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Wielkość przestrzeni zewnątrzkomórkowej u pacjentów hemodializowanych z prawidłowym ciśnieniem tętniczym i nadciśnieniem tętniczym

Streszczenie

Wstęp. Monitorowanie stanu nawodnienia pacjentów dializowanych stanowi istotny aspekt kliniczny jakości ich leczenia. Bioimpedancja elektryczna jest jednym z narzędzi, które służy określaniu stanu nawodnienia.

Cel. Celem było zbadanie korelacji pomiędzy wielkościami stanu nawodnienia a parametrami takimi jak:

- wskaźnik adekwatności dializy, wskaźnik katabolizmu białka (Pcr, Kt/V),
- wskaźniki stanu odżywienia (poziom albumin, poziom białka całkowitego, poziom kreatyniny przed hemodializą) u pacjentów hemodializowanych z prawidłowym ciśnieniem tętniczym i z nadciśnieniem tętniczym.

Materia i metoda. Badanie przeprowadzono u 51 pacjentów dializowanych, podzielonych na dwie grupy – grupę pacjentów hemodializowanych z prawidłowym ciśnieniem tętniczym (11 osób: 5 kobiet i 6 mężczyzn) i grupę pacjentów hemodializowanych z nadciśnieniem tętniczym (40 osób: 17 kobiet i 23 mężczyzn), jednorazowo przed hemodializą przy pomocy metody bioimpedancji elektrycznej całego ciała.

Wyniki. W badaniu korelacji wykazano istotną statystycznie korelację pomiędzy: ECW a Kt/V (r = -0,80; p = 0,003) oraz ICW a Kt/V (r = -0,60; p = 0,05) w grupie pacjentów hemodializowanych z prawidłowym ciśnieniem tętniczym (normotonicy) przed hemodializą.

W grupie pacjentów hemodializowanych z nadciśnieniem tętniczym wykazano istotną statystycznie zależność pomiędzy: ECW a Kt/V (r = -0,43; p = 0,006), ICW a poziomem osoczowego białka całkowitego (r = 0,41; p = 0,008) oraz ICW a poziomem kreatyniny przed HD (r = 0,49; p = 0,001).

W grupie pacjentów hemodializowanych z prawidłowym ciśnieniem tętniczym, jak i z nadciśnieniem tętniczym przed hemodializą wykazano korelację istotną statystycznie pomiędzy: ciśnieniem skurczowym i ECW (r = 0,31; p = 0,03) oraz ciśnieniem skurczowym i ECW/masa ciała przed HD (r = 0,44; p = 0,001).

Wnioski. Uzyskane wyniki potwierdzają odwrotnie proporcjonalną zależność pomiędzy wielkością ECW i wskaźnikiem Kt/V u pacjentów hemodializowanych zarówno z nadciśnieniem tętniczym jak i z prawidłowym ciśnieniem tętniczym.

Słowa kluczowe: hemodializa, przewlekła niewydolność nerek, nadciśnienie, bioimpedancja, przedział pozakomórkowy, Kt/V

Extracellular water compartment in hemodialyzed patients with normal blood pressure and with hypertension

Abstract

Introduction. Evaluation of hydration levels in dialyzed patients is an essential part of dialysis therapy. Bioimpedance is a valuable tool in the evaluation of the hydration level of the body in the dialyzed patient.

Aim. The aim of this study was to examine the correlation between hydration values and parameters such as:

- dialysis adequacy parameter, protein catabolism rate (PCR, Kt/V)
- nutrition rate (albumin concentration, total protein concentration, creatinine concentration before haemodialysis) in haemodialyzed patients with normal blood pressure and with hypertension.

Material and method. A single examination was carried out before haemodialysis with the use of the whole body bioimpedance for 51 dialyzed patients divided into two groups – the group of haemodialyzed patients with normal blood pressure (11 individuals: 5 females and 6 males) and the group of haemodialyzed patients with hypertension (40 individuals: 17 females and 23 males).

In the correlation study statistically significant correlation was proven between: ECW and Kt/V (r = -0.80; p = 0.003), ICW and Kt/V (r = -0.60; p = 0.05) in haemodialyzed patients with normal arterial blood pressure (normotonics) before haemodialysis.

Results. In the group of haemodialyzed hypertonics, significant correlation was shown between: ECW and Kt/V (r = -0.43; p = 0.006), ICW and total serum protein concentration (r = 0.41; p = 0.008), ICW and creatinine concentration before HD (r = 0.49; p = 0.001).

In the group of haemodialyzed patients with normal arterial blood pressure and with hypertension before haemodialysis, statistically significant correlation was proven between: systolic pressure and ECW (r = 0.31; p = 0.03), systolic pressure and ECW/body weight before HD (r = 0.44; p = 0.001).

