

Nutritional Status over Time in Hemodialysis and Peritoneal Dialysis

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Abstract. Malnutrition is a risk factor for mortality in the dialysis population. So far, prospective studies comparing the time course of nutritional status in new hemodialysis (HD) and peritoneal dialysis (PD) patients have not been published. The aims of this study were to compare the time course of nutritional status in patients who were starting HD or PD and to identify the baseline determinants of that time course. In this prospective multicenter cohort study, data were collected from 3 (baseline) to 24 mo after the start of dialysis. Repeated measures ANOVA was used to establish the time course of nutritional status. Differences were adjusted for baseline characteristics. A total of 250 consecutive new patients were included: 132 started on HD, and 118 started on PD. A univariate analysis demonstrated a decrease in serum albumin (SA) in patients who started on HD and an increase in patients who

started on PD. Body fat increased in PD; LBM did not change. The protein equivalent of nitrogen appearance normalized to ideal weight decreased in PD after 1 yr. In a multivariate analysis, SA at 2 yr was 2.0 g/L (95% confidence interval [CI], 0.3 to 3.8) higher in patients who started on PD compared with patients who started on HD. The increase in body fat was 3.2 kg (95% CI, 1.6 to 4.9) higher in women who started on PD than in others. Patients who had diabetes gained 2.3 kg (95% CI, 0.6 to 4.1) more fat than patients who did not have diabetes. Kt/V_{urea} did not affect the time course of nutritional status, but a higher Kt_{urea} was associated with a higher SA at 24 mo. Nutritional status at the start of dialysis, gender, and diabetic status might be considered in making the choice for dialysis modality. Furthermore, providing a higher Kt_{urea} may improve protein metabolism.

Malnutrition is a risk factor for morbidity and mortality (1–5). Many studies have shown that its prevalence in the dialysis population is high, up to 50 to 60% (3,6,7). A number of prospective studies have investigated the evolution of nutritional parameters over time in either hemodialysis (HD) (8,9) or peritoneal dialysis (PD) patients (7,10–14). Only one prospective study compared the time course of nutritional status between HD and PD patients, but these were prevalent patients, who had already been on dialysis for almost 3 yr (15). Prospective studies comparing the evolution in nutritional status over time in new HD and PD patients have not been published. Therefore, our aims were (1) to compare the time course of nutritional parameters in patients starting HD or PD and (2) to identify the baseline determinants of that time course.

Materials and Methods

Patients and Follow-up Period

Patients who had end-stage renal disease and who were older than 18 yr, started chronic dialysis as their first renal replacement therapy, and survived the first 3 mo on dialysis were eligible for the study. From 13 Dutch dialysis centers, we included consecutive patients who started dialysis between October 1, 1993, and April 1, 1995. Informed consent was obtained from all of them. The measurements at 3 mo after initiation of dialysis were taken as baseline. During follow-up, nutritional status was assessed at 6, 12, 18, and 24 mo after the start of dialysis.

Data Collection

In addition to demographic data, we collected the following baseline information.

Renal Disease and Comorbid Conditions. Primary renal disease was classified according to the codes of the European Renal Association–European Dialysis and Transplant Association Registry. Comorbidity that was present at the start of dialysis was scored. The number of comorbid conditions was expressed as Davies risk score: grade I, no comorbid conditions; grade II, one or two comorbid conditions; and grade III, more than two comorbid conditions (16).

Laboratory Investigations. Laboratory blood investigations included hemoglobin, serum albumin (SA), plasma phosphate, and plasma bicarbonate. In HD patients, the blood samples were taken before a dialysis session.

