Nutritional Status of Twice and Thrice-Weekly Hemodialysis Patients with Weekly Kt/V > 3.6

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Background: *Multiple lines of evidence have indicated that the dose of hemodialysis (HD) affects patient outcome. According to K-DOQI, daily spKt/V > 1.2 predicts the morbidity and mortality among thrice-weekly HD. However, in developing countries, about three-fourths of end stage renal disease patients undergo twice-weekly HD. No data studied the outcome and nutritional status between twice- and thrice-weekly HD patients.*
Objective: *To compare the nutritional parameters in twice- and thrice-weekly HD patients who had weekly Kt/V > 3.6*
Material and Method: *The cross-sectional study was performed in the HD unit of the National Kidney Foundation of Thailand. One hundred and forty two informed consent HD patients were enrolled in the present study. Nutritional status was evaluated following a HD treatment by bioelectrical impedance analysis. All patients were interviewed for three-day food record and data were analyzed by Inmucal software program.*
Results: *Sixty patients had thrice-weekly HD and 82 patients were on twice-weekly HD. The characteristics and duration of dialysis of both groups were similar except age. Duration of dialysis in thrice-weekly HD group was 82.64 $\pm$ 50.82 and twice-weekly HD group was 68.92 $\pm$ 31.49 months. The mean age of the thrice-weekly HD group and twice-weekly HD group patients were 47.78 $\pm$ 9.89 and 41.63 $\pm$ 10.47 years, respectively ($p < 0.05$). Between both groups, the student t-test showed no difference in nutrition parameters except daily energy intake which was lower in the thrice-weekly HD group than twice-weekly HD group (19.21 $\pm$ 6.42 vs. 25.02 $\pm$ 7.70 kcal/kg/day, $p < 0.05$).*
Conclusion: *HD patients with delivered weekly Kt/V > 3.6, nutritional status of patients undergoing twice-weekly HD are not different from that of thrice-weekly HD patients. Higher energy intake in twice-weekly HD patients might be the explanation.*

Keywords: *Kidney failure, Chronic, Nutritional status, Renal dialysis, Time factors*

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The mortality and morbidity rate in end-stage renal disease (ESRD) patients is unacceptably high[1]. Among several factors that have been identified as predictors of this poor outcome, malnutrition and muscle wasting are important ones because they are potentially reversible[2]. Since that time, numerous studies have documented that 20-60% of the patients on HD are malnourished[3]. Alterations in nutritional status due to uremia per se as well as from the HD procedure predisposed the HD patients to multiple nutritional complication and mortality.

The cause of malnutrition among HD is multi-factorial[4,5]. Improving the urea clearance would affect favorably on the unacceptably high malnutrition rate. Subsequently, multiple lines of evidence have indicated that the dose of HD affects patient outcome[6,8]. A 5% and 7% decrease in the relative risk of mortality can be demonstrated for each 0.1% increase in Kt/V in HD patients[9]. Recently, the NKF-DOQI HD adequacy work

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group recommended that the minimum delivered dose of HD should be a single-pool Kt/V of 1.2 in thrice-weekly HD, whereas twice-weekly HD is not appropriate for patients with residual renal function less than 2 ml/min/1.73 m^2 [10]. However, this recommendation is based on solute kinetics. No data studied the nutritional status including inflammation markers between twice- and thrice-weekly HD patients. It was also important that about three-fourths of ESRD patients in developing countries undergo twice-weekly HD[11]. The aim of the present study is to compare the nutrition status of patients on twice-weekly HD with patients on thrice-weekly HD by using simple several methods.

Material and Method

One hundred and fifty three informed consent patients, age 18 to 60 years undergoing HD for at least 3 months in the dialysis unit of the National Kidney Foundation of Thailand at the Priest Hospital were enrolled in the cross sectional study in January 2005. All received dialysis dose at least of the sum of single pool Kt/V (spKt/V) more than 3.6 per week and proved to have no residual renal function, which was determined by urine output less than 100 ml per day. Patients with an anticipated life expectancy less than 6 months (*e.g.*, because of a metastasis malignancy or terminal HIV disease), active infectious, or inflammatory disease (*i.e.*, vascular access infections and overt periodontal disease), were excluded from the present study. The patients were stratified into two dialysis dose groups, group 1: three times weekly for 4 hours and group 2: two times weekly for 4 hours. Delivered spKt/V was calculated using pre- and post-dialysis urea concentrations according to the second-generation logarithmic Daugirdas equation[12]. The normalized protein equivalent of total nitrogen appearance (nPNA) was calculated to estimate the daily protein intake. The medical chart of each HD patient was thoroughly reviewed by a nephrologist. The present study protocol was approved by the Ethics Committee of the Institute review board at Phramongkutklao Hospital, and informed consent was obtained from patients.

