for themselves, requiring complete nursing. In contrast, patients with Kt/V>1.2 had a satisfactory rehabilitation, with 7.9% working, full time 7.9% working partial time, and 75.7% of patients were able to work but benefits or lack of a job precluded employment. None in this group was incapable of carrying for himself.

Table 4. Working rehabilitation in three groups of patients on maintenance HD

Kt/V	Degree of rehabilitation *					
	1	2	3	4	5	6
<0.8	0 (0.0)	1 (3.2)	6 (19.3)	11 (35.5)	8 (25.8)	5 (16.1)
0.8 – 1.2	1 (0.9)	10 (8.9)	24 (21.4)	43 (38.4)	27 (24.1)	7 (6.3)
>1.2	3 (7.9)	3 (7.9)	11 (28.9)	14 (36.8)	7 (18.4)	0 (0.0)
Total	4 (2.2)	14 (7.7)	41 (22.7)	68 (37.6)	42 (23.2)	12 (6.6)
SUM	10 %		60 %		30 %	

* Number of patients and percentage in parenthesis are presented.

In 1998, 32 (17.7%) patients were hospitalized, one or more times. A comparison of patients with and without hospitalizations has revealed that hospitalized patients had statistically lower (p<0.05) number of erythrocytes and hemoglobin (Table 5). Some other biochemical, anthropometrical and urea kinetic parameters were not significantly different between these two groups.

Table 3. Biochemical, anthropometrical and urea kinetic parameters in three groups of patients on maintenance HD

	*Kt/V**			*Statistical significance*		
	<0.8	*0.8 - 1.2*	*>1.2*	*I vs. II*	*I vs. III*	*II vs. III*
Hemoglobin, g/L	75.6±14.9	79.0±15.0	81.2±17.5			
Hematocrit	0.22±0.04	0.23±0.04	0.24±0.05			
Erythrocytes, T/L	2.51±0.53	2.60±0.48	2.67±0.51			
Leukocytes, G/L	5.43±1.15	5.76±1.95	6.43±2.80		p<0.05	
S-Phosphate, mmol/L	1.71±0.64	1.72±0.57	1.74±0.42			
S-Calcium, mmol/L	2.01±0.30	2.02±0.29	2.07±0.37			
S-Alkaline phosphatase, IU/L	183.2±75.3	244.9±199.0	402.2±518.3	n.s.	p<0.01	p<0.01
S-Albumin, g/L	43.8±7.1	43.2±5.3	42.9±6.9			
Body weight, kg	64.9±10.9	63.0±11.6	58.3±12.8	n.s.	p<0.05	p<0.05
Body height, cm	167.0±7.5	166.5±9.4	162.0±9.6	n.s.	p<0.05	p<0.05
URR (%)	47.8±4.6	61.6±4.5	71.6±2.5	p<0.001	p<0.001	p<0.001
$Kt/V_{double\text{-}pool}$	0.710±0.08	1.021±0.11	1.328±0.08	p<0.001	p<0.001	p<0.001
Duration of HD session, hours	3.89±0.15	3.94±0.11	3.97±0.11	p<0.05	p<0.01	n.s.
Weight gain, kg	2.61±0.83	2.71±0.90	2.73±0.77			

* Values are means ± S.D. Statistical significance was estimated by Student's t-test.
Kt/V: group I: <0.8; group II: 0.8-1.2; group III: >1.2.

Discussion

Adequacy of hemodialysis was considered

Table 5. Relationship of hospitalizations with some biochemical, anthropometrical and urea kinetic parameters

	Pts. with hospitalizations	Pts. without hospitalizations	Statistical significance
Number of pts.	32 (17.7 %)	149 (82.3 %)	
Age, years	55.6	54.2	
Age at the start of HD, years	51.4	49.0	
HD treatment, months	48.5	68.8	
Urine output, ml/24 h	254.6	175.3	
Duration of HD session, hours	3.91	3.95	
$Kt/V_{double\text{-}pool}$	1.010	1.039	
URR (%)	60.1	61.8	
BMI (kg/m^2)	22.5	23.2	
Relative body weight (%)	87.8	92.0	
Body fat (%)	10.1	11.5	
Erythrocytes (T/L)	2.40	2.74	$p<0.05$
Hemoglobin (g/L)	73.8	81.9	$p<0.05$
S-Albumin (g/L)	43.0	44.1	

* Arithmetic means are presented.

worldwide. From 1986 onwards mortality of ESRD patients in USA decreased from 35% to 22% while the dialysis dose was increased from Kt/V 0.91 up to 1.19. Moreover, the use of synthetic membranes increased from 9% to 55% (14,15). RPA guidelines, obligatory for implementation, probably contributed to this. The same holds for the NKF-DOQI practice guideline (16).