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Nutritional Status. Nutritional status was assessed by the body mass index (BMI), body fat, lean body mass (LBM), serum albumin (SA), and the protein equivalent of nitrogen appearance (PNA). All patients were advised by a dietitian. At the time of investigation, the HD patients generally were prescribed a protein intake of 1.1 g/kg ideal body weight per 24 h, and PD patients were prescribed 1.2 g/kg ideal body weight per 24 h. Body fat and LBM were estimated by anthropometry from the sum of thickness of the biceps, triceps, and subscapular and iliac skinfolds (17) by trained nurses. In HD patients, these assessments were performed after a dialysis session. Subsequently, the observed LBM was divided by the predicted LBM, defined as the 50th percentile of persons of the same age and gender (18) and expressed as a percentage (LBM o/p). SA was determined by the method used routinely in the centers: bromocresol green (BCG; $n = 5$), bromocresol purple (BCP; $n = 7$), or an immunologic method ($n = 1$). The mean lower limit of the reference values was 36 g/L for the BCG method, 34 g/L for the BCP method, and 39 g/L for the immunologic method. The following equations were used for the calculation of PNA: (1) $PNA (g/24 h) = 9.35 \times \text{urea generation rate (mg/min)} + 0.294 \times \text{urea distribution volume (L)}$ in HD (19) and (2) $PNA (g/24 h) = 19 + 7.62 \times \text{urea nitrogen appearance (g/24 h)}$ in PD (20). PNA was normalized in three ways: to actual (nPNA), to standard (nPNA_s), and to ideal (nPNA_i) body weight. The urea distribution volume (V) was determined by the formulae of Watson *et al.* (21) for total body water. Underweight was defined as having a BMI <20 kg/m², overweight was defined as having a BMI between 25 and 30 kg/m² and obesity was defined as having a BMI >30 kg/m². Loss of appetite during the previous 3 wk was scored on a 5-point Likert scale (22), graded 0 (not at all) to 4 (very severe). Nutritional status assessments at follow-up included SA, BMI, body fat, LBM, and nPNA_i.

Blood Pressure. BP was measured before and after each hemodialysis session during a period of 2 wk preceding baseline. These pressures were averaged. BP in PD was measured at a routine visit in the outpatient clinic. Also during follow-up, BP values were recorded to study the potential interference of changes in hydration status over time with the measurement of anthropometric parameters.

Renal Function. Urine was collected during the interdialytic interval in HD and during 24 h in PD. From this we calculated residual GFR (rGFR), renal Kt/V_{urea} , renal Kt_{urea} , urinary urea appearance, and renal urea and creatinine clearance at baseline. rGFR was defined as the mean of the urea and creatinine clearances and expressed in ml/min per 1.73 m².

Therapy Characteristics. HD Kt/V_{urea} at baseline was estimated with the use of a second-generation Daugirdas formula (23). Peritoneal Kt/V_{urea} was calculated from a 24-h dialysate collection. Total clearance of waste products (renal function + dialysis) was expressed as total weekly Kt/V_{urea} , total weekly Kt_{urea} , and total weekly urea appearance. All HD membranes were synthetic or cellulose derivatives.

Analytical Methods

Patients were classified according to dialysis modality at baseline: start-on-HD and start-on-PD. Differences in baseline characteristics among these groups were analyzed with one-way ANOVA for continuous variables and with χ^2 tests for categorical variables. A two-sided P value <0.05 was considered statistically significant. Results are presented as means (SD), unless stated otherwise.

The time course of nutritional status was assessed in an intention-to-treat analysis. During follow-up, the patients remained in the start-on-HD or the start-on-PD group, irrespective of modality switches,

deaths, or transplants. Repeated measures ANOVA was used to assess changes in nutritional status over time (time effect), differences in nutritional status among groups (group effect), and interactions between changes in nutritional status by time and group (time-by-group effect). To study the effect of treatment modality, we adjusted for the baseline values of nutritional parameters, to address the possibility that differences in nutritional status may have influenced modality choice. In addition, we identified other potential confounders by including them as covariates in the ANOVA. Factors that were univariately associated at $P \leq 0.20$ were considered for multivariate adjustment. On the basis of these findings and of data from the literature, we decided to include age, gender, diabetic status, and rGFR in a uniform model to apply to all nutritional parameters, in addition to their baseline value. With this multivariate model, we calculated mean effects with their 95% confidence intervals (95% CI). To search for violations of the assumptions made in multiple regression, we produced normal plots of the residuals. These showed a normal distribution for all models.