Nutritional assessment

Dietary protein and energy intake measurements

Daily protein intake (DPI) and daily energy intake (DEI) were assessed by self-recording of food intake during three consecutive days included Saturday or Sunday. The patients were carefully instructed by a trained dietician to record their total oral intake in a dietary diary using household measures. Energy and protein intake were evaluated using an Inmucal software developed at Mahidol University that contains a nutrient database from foods typically consumed in Thailand. Values of DPI and DEI were normalized by post dialytic weight.

Anthropometric evaluation

Body weight assessment and anthropometric measurements were performed by one experienced nutritionist within 10-20 minutes after termination of the HD treatment. Body mass index (BMI) was calculated using height and weight measurement. Biceps skinfold thickness (BSF), subscapular skinfold thickness (SSF), triceps skinfold thicknesses (TSF), and mid-arm circumference (MAC) were measured with a conventional Lange's skinfold caliper according to standard technique.

Bioelectrical impedance analysis (BIA)

To evaluate the percentage of body fat and lean body mass by using monofrequency bioelectrical impedance analysis, BIA (Maltron®, England) at single frequency: 0.8 MA, 50 MHz. BIA measurement was performed by placing an electrode sensor on the non access upper arm and plantar surface of same foot for several seconds, after the required data (date of birth, gender, race, weight and height) from each patient were entered.

Laboratory evaluation

Plasma albumin concentration was measured by the bromcresol-green method using an auto-analyzer. Serum calcium, phosphate concentrations, and total cholesterol were determined at the study period. All routine laboratory measurements were performed by standard laboratories with the use of automated methods, Integra (Roche Elecsys 2010, USA). Serum highly sensitive C-reactive protein (hsCRP) was measured as indexes of the degree of inflammation. The hsCRP was measured with a turbidimetric immunoassay (Roche Elecsys 2010, USA).

Statistical analysis

A conventional Student's t-test was used to detect significant differences among continuous variables in two groups especially nutritional and inflammation parameters. Chi-square test was used for nonparametric variables such as gender, diabetes, and other primary renal disease. Data are presented as mean $\pm$ standard deviation (SD) or as mean with 95%

confidence intervals (95% CI) unless stated otherwise. A two-sided p-value < 0.05 was considered statistically significant. All statistical calculations were performed using the SPSS for Windows statistical software package.

Results

The weekly sum of spKt/V was obtained from 153 of HD patients; 11 patients were excluded from study due to the weekly sum of spKt/V less than 3.6. Demographic characteristics for all 142 HD patients, divided by the frequency of dialysis per week are shown in Table 1. Fifty percent of all populations were men. Dialysis vintage in thrice-weekly HD group was 82.64 ± 50.82 and twice-weekly HD group was 68.92 ± 31.49 months. In both groups, chronic glomerulonephritis was the main cause of ESRD (thrice-weekly HD: 39.2% vs. twice-weekly HD: 41.3%). Where as diabetes nephropathy, which had been the most common cause of ESRD in Thailand, included only 15.7% of thrice-weekly HD and 6.7% of twice-weekly HD group. The thrice-weekly HD group was significantly older than the twice-weekly HD group (47.78 ± 9.89 vs. 41.63 ± 10.47, respectively, p = 0.001). When clearance of uremia toxin was evaluated at study, the weekly sum of spKt/V in patients in the thrice-weekly HD group was significantly greater compared with patients in the twice-weekly HD group (5.21 ± 0.85 vs. 4.67 ± 0.60, respectively, p < 0.001). There were no significant differences for time on dialysis, gender, co-morbid disease, and primary renal disease between groups.