Conclusions. The results of the study have shown the inverse proportional relation between ECW and Kt/V among hemodialyzed patients either with normal blood pressure or with hypertension.

Key words: hemodialysis, chronic renal failure, hypertension, bioimpedance, extracellular water compartment, Kt/V

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INTRODUCTION

Evaluation of hydration levels in dialyzed patients is an essential part of dialysis therapy specifically because of the risk of over-hydration and its association with arterial hypertension, and/or dehydration that leads to hypotonia during dialysis [1-4]. Elimination of fluid excess during dialysis treatment is achieved with the use of ultrafiltration so that the patient reaches a weight called "optimal dry weight." Optimal dry weight is often defined as "target weight". Optimal dry weight is described as the lowest body mass which is tolerated by a patient without an occurrence of side effects during dialysis or hypotonia at the end of dialysis session [5]. Complications during dialysis can be caused by an imbalance between ultrafiltration rate and plasma refilling index [6]. Removal of fluid through ultrafiltration occurs first from intravascular space and central segment of the body (trunk) [7]. At the same time, fluids flow from peripheral segments (interstitial) into the central compartment (trunk). This movement of fluid between compartments, moving from interstitial to intravascular space (refilling), causes a change in total blood volume in that compartment. The rate that refilling occurs is known as the plasma refilling index in the intravascular compartment [8]. During dialysis treatment, when the ultrafiltration rate is higher than the plasma refilling index, there is a greater risk that hypotonia will occur [9].

Unfortunately, there is no current standardized method of evaluating dry weight in dialyzed patients. Therefore, it is very difficult to set an ideal ultrafiltration rate and level for each patient to decrease the risk of complications occurring during dialysis [10]. In many dialysis centres optimal dry weight is assessed by clinical examination [11]. Unfortunately, this method, while incorporating many components specific to this population, continues to underestimate over-hydration or dehydration in these patients. Many other techniques have been utilized to compensate or assist in the evaluation of hydration status in this population.

Bioimpedance has been established as a valuable tool in the evaluation of hydration states of various compartment of the body in the dialyzed patient [12, 13].

The bioimpedance technique incorporates a precise evaluation of hydration levels utilizing physiological data concerning assessment of water compartments sizes, such as TBW (total body water), ECW (extracellular water), ICW (intracellular water) and interstitial compartment water [14]. The specific mechanisms of this technique are based on an elementary principle that electrical resistance of a cylinder is directly proportional to the length and inversely proportional to the cross section area of the cylinder multiplied by the density. This method is based on the evaluation of electrical resistance in body tissues with relationship to an alternating multi frequency amplitude current [15].

Although, the principal bioimpedance techniques were first introduced by Thomassett in 1963, increased interest in this technique appeared in the early seventies of the last century when Nyboer demonstrated a correlation between bioimpedance value assessed with the use of an alternating current and changes in blood volume [16]. Many articles described the method of the whole body bioimpedance analysis (WBIA). The WBIA method places electrodes on the palm and foot (wrist and ankle placement of electrodes have also been used). An alternating current, with the frequencies from 5 to 500 kHz reaches the electrodes placed at the level of the metacarpophalangeal joint in finger III of the upper extremity and at the base of the metatarsophalangeal joint in toe II and III of the lower extremity – the voltage is measured between the electrodes placed on the wrist in an imagined line connecting the styloid process of the ulnar bone with the styloid process of the radial bone and an electrode placed in a line connecting the medial and lateral condyles. It is possible, utilizing the bioimpedance technique to choose an option of one current frequency usage or a multi-frequency option with an amplitude from a few to a few hundred (500) kHz. It should be noted that WBIA assessment is dependent on changes in body position. Therefore, body position changes must be considered when analyzing the results using this method. The segmental bioimpedance technique is an assessment of independent body segments, such as upper extremities, trunk, and lower extremities. The analysis of the results using this technique has been found to be a more precise evaluation of hydration states and dynamical changes during dialysis sessions.

The bioimpedance technique provides a useful method to assess the size of TBW and ECW compartments during the dialysis process. The purpose of this study was to evaluate the relation between hydration state parameters (ECW, ICW, TBW) and dialysis adequacy parameters (Kt/V, PCR) and nutrition rate (albumin concentration, total protein concentration, creatinine concentration before haemodialysis).