To identify groups with a different evolution of nutritional status, we performed subgroup analyses. In addition, we investigated the potential relationship with parameters of dialysis dose at baseline, *i.e.*, total and dialysate Kt/V_{urea} , Kt_{urea} , and urea appearance. In these analyses, the rGFR within the model was replaced by the complementary renal factor of the parameter studied, *e.g.*, the effect of dialysate Kt_{urea} was adjusted for renal Kt_{urea} . The effects of urea removal at baseline were studied separately in the start-on-HD and start-on-PD groups.

To study the influence of selective dropout (deaths and transplants) and modality switches, we repeated the repeated measures ANOVA on a stay-on-treatment basis, *i.e.*, in patients who stayed on their initial dialysis modality for the entire 24-mo period.

All analyses were carried out with SAS for Windows 6.12 statistical software (SAS Institute Inc., Cary, NC). The repeated measures ANOVA was performed with the PROC mixed procedure. This procedure provides maximum likelihood estimates for missing values on the basis of previous values of the same patient and the time course of the parameter in other patients.

Results

Baseline Characteristics

A total of 250 patients participated in the study; 132 of them started on HD, and 118 started on PD. During follow-up, 72 stayed on HD, 40 stayed on PD, 25 (4 HD and 21 PD) changed dialysis modality, 60 (26 HD, 34 PD) received a transplant, 2 recovered renal function (2 HD), and 51 (28 HD, 23 PD) died. In the entire cohort, the mean baseline SA level was 36.9 (5.4) g/L. A value below 35 g/L was present in 32% of the patients. The mean BMI was 23.9 (4.1) kg/m². Sixteen percent of the patients were underweight, 27% were overweight, and 7% were obese. Twenty-six percent had an nPNA_i <0.8 g/kg per 24 h.

The baseline characteristics of the start-on-HD and start-on-PD groups are shown in Table 1. Patients who started on HD were older than those who started on PD, and they had lower hemoglobin levels. Several parameters indicated that nutritional status was slightly better in HD patients, and fewer of them complained of a moderate to severe loss of appetite. In addition, HD patients had lower bicarbonate levels, a higher systolic and a lower diastolic BP, and, as expected, their values representing total urea removal were higher.

Table 1. Baseline characteristics of patients according to initial dialysis modality [mean (SD) or %]^a

Characteristic	Start on HD (N = 132)	Start on PD (N = 118)	P Value
Demography			
age (yr)	59 (16)	54 (14)	<0.01
male (%)	53	64	NS
Caucasian (%)	93	92	NS
Renal disease and comorbidity			
primary renal disease (%)			NS
diabetes mellitus	14	16	
glomerulonephritis	9	16	
vascular	23	23	
other	54	45	
diabetes mellitus (%)	17	20	NS
comorbidity, grade II/III (%)	54	47	NS
Nutritional status, BP, and adequacy			
hemoglobin (g/dl)	10.2 (1.4)	11.4 (1.5)	<0.001
serum albumin (g/L)	37.8 (4.6)	36.0 (6.0)	<0.01
plasma phosphate (mmol/L)	1.9 (0.5)	1.7 (0.5)	<0.001
body weight (kg)	69.1 (14.8)	68.5 (13.0)	NS
body mass index (kg/m ²)	24.5 (4.4)	23.1 (3.5)	<0.01
underweight (%)	14	19	NS
body fat (kg)	18.9 (7.9)	15.9 (6.7)	<0.01
lean body mass o/p (%)	101.2 (12.8)	100.3 (11.4)	NS
PNA (g/24 h)	69 (23)	71 (20)	NS
nPNA (g/kg per 24 h)	0.99 (0.26)	1.07 (0.28)	<0.05
nPNAi (g/kg per 24 h)	0.96 (0.29)	0.99 (0.25)	NS
nPNAs (g/kg per 24 h)	1.11 (0.28)	1.15 (0.30)	NS
moderate/severe loss of appetite (%)	5	12	<0.05
plasma bicarbonate (mmol/L)	20.6 (3.5)	26.0 (3.8)	<0.001
metabolic acidosis (%)	85	15	<0.01
systolic BP (mmHg)	148 (16)	143 (22)	<0.05
diastolic BP (mmHg)	81 (9)	85 (11)	<0.001
rGFR (ml/min per 1.73 m ²)	2.9 (2.5)	3.0 (2.2)	NS
urea appearance (mmol/wk per 1.73 m ²)			
urinary	391 (343)	445 (380)	NS
total	2109 (600)	1671 (578)	<0.001
Kt _{urea} (L/wk)			
residual	22 (19)	22 (18)	NS
total	122 (34)	75 (19)	<0.001
Kt/V _{urea} (wk)			
residual	0.6 (0.5)	0.6 (0.5)	NS
total	3.4 (1.0)	2.1 (0.5)	<0.001