Nutritional parameters are shown in Table 2 for each patient group. No significant differences were observed for anthropometric measurements (*i.e.*, BMI, waist circumference, and all skinfold thickness). In addition anthropometric measurements, BIA for body compositions (*i.e.*, fat free mass (FFM), percentage of fat free mass (%FFM), body fat (BF), percentage of body fat (% BF), body cell mass (BCM) and phage angle) were not significantly different between the thrice and twice-weekly HD group. Whereas DEI, as reflected by the 3-day food dietary, was significantly lower in thrice-weekly HD patients than twice-weekly HD patients (19.21 ± 6.42 vs. 25.02 ± 7.70 kcal/kg per day, p < 0.001). A similar trend was also found for DPI, thrice-weekly HD patients had a slightly lower protein intake, but no statistically significant difference (thrice-weekly HD: 0.89 ± 0.38 vs. twice-weekly HD: 1.06 ± 0.46 g/kg/day, p > 0.05).

As shown in Table 3, the most laboratory values reflecting nutritional status including serum albumin, total cholesterol, and nPNA were similar in the two groups. However, serum concentration of calcium phosphate product was significantly less in the thrice-weekly HD group than in the twice-weekly HD group (40.80 ± 24.49 vs. 51.95 ± 15.06, p = 0.002), whereas serum concentrations of calcium, phosphorus, and

Table 1. Demographic characteristics in thrice and twice weekly HD patients

	Thrice weekly HD	Twice weekly HD	p-value
Number, n	60	84	
Age (y)	47.78 ± 9.89	41.63 ± 10.47	0.001
Male (%)	58.3	43.9	NS
Dialysis vintage (mo)	82.64 ± 50.82	68.92 ± 31.49	NS
spKt/V	1.73 ± 0.28	2.33 ± 0.32	<0.001
Weekly sum of spKt/V	5.21 ± 0.85	4.67 ± 0.60	<0.001
Primary renal disease (%)			
Chronic glomerulonephritis	39.2	41.3	NS
Diabetes	15.7	6.7	NS
Hypertension	5.9	8.0	NS
Unknown renal disease[#]	23.5	41.3	NS
Co-morbid condition (%)			
Cerebrovascular disease	6.7	5.8	NS
Congestive heart failure	1.7	1.4	NS
Coronary heart disease	3.3	2.9	NS

Data are expressed as mean ± SD
spKt/V, single pool Kt/V

Table 2. Nutritional parameters in thrice and twice weekly HD patients

Parameter	Thrice weekly HD (n = 60)	Twice weekly HD (n = 84)	p-value
Anthropometric measurements			
BMI (kg/m^2)	20.65 ± 3.40	21.64 ± 4.24	NS
Waist circumference (cm)	74.99 ± 13.81	79.95 ± 12.55	NS
MAC (cm)	25.85 ± 4.11	24.64 ± 3.36	NS
TSF (cm)	21.73 ± 8.76	20.91 ± 8.18	NS
BSF (cm)	12.70 ± 7.07	11.61 ± 5.27	NS
SSF (cm)	25.73 ± 11.50	23.36 ± 10.21	NS
Bioimpedance analysis			
FFM (kg)	41.38 ± 7.36	43.63 ± 7.01	NS
% FFM	43.63 ± 7.01	41.37 ± 7.61	NS
BF (kg)	12.52 ± 8.10	11.47 ± 6.72	NS
% BF	20.63 ± 8.23	21.43 ± 8.99	NS
BCM (kg)	23.29 ± 3.98	22.38 ± 3.94	NS
Phase angle	5.45 ± 1.02	6.07 ± 2.64	NS
Nutrient intake			
DPI (g/kg/d)	0.89 ± 0.38	1.06 ± 0.46	NS
DEI (kcal/kg/d)	19.21 ± 6.42	25.02 ± 7.70	<0.001

All data are expressed as mean ± SD

BMI, body mass index; MAC, mid-arm circumference; TSF, triceps skinfold thicknesses; BSF, Biceps skinfold thickness; SSF, subscapular skinfold thickness; FFM, fat free mass; %FFM, percentage of fat free mass; BF, body fat; %BF, percentage of body fat; BCM, body cell mass; DPI, daily protein intake; DEI, daily energy intake