MATERIAL AND METHODS

The aim of this study was to examine the correlation between hydration values and parameters such as:

- dialysis adequacy parameter, protein catabolism rate (PCR, Kt/V)
- nutrition rate (albumin concentration, total protein concentration, creatinine concentration before haemodialysis)

in haemodialyzed patients with normal blood pressure and with hypertension (a single examination was carried out before haemodialysis with the use of the whole body bioimpedance for 51 dialyzed patients divided into two groups – the group of haemodialyzed patients with normal blood pressure (11 individuals – 5 females and 6 males) and the group of haemodialyzed patients with hypertension (40 individuals – 17 females and 23 males). The criteria of dividing haemodialyzed patients into the groups of normotinics and hypertonics was respectively lack or presence (and treatment) of hypertension for the past 5 years (hypertension diagnosed as pre-dialysis mean arterial pressure MAP > 106 mmHg)).

Clinical, biochemical and hydrate state characteristics in the study group patients (hemodialyzed with normal blood pressure and hypertension) - Table 1 and 2.

Inclusion criteria

- Patients diagnosed with chronic renal failure (CRF) were included in the study
- Age between 18 and 80 years
- Clinically stable
- Written consent of the patients for participation in this study

Exclusion criteria

- Patient with mental problems
- Pregnancy or lactation patients
- Patients with amputation of a lower limb
- Patients with implanted pacemaker
- Patient with severe hemodynamic circulatory insufficiency

TABLE 1. Clinical, biochemical and hydration state characteristics in the study group patients (hemodialyzed with normal blood pressure).

Parameter	Mean (M)	SD
Height (cm)	169.27	7.88
Age (years)	49.46	15.95
Dialysis time (months)	69.45	40.83
Kt/V	0.98	0.34
PCR	1.68	0.48
Dry weight (kg)	66.78	12.64
Weight before HD (kg)	68.95	12.79
Weight after HD (kg)	66.85	12.59
Systolic BP before HD (mmHg)	117.55	26.89
Diastolic BP before HD (mmHg)	73.18	12.10
Pulse	76.73	8.73
ECW before HD (l)	17.19	4.07
ICW before HD (l)	19.55	6.24
ECW/TBW before HD	0.47	0.04
Urea before HD (mg/dl)	133.15	26.38
Urea after HD (mg/dl)	52.15	18.99
Creatinine before HD (mg/dl)	10.79	3.75
Creatinine after HD (mg/dl)	4.90	1.49
Na before HD (mEq/l)	137.85	4.30
Na after HD (mEq/l)	139.89	1.64
Albumin level (g/dl)	4.02	0.35
Total protein level (g/dl)	6.83	0.55
Phosphorus after HD (mg/dl)	4.62	1.19
Hct after HD (%)	31.62	4.82

Table 2. Clinical, biochemical and hydration state characteristics in the study group patients (hemodialyzed with hypertension).

Parameter	Mean (M)	SD
Height (cm)	166.15	10.65
Age (years)	53.33	16.04
Dialysis time (months)	54.85	61.21
Kt/V	1.06	0.21
PCR	1.92	0.44
Dry weight (kg)	62.75	11.64
Weight before HD (kg)	64.86	11.95
Weight after HD (kg)	62.74	11.63
Systolic BP before HD (mmHg)	150.75	22.66
Diastolic BP before HD (mmHg)	83.75	11.59
Pulse	73.7	11.77
ECW before HD (l)	17.46	3.64
ICW before HD (l)	16.80	4.78
ECW/TBW before HD	0.51	0.05
Urea before HD (mg/dl)	147.51	31.49
Urea after HD (mg/dl)	52.09	15.95
Creatinine before HD (mg/dl)	8.68	2.52
Creatinine after HD (mg/dl)	3.73	1.11
Na before HD (mEq/l)	140.18	3.18
Na after HD (mEq/l)	139.08	2.57
Albumin level (g/dl)	3.99	0.52
Total protein level (g/dl)	6.59	0.61
Phosphorus after HD (mg/dl)	4.56	1.60
Hct after HD (%)	30.67	5.22

Measures

Following parameters were measured in each patient:

- Body mass before and after hemodialysis (in kg)
- Height of patient (in cm)
- Blood pressure before hemodialysis

Anthropometric measures

Body mass of a patient was measured with the use of a scale with an acceptable deviation of 0.1 kg

Height of a patient (in cm without shoes) was measured with the use of a standard measure.

Electrical bioimpedance measure

Bioimpedance measurements were performed with a bioimpedance analyzer (Xitron Hydra 4200 Bioimpedance spectroscopy device measuring at 50 frequencies between 5 kHz and 1 MHz) with electrodes (7.7 x 1.9 cm^2). The software for this device is the fluid management tool (FMT ver. 2.0).

Study protocol

All parameters were measured at the beginning of hemodialysis. Parameters were not measured during dialysis treatment to avoid errors in evaluation of the data as the greatest fluid distribution occurs within the first hour of hemodialysis.

Examination procedure

Patients were placed in a reclining position for 10 minutes before WBIA was preformed. Bioimpedance was measured in a logarithmic spectrum of 10 frequencies starting from 5 kHz to 500 kHz. Two electrodes inducing an alternating current were placed dorsally on the hand (I1) and the ankle (I2) on the same side of the patient's body.