^a HD, hemodialysis; PD, peritoneal dialysis; PNA, protein equivalent of nitrogen appearance; nPNA, PNA normalized to actual body weight; nPNAi, PNA normalized to ideal body weight; nPNAs, PNA normalized to standard body weight; rGFR, residual GFR.

Nutritional Status over Time: Univariate Analysis

Figure 1 shows the crude changes in nutritional status over time in the two groups. SA levels in the start-on-HD group showed a modest decrease during the second year ($P < 0.05$). PD patients had lower levels at baseline, which increased over time ($P < 0.01$). The BMI increased in both modalities, but in HD patients this was not statistically significant. There was a slight, statistically nonsignificant rise in body fat in HD pa-

tients and a larger one in PD patients ($P < 0.01$) but no change in LBM. In PD patients, nPNAi showed a temporary increase followed by a decrease.

Nutritional Status over Time in Start-on-HD Versus Start-on-PD Patients: Multivariate Analysis

Figure 2 compares the time course of nutritional parameters in the start-on-HD and the start-on-PD groups, adjusted for

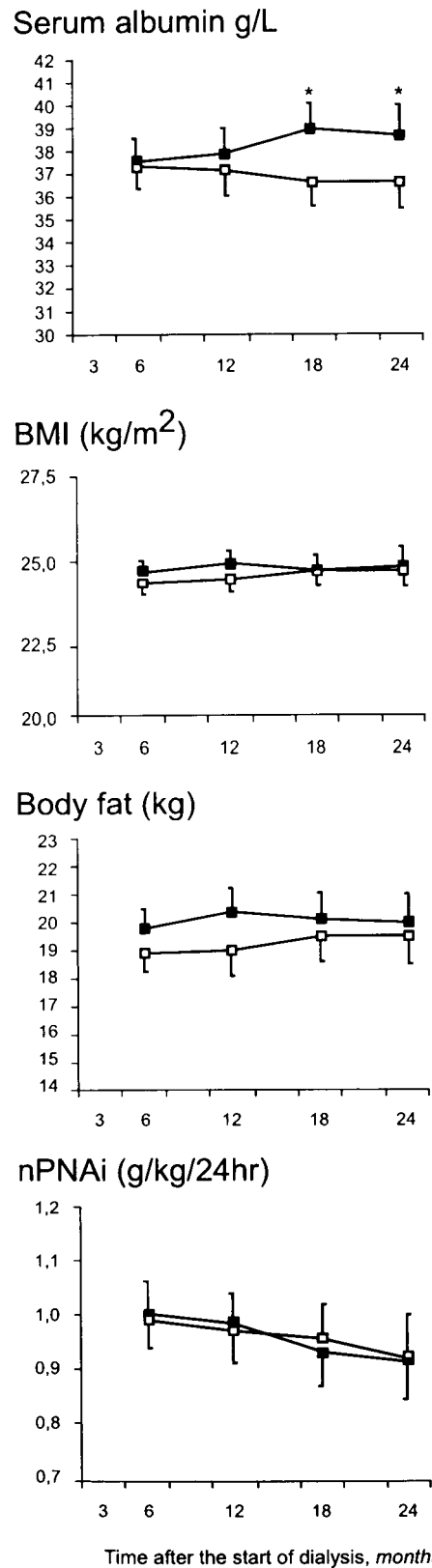
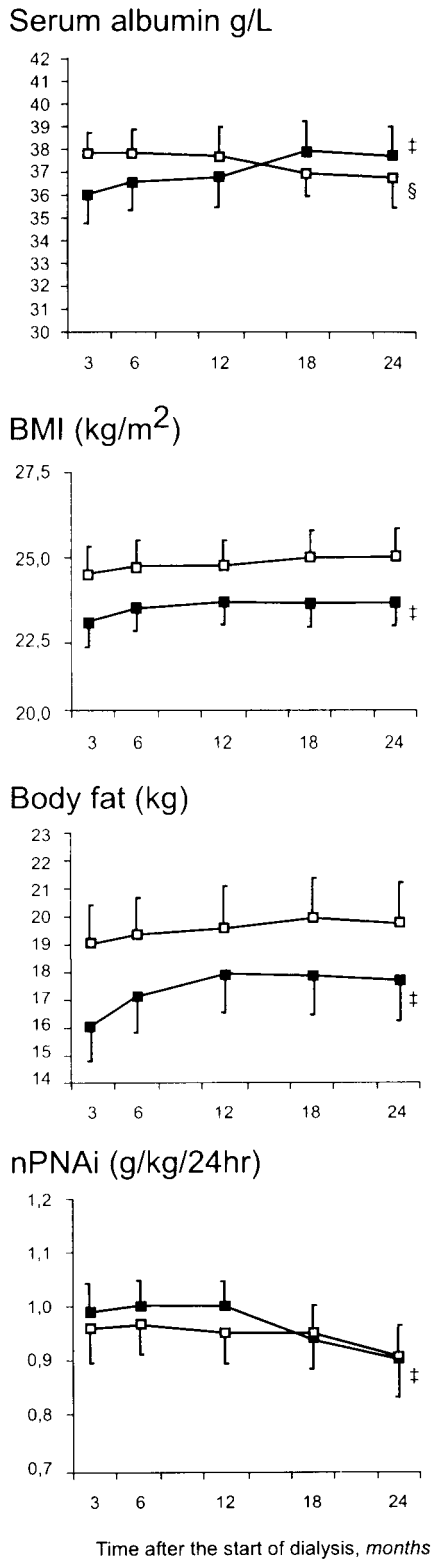