Table 3. Laboratory parameters in thrice and twice weekly hemodialysis patients

Parameter	Thrice weekly HD (n = 60)	Twice weekly HD (n = 84)	p-value
Hematocrit (%)	31.45 ± 5.65	28.41 ± 6.41	0.007
nPNA	1.03 ± 0.21	1.06 ± 0.22	NS
Serum albumin (g/dl)	4.10 ± 0.43	4.22 ± 0.46	NS
Serum total cholesterol (g/dl)	176.68 ± 52.59	190.62 ± 50.29	NS
Serum calcium (mg/dl)	9.87 ± 0.97	10.03 ± 0.89	NS
Serum phosphorus (mg/dl)	4.97 ± 1.64	5.18 ± 1.47	NS
Calcium phosphorus product	40.80 ± 24.49	51.95 ± 15.06	0.002
Serum iPTH (pg/ml)	342.42 ± 348.71	353.89 ± 305.63	NS
hsCRP(ug/ml)	5.48 ± 16.03	5.46 ± 15.25	NS

All data express as mean ± SD

nPNA, normalized protein equivalent of total nitrogen appearance; iPTH, intact parathyroid hormone; hsCRP, highly sensitive C-reactive protein

iPTH were not significantly different between the two groups. The authors also looked for other nutritionally related factors, such as hematocrit and hsCRP values. There was statistically significant difference in hematocrit levels between the thrice and twice-weekly HD group (31.45 ± 5.65 vs. 28.41 ± 6.41, p = 0.007), but no significant difference in hsCRP levels (thrice-weekly HD group: 5.48 ± 16.03 vs. twice-weekly HD group: 5.48 ± 15.25, p > 0.05).

The prevalence of malnutrition was present in this group. Mean serum albumin levels was less than the normal range at 3.5 g/dl; 6.8% of thrice-weekly HD

patients and 4.4% of twice-weekly HD patients, which was not significantly different between the two groups.

Discussion

In the present study, the authors found that among those ESRD patients who were undergoing thrice or twice-weekly HD which the weekly sum of spKt/V more than 3.6, nutritional status determine by anthropometric measurements and laboratory profiles especially serum albumin were not different, except significantly higher DEI was detected in the twice-weekly HD patients.

Malnutrition is one of most common problems that HD patients frequently encountered[13,14]. Potential causes of protein energy malnutrition are low nutrient intake and uremia from inadequate dialysis[15,16]. Concomitant with the low dietary intake, a process of chronic inflammation and uremic toxin contributes to malnutrition. Although several studies suggest that the increased clearance of uremic toxins by dialysis is associated with improved nutrition balance, but some studies noted the documented catabolic process induced by dialysis procedure. The NKF-DOQI HD Adequacy Work Group recommends HD three times per week for all patients who require HD. Twice-weekly HD is usually inadequate unless there is a reasonable amount of residual kidney function, but this recommendation is based on solute kinetics of HD patients who are on two times per week. In addition, at the time of the present guideline, there is a paucity of information regarding the nutritional outcome comparing conventional thrice-weekly HD with twice-weekly HD in patients who are absent of residual renal function. Only a cross sectional study in earlier initiation dialysis patients with higher levels of residual renal function suggested that survival in twice-weekly HD was no worse[17]. There are no established criteria for the adequacy of dialysis in twice-weekly HD patients. Ballal et al reported that most of the twice-weekly HD patients seem to do well and there was no difference in the serum albumin between patients who were on twice- and thrice-weekly HD[18]. The present results are consistent with previous data. Therefore, the present results may be interpreted to suggest that the spKt/V (2.33 ± 0.32) of twice-weekly HD, which might achieve a clearance of uremic toxin, has a beneficial effect in improving nutritional parameters as the spKt/V (1.73 ± 0.28) of thrice-weekly HD patients.

