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Original Article

Nutritional status of haemodialysis patients: a French national cooperative study

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Abstract

Background. Despite the severity and the prognosis value of undernutrition in haemodialysed patients, no large study is available as yet in Europe. Hence, this French National Cooperative Study aimed to determine the prevalence of undernutrition and its relationship to dialysis efficacy.

Methods. Nutritional status was determined in 7123 patients (i.e. one-third of the French haemodialysis population) using body mass index (BMI), predialysis haemoglobin, albumin, pre-albumin, cholesterol, and also normalized protein catabolic rate (nPCR) and lean body mass (LBM) calculated from pre- and postdialysis urea and creatinine. Dialysis treatment was estimated from weekly dialysis time and KtV determination.

Results. Dialysis time was 12.4 ± 2.7 h/week and KtV 1.36 ± 0.36. BMI was below 20 kg/m^2 in 24% and the observed/expected LBM ratio below 90% in 62%. Albumin, pre-albumin and nPCR were below the high-risk thresholds of 35 g/l, 300 mg/l and 1g/kg/day in 20%, 36% and 35% of patients, respectively. Pre-albumin was the most representative nutritional parameter. Albumin, pre-albumin and LBM correlated with nPCR. A dialysis time above 12 h/week was associated with higher BMI, albumin, pre-albumin and LBM. LBM was higher in patients with a KtV value > 1.1.

Conclusion. This study showed life-threatening undernutrition in 20–36% of the studied population, according to nutritional parameters. Protein intake (estimated by nPCR) and dialysis efficacy (estimated by dialysis time and KtV) appeared to be major determinants of nutritional status in this population.

Key words: albumin; haemodialysis; KtV; lean body mass; nPCR; nutrition; pre-albumin

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* The complete list of the dialysis centres involved in this study is given in the Appendix.

Introduction

Despite continuous progress in the delivery of renal replacement therapy, mortality in patients on maintenance dialysis remains higher than in the general population, although important differences in outcome exist between countries, as illustrated by comparing US, Japanese and European registries [1]. The annual mortality rate in Japan was 9.5% in 1994, compared with 23.6% in the USA in 1993 [2,3] and 10.7% in Europe [4]. A common finding of all these studies was the apparent role of undernutrition in the increased death risk, affecting 30–70% of patients according to nutritional parameters [5]. Serum albumin < 35 g/l [6–12] and serum pre-albumin < 300 mg/l [6,13–16] have been shown to be independent predictors of increased morbidity and mortality. Undernutrition may in turn be attributed to reduced dietary intake, metabolic disorders or inadequate dialysis [17] on account of dose [18,19] or membranes biocompatibility [20,21]. To date, there are no data from French dialysis registries, and EDTA files do not include nutritional parameters. This study thus presents data from a large national cross-sectional survey of 7000 patients on the nutritional status of the French haemodialysis population.

Materials and methods

Data collection

In January 1996, a letter was sent to the 230 French haemodialysis centres, to invite them to participate in a 'one-day' cross-sectional survey on the nutritional status of their dialysed patients. One hundred and six centres agreed to participate and received a questionnaire to be completed for each patient and returned before April 1996. This questionnaire included items related to general characteristics (birth date, gender, height), primary renal disease, dialysis characteristics and parameters related to dialysis adequacy, and nutritional status. We received 7177 questionnaires allowing us to evaluate about

one-third of the French haemodialysis patient population (around 21 000 patients).

Dialysis conditions

Date of first haemodialysis session, weekly dialysis duration and description of the usual treatment facility were requested. Treatment facilities were categorized as 'in-hospital' dialysis centre, 'self-dialysis' centre and home dialysis. In Tables 1 and 2, self-dialysis centre and home dialysis patients are separate, but we have combined in-hospital and self-dialysis (home and centre) in the text as in other studies. Pre- and post-dialysis body mass was recorded from a single mid-week dialysis session. Centres were asked to include all patients.

Laboratory tests

On the same day, pre- and post-dialysis blood samples were collected according to recommended procedures for dialysis quantification [22]. Predialysis bicarbonate, haemoglobin, albumin, pre-albumin, cholesterol, and pre- and postdialysis urea and creatinine concentrations were determined by the usual laboratories at the different centres using conventional autoanalysers.