Measuring electrodes were placed on the wrist (S1) and the ankle (S2) on the same side of the patient's body. A computer was used to collect and store data, from each measurement.

Statistical methods

Our results were statistically analyzed. Analysis parameters included arithmetical mean (M), standard deviation (SD) with a defined range of variability (Min – Max) and confidence interval for the mean (95 % Cl). The Shapiro-Wilk (S-W) test was used to assess the distribution conformity of the examined parameters with a normal distribution; The Fisher (F) test was used to assess variance homogeneity. To compare the two groups (independent samples) according to the type of distribution and variance homogeneity the Student's T-Test or the Cochrane-Cox test was used; the Student's T-test was used for dependent samples. Non-parametric equivalents of the Student's T-test were used for skewed distributions: for independent samples – the U Mann-Whitney test and for dependent samples - a pair sequence Wilcoxon's test. To assess if there was a correlation between two parameters, a correlation coefficient significance test (Pearson's or Spearman's) was used. An accepted conclusion error was 5 % and connected with it statistical significance was $p < 0.05$ which would reveal the existence of statistically significant differences of correlations. The statistical analysis of this study was performed using computer software STATISTICA v.6.0 (StatSoft, Poland).

RESULTS

The study of extracellular (ECW) and intracellular (ICW) compartments and ECW/TBW ratio before haemodialysis (HD) in haemodialyzed patients with normal arterial blood pressure and with hypertension showed statistically significant difference only of the ECW/TBW ratio before HD in those two groups ($t = 2.54$; $p = 0.01$) (Table 3-7 and Figure 1-3).

TABLE 3. Hemodialysis parameters in hemodialyzed patients group with normal blood pressure.

Parameter	N	Mean (M)	SD	Confidence interwal 95%Cl	Min – Max
Systolic BP before HD (mmHg)	11	117.55	26.89	99.48-135.61	95.00-188.00
Diastolic BP before HD (mmHg)	11	73.18	3.65	65.05-81.31	60.00-90.00
Kt/V	11	0.98	0.34	0.75-1.21	0.36-1.50
PCR	11	1.68	0.48	1.36-2.00	0.81-2.69
Urea before HD (mg/dl)	11	133.15	26.38	115.43-150.87	92.30-182.90
Urea after HD (mg/dl)	11	52.15	18.99	39.39-64.90	22.50-81.70
Creatinine before HD (mg/dl)	11	10.79	3.75	8.27- 13.31	5.94-17.82
Creatinine after HD (mg/dl)	11	4.90	1.49	3.90-5.91	2.85-8.50
Na before HD (mEq/l)	11	137.85	4.30	134.97-140.74	127.00-142.80
Na after HD (mEq/l)	11	139.89	1.64	138.79-140.99	137.10-141.50
Hct after HD (%)	11	31.62	4.82	28.38-34.86	26.90-43.20
Total protein level (g/dl)	11	6.83	0.55	6.46-7.20	5.70-7.70
Albumin level (g/dl)	11	4.02	0.35	3.78-4.25	3.50-4.60

TABLE 4. Hydrate status in hemodialyzed patients group with normal blood pressure.

Parameter	N	Mean (M)	SD	Confidence interval 95%Cl	Min – Max
ECW before HD (l)	11	17.19	1.23	14.46-19.93	10.98-26.25
ICW before HD (l)	11	19.55	1.88	15.36-23.74	11.99-32.98
ECW before HD/body weight before HD	11	0.25	0.03	0.23-0.27	0.21-0.29
ECW/TBW before HD	11	0.47	0.04	0.45-0.50	0.42-0.54

TABLE 5. Hemodialysis parameters in hemodialyzed patients group with hypertension.

Parameter	N	Mean (M)	SD	Confidence interwal 95%Cl	Min – Max
Systolic BP before HD (mmHg)	40	150.75	22.66	143.50-158.00	100.00-210.00
Diastolic BP before HD (mmHg)	40	83.75	11.59	80.04-87.46	50.00-120.00
Kt/V	40	1.06	0.23	1.00-1.13	0.64-1.47
PCR	40	1.92	0.44	1.78-2.06	1.10-2.97
Urea before HD (mg/dl)	40	147.51	31.49	137.44-157.58	92.10-236.10
Urea after HD (mg/dl)	40	52.09	15.95	46.99-57.19	28.60-88.50
Creatinine before HD (mg/dl)	40	8.68	2.52	7.88-9.49	3.62-14.13
Creatinine after HD (mg/dl)	40	3.73	1.11	3.38-4.08	1.62-6.03
Na before HD (mEq/l)	40	140.18	3.18	139.16-141.19	130.00-145.40
Na after HD (mEq/l)	40	139.08	2.57	138.26-139.91	132.70-144.30
Hct after HD (%)	40	30.67	5.22	29.00-32.34	19.20-48.70
Total protein level (g/dl)	40	6.59	0.61	6.39-6.78	5.00-7.50
Albumin level (g/dl)	40	3.99	0.52	3.82-4.16	2.61-5.03

TABLE 6. Hydrate status in hemodialyzed patients group with hypertension.