Nutrient intake is the important factor determining the development of malnutrition, which is frequently observed in the dialysis population[6]. Recently, the NKF-DOQI recommendation for DPI in HD patients is 1.2 g of protein per kg body weight per day and DEI in HD patients is 35 kcal per kg body weight per day for those who are less than 60 years of age, and 30-35 kcal per kg body weight per day for individuals 60 years of age or older[19]. The presented patients had DPI between 0.89 and 1.06 g of protein per kg body weight per day and DEI between 19.21 and 25.02 kcal per kg body weight per day, which was lower than the recommendation. While, the presented HD patients had well being, they did not detect the malnutrition parameters. These results reflect a previous studies[20,23] and confirm those of previous data that demonstrated approximately 0.75 g/kg per day of high biological value protein to maintain neutral nitrogen balance and serum albumin concentrations in anephric patients who are dialyzed twice-weekly[24]. However, measurement of nutrient intake based on the food diary depends on the skill of the patients and the recorded dietitian. Not only could a few patients describe the amount of their ingested foods accurately, the measurement of energy intake usually is difficult. That might be the reason the low energy intake with both groups.

The authors explored potential explanations for the same nutritional outcome between thrice and twice-weekly HD patients. The authors suggested that older patients have influence on declining of nutrition markers especially decreasing of serum albumin levels, BCM,%BF and FFM. The finding of the present study was significantly higher age in thrice-weekly HD patients than in twice-weekly HD patients, so benefit effect of thrice-weekly dialysis could not appear on the nutritional status in the present study. Furthermore, trends in increasing dialysis vintage with three times weekly HD group have important practical implications, because a dialysis vintage of more years associated with a significant decline in all measured nutritional parameters[25]. There is a direct correlation between the levels of energy intake and the changes in nutritional parameters including body weight, BMI, body fat, plasma albumin and the nitrogen balance[26], it is also possible that high energy intake in twice-weekly HD patients of the present study may result in improving of the nutritional status.

Hypoalbuminemia is a result of malnutrition or simply a reflection of inflammatory states from underlying diseases, it frequently is present in HD patients and associated with greater rates of morbidity and mortality in patients with ESRD[27]. The present study showed the low prevalence of hypoalbuminemia

and serum albumin concentration between 4.17 $\pm$ 0.45 g/dl in the both groups, including a few co-morbid conditions with our patients. To explore whether the similar nutritional profiles of thrice and twice-weekly HD groups could be explained by including healthy HD patients into the present study.

One of the main benefits of thrice-weekly HD can be increasing of the hematocrit levels. A similar recent study reported that a higher delivered dose of dialysis improves epoetin effectiveness and anemia[28]. The present findings, however, are not convincing, because the other potential reasons for anemia such as infection/inflammation (*eg.*, access infections, surgical inflammation), chronic blood loss, osteitis fibrosa, aluminum toxicity, and hemoglobinopathies have not been excluded. Whether the magnitude of the delivered dialysis dose has an effect on increase hematocrit levels in the HD patient and needs further investigation.

Another benefit can be in better control of calcium-phosphorus production with thrice-weekly HD patients. Particularly, more intensive dialysis schedules markedly improve phosphate removal[29] as in the results that serum phosphorus levels tended to be lower among patients of thrice-weekly HD. Since the overwhelming majority of dialysis patients receive standard thrice-weekly hemodialysis, dietary restriction and prescription of phosphorus binders play a much more important role. An alternative hypothesis to explain a difference of calcium-phosphorus production, the dietary protein intake that is clearly linked to phosphorus intake was a slightly lower in the thrice-weekly HD patients than in the twice-weekly HD patients. Unfortunately, poor compliance with both diet and medication use such as vitamin D and phosphate binder is not description and analysis in the present study.

The main limitation of the present study is the initial recruitment patients in HD unit of National Kidney Foundation of Thailand. Their HD patients were generally healthier groups. Regarding underlying kidney disease, study participants had a substantial prevalence of chronic glomerulonephritis different to that in the overall population of patients in Thailand undergoing HD who were diabetes mellitus and hypertension, which reflects a disagreement to the present study. Whereas patients with diabetes were 6.7% and the elderly patients were excluded from study. Despite the intense interest in the challenge of nutritional status between thrice and twice-weekly on dialysis, it has remained difficult to explain why the results are similar. The results need to be studied further with a randomized prospective trial in nutritional status between thrice and twice-weekly HD patients that clearly demonstrate these findings.

Conclusion

In HD patients that are delivered weekly Kt/V > 3.6, the nutritional status of patients undergoing twice-weekly HD are not different from that of thrice-weekly HD patients. The higher energy intake and younger in twice-weekly MHD patients may be the possible reasons for this phenomena in present study.