Figure 1. Change over time in serum albumin (SA; g/L), body mass index (BMI; kg/m²), body fat (kg), and protein equivalent of nitrogen appearance normalized to ideal body weight (nPNAi; g/kg per 24 h) in univariate analysis, according to dialysis modality at baseline: □, start-on-hemodialysis (start-on-HD); ■, start-on-peritoneal dialysis (start-on-PD) patients (means, 95% confidence interval [CI]). Statistically significant time effect in start-on-HD (§) or start-on-PD (‡) patients.

Figure 2. Change over time in SA (g/L), BMI (kg/m²), body fat (kg), and nPNAi (g/kg per 24 h) after adjustment for the baseline value of the nutritional parameter, age, gender, diabetes mellitus, and residual GFR: □, start-on-HD; ■, start-on-PD patients (means, 95% CI). *, statistical significant differences compared with start-on-HD patients.

their baseline value, age, gender, diabetic status, and rGFR. At 24 mo, the SA levels were 2.0 g/L (95% CI, 0.3 to 3.8) higher in patients who started on PD compared with those who started on HD. With respect to the other nutritional parameters, the differences in time course between the treatment modalities were small and not statistically significant.

We then compared PD women to all other patients, as subgroup analyses suggested that their change in nutritional status was different from that of others (time by gender effect for body fat, $P = 0.10$ as a result of a more pronounced increase in women in the start-on-PD group). PD women had a lower BMI at baseline than other patients (22.4 [4.4] versus 24.1 [4.0] kg/m²; $P < 0.05$). In addition, they had lower SA levels (35.4 [6.7] versus 37.3 [5.1] g/L; $P < 0.05$). The mean increase of BMI and body fat over time was 1.5 kg/m² (95% CI, 0.7 to 2.3) and 3.2 kg (95% CI, 1.6 to 4.9) higher in PD women than in the other patients. These increases were higher over the entire BMI range, from underweight to obese PD women. The time course of SA was not different from that of others.