Parameter	N	Mean (M)	SD	Confidence interval 95%Cl	Min – Max
ECW before HD (l)	40	17.46	3.64	16.30-18.63	10.50-26.35
ICW before HD (l)	40	16.80	4.78	15.27-18.33	8.52-30.29
ECW before HD/body weight before HD	40	0.27	0.03	0.26-0.28	0.20-0.33
ECW/TBW before HD	40	0.51	0.05	0.50-0.53	0.40-0.65

TABLE 7. The table shows statistical differences.

	ECW before HD	ICW before HD	ECW/TBW before HD
Hemodialyzed with normal blood pressure	t = 0.21	t = -1.58	t = 2.54
Hemodialyzed with hypertension	p = 0.83	p = 0.12	p = 0.01

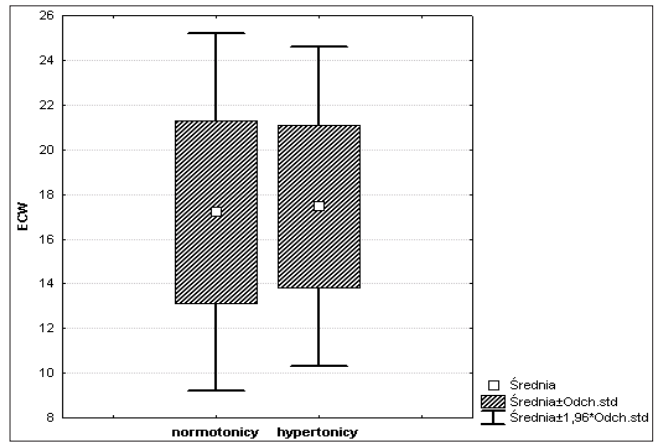


FIGURE 1. ECW before HD in hemodialyzed patients with normal blond pressure and hypertension (in the Figure those with normal blood pressure- normotonics and those with hypertension-hypertonics).

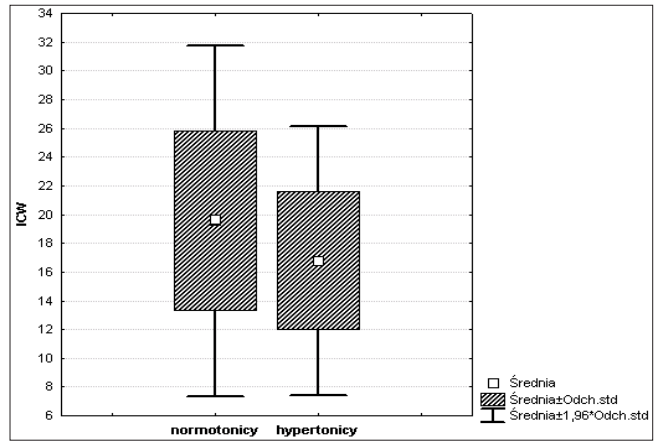


FIGURE 2. ICW before HD in hemodialyzed patients with normal blond pressure and hypertension (in the Figure those with normal blood pressure- normotonics and those with hypertension-hypertonics).

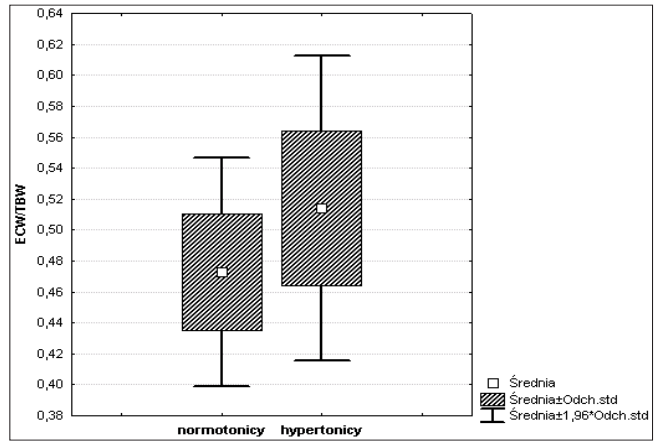


FIGURE 3. ECW/TBW before HD in hemodialyzed patients with normal blond pressure and hypertension (in the Figure those with normal blood pressure- normotonics and those with hypertension-hypertonics).