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ภาวะโภชนาการระหว่างผู้ป่วยไตวายเรื้อรังฟอกเลือดด้วยเครื่องไตเทียม 2 ครั้ง กับ 3 ครั้งต่อสัปดาห์ ที่มีค่า Kt/V รวมมากกว่า 3.6 ต่อสัปดาห์

อุปถัมภ์ ศุภสินธุ์, บัญชา สถิระพจน์, สุดารัตน์ สีน้ำเงิน, สมชาย ยงศิริ, พรรณบุปผา ชูวิเชียร, สุพัฒน์ วาณิชย์การ

ภูมิหลัง: *ปริมาณการฟอกเลือดมีความสัมพันธ์ต่ออัตราการเจ็บป่วย และการเสียชีวิตของผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดด้วยเครื่องไตเทียม ตามคำแนะนำของ K-DOQI ควรทำการฟอกเลือดสัปดาห์ละ 3 ครั้ง และมีค่าของ spKt/V มากกว่า 1.2 อย่างไรก็ตามสามในสี่ของผู้ป่วยในประเทศกำลังพัฒนาจะได้รับการฟอกเลือดเพียงสัปดาห์ละ 2 ครั้ง และไม่มีข้อมูลการศึกษาภาวะโภชนาการระหว่างผู้ป่วยที่ทำการฟอกเลือดสัปดาห์ละ 2 ครั้ง กับการฟอกเลือดสัปดาห์ละ 3 ครั้ง*

วัตถุประสงค์: *เพื่อศึกษาเปรียบเทียบภาวะโภชนาการของผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 2 ครั้ง กับ สัปดาห์ละ 3 ครั้ง*

วัสดุและวิธีการ: *การศึกษาแบบเชิงพรรณนาในผู้ป่วยไตวายเรื้อรังฟอกเลือดด้วยเครื่องไตเทียมจำนวน 142 ราย ณ มูลนิธิโรคไตแห่งประเทศไทย โรงพยาบาลสงฆ์ มีผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 2 ครั้ง จำนวน 60 ราย และฟอกเลือดสัปดาห์ละ 3 ครั้ง จำนวน 82 ราย เข้าร่วมการศึกษา ผู้ป่วยทุกรายทำการตรวจวัดประเมินภาวะโภชนาการจากการตรวจร่างกาย การตรวจวัดมวลกล้ามเนื้อ และไขมัน ด้วยวิธี bioelectrical impedance analysis และประเมินสัดส่วนการบริโภคอาหารจากบันทึกรายการอาหาร 3 วัน โดยคำนวณด้วยโปรแกรม Inmucal*

ผลการศึกษา: *ลักษณะพื้นฐานของผู้ป่วยทั้งสองกลุ่ม ไม่มีความแตกต่างกัน ยกเว้น กลุ่มผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 2 ครั้ง มีอายุเฉลี่ยมากกว่ากลุ่มผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 3 ครั้ง (47.78 $\pm$ 9.89 ปี กับ 41.63 $\pm$ 10.47 ปี, $p < 0.05$) การตรวจวัดประเมินภาวะโภชนาการจากการตรวจร่างกาย การตรวจวัดมวลกล้ามเนื้อและไขมัน ด้วยวิธี bioelectrical impedance analysis ไม่มีความแตกต่างกันระหว่างผู้ป่วยทั้งสองกลุ่ม แต่พบว่าผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 3 ครั้ง บริโภคอาหารที่มีพลังงานน้อยกว่าผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 2 ครั้ง (19.21 $\pm$ 6.42 กับ 25.02 $\pm$ 7.70 กิโลแคลอรี ต่อ กก./วัน, $p < 0.05$)*

สรุป: *เมื่อค่า Kt/V รวมมากกว่า 3.6 ต่อสัปดาห์พบว่า ผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 2 ครั้ง มีภาวะโภชนาการไม่แตกต่างกัน กับผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 3 ครั้ง อาจเป็นผลมาจากกลุ่มผู้ป่วยไตวายเรื้อรังที่ฟอกเลือดสัปดาห์ละ 2 ครั้ง มีการบริโภคอาหารที่มีพลังงานสูงกว่า*