At baseline, the BMI of patients with diabetes was higher than that of patients without diabetes: 25.3 (4.3) versus 23.6 (4.0) kg/m² ($P < 0.05$). Their SA level was 35.0 (5.1) g/L compared with 37.4 (5.3) g/L in patients without diabetes ($P < 0.01$). The mean increase of body fat over time was 2.3 kg (95% CI, 0.6 to 4.1) higher in patients with diabetes compared with patients without diabetes. The time course of BMI and SA was similar in these groups.

After multivariate adjustment, there was no effect of baseline total or dialysate Kt/V_{urea} on the time course of nutritional status in any of the dialysis modalities. However, start-on-HD patients with a total Kt_{urea} higher than 124 L/wk had 3.4 g/L (95% CI, 1.1 to 5.6) higher SA levels at the end of follow-up than patients with a lower Kt_{urea} (Figure 3A), despite similar SA values at baseline. Dialysate Kt_{urea} was a determinant of the time course of SA. Total urea appearance was also associated with the evolution of SA in the start-on-HD group but was less strong than total Kt_{urea} . A similar association with respect to Kt_{urea} was found in the start-on-PD group: patients with a total Kt_{urea} higher than the median of 75 L/wk had 2.7 g/L (95% CI, 0.3 to 5.1) higher SA levels than those with lower total Kt_{urea} levels (Figure 3B). In these patients, we did not find an independent effect of dialysate Kt_{urea} . The time course of BMI, body fat, or LBM was not affected by urea removal in either dialysis modality.

There was no difference in the time course of total body weight between start-on-HD patients who were using synthetic membranes ($n = 62$) or cellulose derivatives ($n = 70$). There also was no association of bicarbonate levels at baseline with the subsequent time course of SA levels, BMI, or LBM in HD or PD.

Nutritional Status over Time in Stay-on-HD Versus Stay-on-PD Patients: Multivariate Analysis

To study the influence of selective dropout and modality switches, we also performed a multivariate stay-on-treatment analysis, *i.e.*, stay-on-HD versus stay-on-PD patients. This

Serum albumin g/L

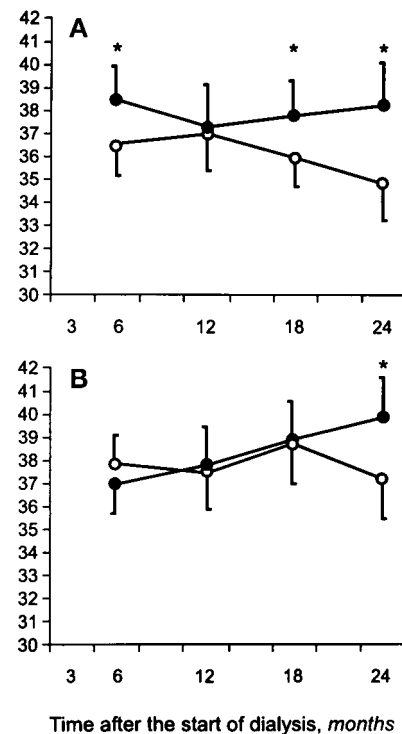


Figure 3. (A) Change over time in SA (g/L) of the start-on-HD patients with a total $Kt_{urea} < 124$ L/wk (○) and ≥ 124 L/wk (●) after adjustment for the baseline value of SA, age, gender, and diabetes mellitus (means, 95% CI). (B) Change over time in SA (g/L) of the start-on-PD patients with a total $Kt_{urea} < 75$ L/wk (○) and ≥ 75 L/wk (●) after adjustment for the baseline value of SA, age, gender, and diabetes mellitus (means, 95% CI). *, statistically significant differences compared with low baseline Kt_{urea} .

analysis showed similar results to the intention-to-treat analysis with one exception. In contrast to the intention-to-treat analysis, the time course of SA was similar in both groups.