Średnia - mean value
Odch.std - standard deviation

In the study of correlation between hydration parameters (ECW, ICW) and dialysis adequacy parameters and nutritive rates: protein catabolism rate, PCR, Kt/V, albumin concentration, total protein concentration, creatinine concentration before haemodialysis in haemodialyzed patients with normal arterial blood pressure (normotonics), statistically significant correlation was proven between: ECW and Kt/V (r = -0.80; p = 0.003), ICW and Kt/V (r = -0.60; p = 0.05).

In the group of haemodialyzed hypertonics, significant correlation was shown between:

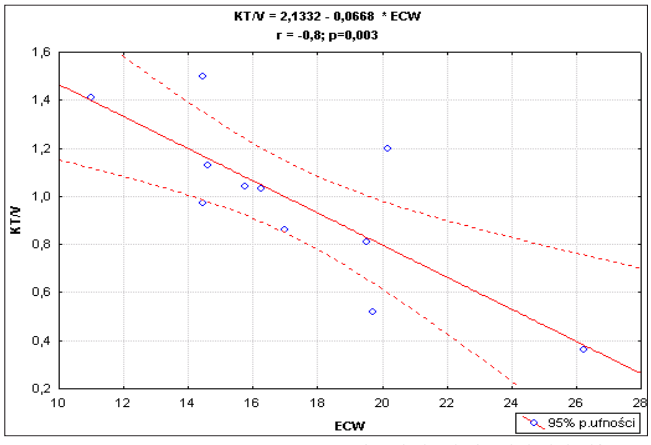
ECW and Kt/V (r = -0.43; p = 0.006), ICW and total serum protein concentration (r = 0.41; p = 0.008), ICW and creatinine concentration before HD (r = 0.49; p = 0.001).

In the study of correlation between values of systolic and diasystolic pressure before dialysis and such parameters as: ECW before haemodialysis / body weight before dialysis and ECW before dialysis / TBW both in patients with normal arterial blood pressure and with hypertension statistically significant correlation was proven between:

systolic pressure and ECW (r = 0.31; p = 0.03), systolic pressure and ECW/body weight before HD (r = 0.44; p = 0.001) (details Table 8, 9 and Figure 4, 5, 6, 7, 8, 9, 10).

TABLE 8. Statistical correlations between parameters of hydrate status (ECW, ICW) and parameters of dialysis adequacy and nutrtition state.

	Kt/V	PCR	Albumin level	Total protein level	Creatinine before HD
Hemodialyzed with normal blood pressure			n = 11		
Ecw	**r = -0.80; p = 0.003**	r = -0.47; p = 0.15	r = 0.36; p = 0.28	r = 0.33; p = 0.32	r = 0.36; p = 0.28
Icw	**r = -0.60; p = 0.05**	r = -0.44; p = 0.18	r = 0.33; p = 0.32	r = 0.46; p = 0.16	r = 0.59; p = 0.06
Hemodialyzed with hypertension			n = 40		
Ecw	**r = -0.43; p = 0.006**	r = -0.13; p = 0.43	r = -0.29; p = 0.07	r = 0.03; p = 0.86	r = 0.27; p = 0.09
Icw	r = -0.17; p = 0.30	r = 0.03; P = 0.88	r = 0.08; p = 0.63	**r = 0.41; p = 0.008**	**r = 0.49; p = 0.001**



p.ufności - level of statistical significance

FIGURE 4. Correlation between ECW before HD and Kt/V (in the Figure KT/V in hemodialyzed patients with normal blood pressure).

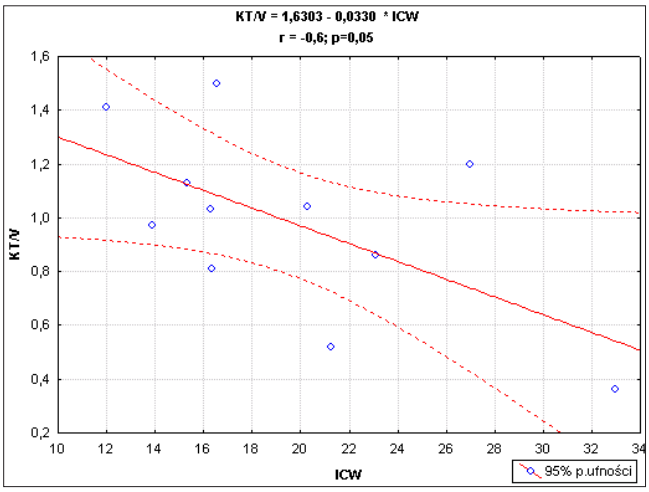


FIGURE 5. Correlation between ICW before HD and Kt/V (in the Figure KT/V in hemodialyzed patients with normal blood pressure).