The present study of dialysis adequacy in a large university-affiliated dialysis center has revealed that 50.3% of patients have a Kt/V greater than 1.2. Severely insufficient dialysis was delivered to 6.7% of dialysis patients with a Kt/V bellow 0.8. Further 18.4% of patients were markedly underdialyzed, with a Kt/V over 0.8-1.0. Another group (24.6% of patients) received also insufficient treatment, with a Kt/V over 1.0-1.2.

Insufficient dialysis in this center, according to the NKF-DOQI criteria, was reviewed. More efficient, high-flux dialysis requires volumetric machines, but actual funding constraints preclude the wider use of high-flux dialyzers and volumetric machines. This was, however, expensive for much richer countries, like Australia (17).

On the other hand, aggressive dialysis techniques have potential drawbacks; a slow and gentle dialysis is, after all, optimal. Extended time on dialysis is a gentle dialysis. Charra et al. have clearly demonstrated that long, gentle dialysis directly translates into reduced morbidity and mortality (18). By restructuring dialysis patient shifts and nursing schedules, it should be possible to create an individual dialysis regimen for each patient, based primarily upon an individualized dialysis time. This is still feasible, although a rather small number of dialysis machines preclude necessary manipulation. Underdialysis was documented world-wide. Delmez et al have shown that in a USA hemodialysis population form a large metropolitan area nearly 50% of patients received suboptimal treatment (19). In a study from Australia many of patients were found chronically underdialyzed, and the only dialysis prescription capable of impacting positively on dialysis adequacy was a significant increase in the time spent on dialysis (17).

All patients in this dialysis center were treated with a standard procedure, 3 times weekly, and 4 h each hemodialysis session. It was shown (Table 3) that patients with the Kt/V>1.2 were with lower body mass, compared to groups of patients with underdialysis. Inadequate treatment of patients with a large body mass has been previously described (20). Thus, this group of patients requires individualized treatment, and careful monitoring of delivered dose of hemodialysis.

Morbidity and, thereof, hospitalizations could be regarded as an index of dialysis adequacy. In the present study relationship of increased hospitalizations to anemia was revealed. Hospitalizations were found not to correlate with Kt/V or URR.

The beneficial effect of anemia therapy was previously observed. Effective treatment of anemia of ESRD improves survival, decreases morbidity, and increases quality of life (21-25).

The goal of adequate hemodialysis treatment is to bring to complete psychosocial and working rehabilitation. In this study adequate dialysis was associated with a maximum of rehabilitation. Most of the severely underdialyzed patients were not able to work, or even not able to take care of themselves.

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ADEKVATNOST HEMODIJALIZE U JEDNOM VELIKOM UNIVERZITETSKOM DIJALIZNOM CENTRU U SRBIJI

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Kratak sadržaj: *Analizirana je adekvatnost hemodijalize ambulantnih bolesnika u jednom velikom dijaliznom centru univerzitetske bolnice u Južnoj Srbiji. Na programu hronične hemodijalize u 1998. godini lečen je 181 bolesnik (prosečna starost 54,5 godina; žene 47,5%, muškarci 52,5%; osnovna bolest intersticijski nefritis 28%, glomerulonefritis 27%). Dozu dijalize, merenu sa Kt/V, manju od 0,8 primilo je 6,7% bolesnika (I grupa), 0,8-1,2 43% bolesnika (II grupa), a više od 1,2 50,3% bolesnika (III grupa). U gotovo svih bolesnika trajanje jedne dijalize bilo je 4 h. Bolesnici III grupe imali su manju telesnu težinu i to je, verovatno, bio razlog što su imali značajno viši Kt/V i URR. Pokazano je da su bolesnici II i III grupe bolje rehabilitovani nego bolesnici I grupe. U 1998. godini hospitalizovana su 32 bolesnika, a 149 bolesnika nije bolnički lečeno. Bolesnici bez hospitalizacija imali su statistički značajno veći broj eritrocita i sadržaj hemoglobina nego bolesnici sa hospitalizacijama.*
Ovim ispitivanjem je ustanovljeno da je bolesnicima sa većom telesnom masom potrebna duža hemodijaliza. Teška anemija povezana je sa češćim hospitalizacijama. U bolesnika sa niskim Kt/V (<0.8) mali je stepen rehabilitacije.

Ključne reči: *Hemodijaliza, adekvatnost, Kt/V, stepen redukcije ureje, hospitalizacija, rehabilitacija*

Received: December 30, 1998