Discussion

Nutritional Status over Time: HD

In the only other prospective study in new HD patients, Parker *et al.* (8) showed that body weight increased in patients who were using a biocompatible synthetic dialysis membrane, whereas it remained stable in patients who were using cellulose membranes. Our data did not show a difference between patients who were using synthetic membranes and cellulose derivatives. They also showed a rise in SA in the first 18 mo after the start of dialysis, irrespective of the membrane used. In our HD patients, SA remained constant up to 12 mo, followed by a gradual decrease. Parker *et al.* did not report Kt_{urea} values, but in the light of our findings, the increase of SA might have been due to a higher Kt_{urea} .

Nutritional Status over Time: PD

The improvement of nutritional status during the first 2 yr of dialysis in our start-on-PD patients confirmed the data from previous prospective studies in new PD patients (7,10,12–14).

Nutritional Status over Time: Baseline Determinants in Start-on-HD and Start-on-PD Patients

Dialysis Modality. Adjusted for other covariates, there was a difference in the time course of SA levels in favor of the start-on-PD patients and a larger gain in body fat in PD women. Pollock *et al.* (15) studied the evolution of nutritional status in both dialysis modalities with an initial cross-sectional assessment after almost 4 yr on dialysis in HD patients and after less than 2 yr on dialysis in PD patients. In their population, anthropometric and total body nitrogen measurements suggested that nutritional status was better on PD, whereas SA levels were lower compared with HD patients. Total body nitrogen tended to fall over time in HD patients, but it increased in PD patients. All other studies comparing HD and PD patients lack follow-up (6,24–26). Some authors concluded that there were no modality differences in nutritional status (6). Others found that PD patients had lower SA values (24,25), a higher body weight (24), more body fat (25), a lower BMI (26), and a higher protein intake (24) and that they were more often malnourished (24,25). None of these studies could distinguish whether these differences should be attributed to differences in case mix, therapy history, or a modality difference.

Gender. In line with our findings, other studies reported a larger impact of PD on the nutritional status of females compared with males (10,12). This finding may be explained by the peritoneal glucose absorption, which may have a more pronounced effect in women, whose caloric demand generally is lower than that of males. Tzamaloukas *et al.* (27) showed that fluid retention in PD patients often is accompanied by increased BP values. Therefore, we analyzed BP values during follow-up to gain support for our assumption that we had measured a difference in the gain of body fat and not in hydration status. In PD women, the mean increase in systolic pressure over time was 15 mmHg (95% CI, 11 to 24) and in diastolic pressure was 5 mmHg (95% CI, 0.3 to 9), whereas in other patients, BP remained stable. Therefore, a part of the observed gain in body fat probably was not fat but water and due to a larger fluid retention. However, no studies have suggested a gender difference in peritoneal ultrafiltration.

Diabetes Mellitus. The prevalence of malnutrition in individuals with diabetes depends on the type of diabetes within the population studied as well as on the definition used for malnutrition. Studies comparing the time course of nutritional status in individuals with and without diabetes are lacking. Cross-sectional studies have demonstrated a higher prevalence of malnutrition in individuals with diabetes (24), especially in individuals with insulin-dependent diabetes (28). Our patients with diabetes, approximately 55% of whom had type II diabetes mellitus, had lower SA levels but a higher BMI than patients without diabetes, which increased further during follow-up. An analysis of the BP values showed nonsignificant differences in time course: a mean increase of 7 mmHg (95% CI, –2 to 16) in systolic pressure and a mean decrease of 2 mmHg (95% CI, –3 to 6) in diastolic pressure in patients with diabetes compared with patients without diabetes. This makes a large component of overhydration in the observed weight gain less likely.

Dialysis Dose. The CANUSA study showed a relationship between changes in dialysis adequacy (defined as total Kt/V_{urea} and creatinine clearance) and changes in nutritional status of PD patients (7). However, Flanigan *et al.* (29) found little evidence that the efficiency of PD had a major influence on nutritional status. A cross-sectional analysis by Frankenfield *et al.* (30) showed that a low urea reduction ratio was associated with a high BMI and a low SA level in HD. They concluded that a prospective study was required to determine whether an increase in delivered dialysis dose would affect SA concentration. In such a prospective study in HD patients with negligible residual renal function, randomized for dialysis dose, Kloppenburg *et al.* (31) showed that a relationship between dialysis Kt/V_{urea} and nutritional status was absent. However, correction for the urea distribution volume can flaw the relationship between Kt_{urea} and clinical outcome (32). This would explain why an effect of Kt_{urea} on the time course of SA could be demonstrated in our relatively small study, whereas no effect of Kt/V_{urea} was detected, potentially because of a lack of statistical power.