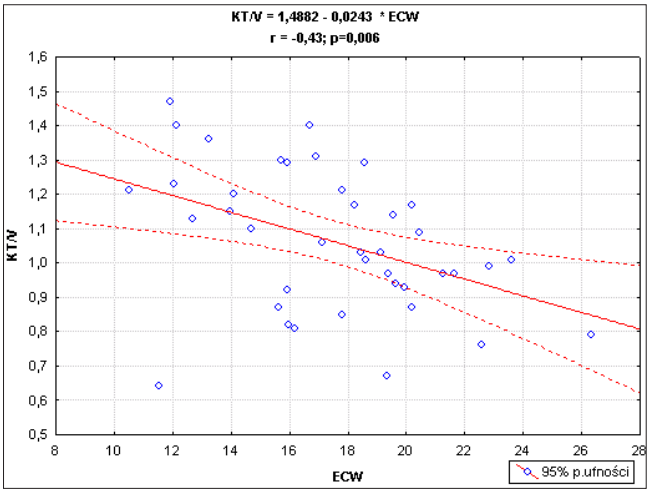


FIGURE 6. Correlation between ECW before HD and Kt/V (in the Figure KT/V in hemodialyzed patients with hypertension).

TABLE 9. Table shows statistical correlations between values of systoli and diastoli BP before HD and the following parameters: ECW before hemodialysis /body weight before HD and ECW before HD /TBW.

N = 51	ECW before HD	ICW before HD	ECW/TBW before HD	ECW/body weight before HD
Systolic BP	r = 0.31; p = 0.03	r = 0.08; p = 0.59	r = 0.22; p = 0.12	r = 0.44; p = 0.001
Diastolic BP	r = 0.13; p = 0.35	r = 0.03; p = 0.83	r = 0.10; p = 0.48	r = 0.16; p = 0.25

DISCUSSION

It is clear that a precise evaluation of a human body structure and the state of hydration plays a significant role in obtaining expected dry weight in CRF patients treated with hemodialysis [17]. The assessment of water compartments is vital because it provides an evaluation of optimal hydration state. The total volume of fluid removed during dialysis should be individualized to a patient undergoing this therapy, in order to reach expected dry weight. One of the methods of measuring the state of hydration is the whole body bioimpedance technique. This technique provides as easy to use and non-invasive method of monitoring fluid compartments sizes within the body [18]. This method assesses the size of TBW, ECW and ICW compartments. The correct evaluation of ECW value is a precise indicator

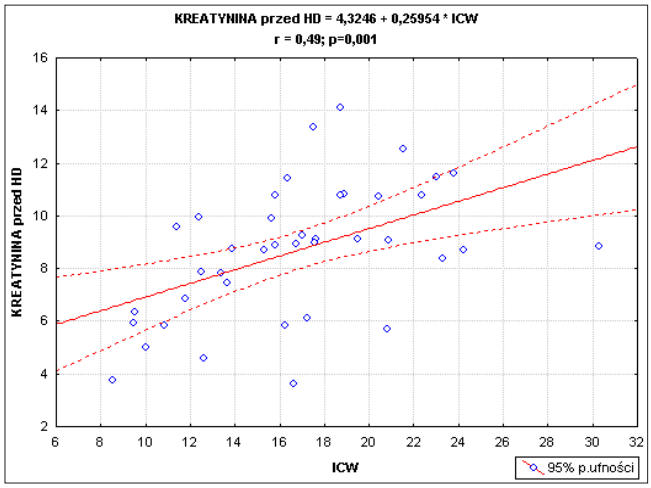


FIGURE 7. Correlation between creatinine level and ICW before HD in hemodialyzed patients with hypertension.

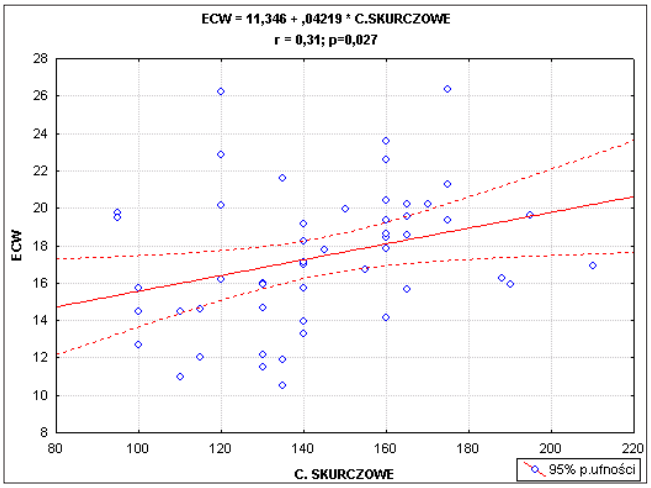


FIGURE 9. Correlation between systolic BP and ECW before HD in hemodialyzed patients with normal blood pressure and hypertension.