Metabolic Acidosis. Other researchers have demonstrated beneficial effects of the correction of metabolic acidosis on body weight, midarm circumference (13), and protein turnover (33) in continuous ambulatory PD patients. Also in HD, protein turnover was reduced by a correction of metabolic acidosis (34). However, in keeping with the findings of Graham *et al.* (33,34), we did not detect an association between acid-base status and a change in BMI (34) or LBM (33,34).

Other Factors. In recent years, malnutrition has been linked to inflammation (35). Proinflammatory cytokines may cause muscle wasting and hypoalbuminemia and increase serum concentrations of C-reactive protein. The latter was shown to be an even better predictor of death than SA (36). We did not measure markers of inflammation in our patients. Hence, we were not able to correct for potential baseline differences in inflammatory state.

Nutritional Status over Time: Stay-on-HD and Stay-on-PD Patients

In the intention-to-treat analysis, we found a difference in the time course of SA in favor of patients who were starting on PD. However, in the stay-on-HD *versus* stay-on-PD analysis, comparing patients who stayed on their initial dialysis modality during follow-up, there was no modality difference. There are two potential explanations: an effect of selective dropout in the stay-on-HD *versus* stay-on-PD analysis or an effect of the different laboratory methods used to measure SA.

To study the effects of selective dropout on these results, we analyzed the distribution of the initial dialysis modalities within the groups of deceased patients, dialysis switchers, and transplant recipients. More patients who started on PD were present in the groups of modality switchers and transplant recipients. As SA levels tended to increase in these two groups, the exclusion of these groups from the stay-on-treatment analysis resulted in a lower increase in the stay-on-PD group.

It is unlikely that a difference in laboratory methodology influenced the stay-on-PD *versus* stay-on-HD analysis, as the

time course of SA was corrected for baseline levels. However, in the intention-to-treat analysis, the dropout might have been different for the various laboratory methods. The percentage of the use of BCG remained constant in start-on-PD patients but increased from 42 to 57% in the start-on-HD group. As the BCG method provides higher SA levels than BCP (37,38), this indicates that the difference in the intention-to-treat analysis was even higher than reported.

Our data indicate that starting on PD would result in higher SA levels at 2 yr. However, they have to be interpreted with caution. This was an observational study without randomization for dialysis modality. Unmeasured case-mix differences at baseline may have had an impact on outcome, *e.g.*, on the way SA levels reacted to the improvement of uremia. Also, the 0.1-g higher dietary protein prescription in PD patients may have influenced the results. Finally, differences in outcome may be due to a difference in dialysis adequacy instead of to a modality difference.

Conclusion

This prospective study presents data on the time course of nutritional status of patients in the first 2 yr on dialysis. At the start of dialysis, the energy stores of these patients seemed less affected than their protein metabolism. In general, there was a slight further improvement in energy stores over time. SA levels increased in patients who started on PD. Patients with diabetes and PD women gained more body fat than other patients, although increased BP values in the latter group suggested that a part of the weight gain was due to fluid retention. Dialysis dose, defined as Kt/V_{urea} , did not affect the time course of SA, but a higher Kt_{urea} at baseline was associated with a higher SA at 2 yr after the start of dialysis. There were no relationships between dialysis dose and an increase in energy stores.

Mostly, dialysis modality choice is made on the basis of patient preference and medical criteria. The results of this study suggest that the nutritional status at the start of dialysis and the patient's gender and diabetic status are among the factors to consider when a choice for one of the dialysis modalities is made. Patients whose energy stores are low may benefit to a larger extent from PD, whereas this treatment may have undesirable effects in overweight or obese females and individuals with diabetes. Furthermore, the results of this study indicate that Kt_{urea} may be a better measure of dialysis dose than Kt/V_{urea} and that the patient's protein metabolism may be improved by providing a higher Kt_{urea} .

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