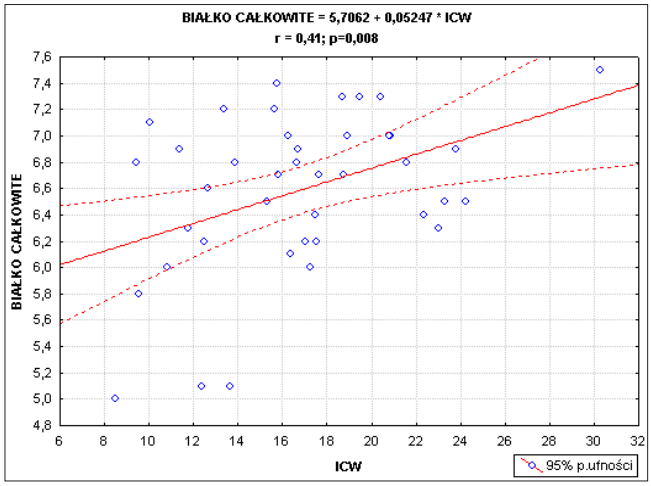


FIGURE 8. Correlation between total protein level and ICW before HD in hemodialyzed patients with hypertension.

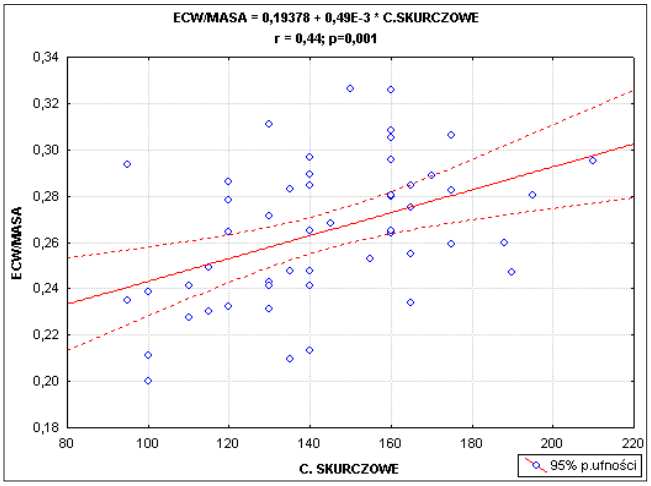


FIGURE 10. Correlation between systolic BP and ECW/body weight before HD in hemodialyzed patients with normal blood pressure and hypertension.

of dry weight assessment whereas the volume of TBW equals the volume of urea distribution, which is essential to calculate dialysis adequacy Kt/V [19].

Dialysis efficacy is one of the predominant factors determining survival in haemodialysis patients. The index Kt/V_{urea}, which is a function of dialyser urea clearance, treatment time and urea distribution volume is by far the most commonly used marker for dialysis adequacy and was found to be related to morbidity and mortality in various studies [20,21]. Therefore, Kt/V_{urea}, or more commonly called Kt/V, is generally proposed as the predominant treatment parameter in influential guidelines and multi-centre studies [22].

In our study the correlation between ECW and Kt/V was observed either in the group of hemodialyzed patients with normal blood pressure or hypertension ($r = -0.43$, $p = 0.006$ and $r = -0.8$, $p = 0.003$, respectively). The conducted research indicates that the higher ECW, the lower Kt/V.

ICW has been postulated as an indicator of nutrition status. In the study the correlation between ICW and total protein level was found in the group of hemodialyzed patients with hypertension ($r = 0.41$, $p = 0.008$). Such correlation was not found in the group of haemodialyzed patients with normal blood pressure maybe because of the size of the group (11 patients). Arterial hypertension is present before hemodialysis therapy has been initiated, in about 85 – 90% of patients with chronic renal insufficiency and that is the reason why it is so difficult to find the hemodialyzed patients with normal blood pressure.

CONCLUSION

The hydration status is an extremely important factor determining the development of arterial hypertension in hemodialyzed patients whereas dialysis adequacy is one of the predominant factors determining survival in haemodialysis patients.

The whole body bioimpedance technique provides a useful tool to assess TBW, ECW and ICW. The first value is required to calculate dialysis adequacy Kt/V, the second to assess the correct dry weight whereas ICW is postulated as an indicator of nutrition status. Our study showed the inverse proportional relation between ECW and Kt/V among hemodialyzed patients either with normal blood pressure or with hypertension.

The bioimpedance technique can be a useful tool in monitoring hydration status. The method by assessing the size of TBW, ECW and ICW provides information which can be used to correct dry weight, calculate dialysis adequacy and evaluate the nutrition status.

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