Table 1. Description of patient population and dialysis parameters (mean ± SD)

Patients	7123
Age (years)	62.2 ± 15.9
Gender (M/F, %)	4108 (57.7)/3015 (42.3)
Primary renal disease (%)	
Glomerulonephritis	1919 (26.9)
Interstitial nephritis	1129 (15.8)
Nephrosclerosis	1073 (15.1)
Diabetes	734 (10.3)
Cystic kidney disease	775 (10.9)
Others or unknown	1493 (21)
Months on dialysis	62 ± 66
Dialysis facility (%)	
Hospital dialysis	5833 (81.9)
Self-dialysis	782 (10.9)
Home dialysis	508 (7.1)
Weekly dialysis time (h)	12.4 ± 2.7
Kt/V	1.36 ± 0.36

Calculations

Body mass index (BMI) was obtained from height and postdialysis body mass, whereas ideal body mass was calculated using the Lorentz formula. Dialysis adequacy was estimated by KtV according to Garred *et al.* [23]. Normalized protein catabolic rate for dry body mass (nPCR) was calculated from the urea generation rate [24,25]. Estimated lean body mass (LBM) was calculated from total body water, and observed LBM from the creatinine generation rate as described previously [26]. Observed/expected LBM ratio (obs/exp LBM) was used as a lean body mass undernutrition index.

Statistics

Results are given as mean ± SD except for Figures 2–4 where 95% confidence intervals were used as indicated in the figure legends. Group comparisons were achieved using one-way ANOVA (Statview 4™). The interrelationships between nutritional parameters were studied using a Pearson's correlation matrix. When significant main effect was found for nutritional parameters and variable categories by ANOVA, individual comparisons between adjacent categories were performed using Protected Least Significant Difference PLSD Fisher's test (Statview 4™, Figures 1–3). Given the large number of patients studied as well as the number of comparisons performed, significance was set at $P < 0.0001$.

Results

Patients and dialysis treatment

A complete set of data was obtained for 7123 of the 7177 patients considered initially and was therefore used for analysis (Table 1). The geographical distribution of the centres is shown in Figure 1. Patients older than 65 years represented 47.8% of subjects, whereas 16.5% were older than 75 years. The sex ratio (M/F) was 1.36, and 82% of the patients received in-hospital dialysis, whereas 18% were on self-dialysis. Among the various aetiologies of chronic renal failure, three appeared to be dominant: glomerulonephritis, interstitial nephritis and nephrosclerosis accounting for

Table 2. Nutritional parameters according to haemodialysis facilities

Nutritional parameters	Entire population (7123)	Hospital dialysis centre (5833)	Self-dialysis centre (782)	Home dialysis (508)
Age (years)	61.2 ± 15.7	62.5 ± 15.7	56.5 ± 15.6[a]	52.9 ± 15.2[a,b]
BM (kg)	63.4 ± 14.1	63.1 ± 14.1	63.9 ± 13.7[a]	64.7 ± 13.5[a]
(% ideal BM)	1.05 ± 0.23	1.06 ± 0.24	1.04 ± 0.19	1.04 ± 0.18
BMI (kg/m^2)	23.3 ± 4.6	23.4 ± 4.7	23.0 ± 4.2[a]	23.1 ± 4.1
obs/exp LBM	0.86 ± 0.21	0.84 ± 0.21	0.92 ± 0.21[a]	0.89 ± 0.21[a]
Creatinine (μmol/l)	805 ± 216	789 ± 215	892 ± 208[a]	865 ± 213[a]
Urea (mmol/l)	24.4 ± 7.0	24.3 ± 7.0	24.7 ± 6.7	24.3 ± 6.7
nPCR (g/kg/day)	1.13 ± 0.32	1.13 ± 0.31	1.14 ± 0.38	1.13 ± 0.30
Albumin (g/l)	38.8 ± 5.3	38.3 ± 5.18	41.0 ± 5.52[a]	40.6 ± 5.03[a]
Pre-albumin (g/l)	0.34 ± 0.09	0.33 ± 0.09	0.36 ± 0.09[a]	0.38 ± 0.09[a]
Cholesterol (mmol/l)	5.35 ± 1.55	5.34 ± 1.58	5.40 ± 1.46	5.45 ± 1.38
Haemoglobin (g/l)	104 ± 15	103 ± 15	107 ± 15[a]	107 ± 15[a]

BM, body mass; BMI, body mass index; obs/exp LBM, observed/expected lean body mass; nPCR, normalized protein catabolic rate. Values are expressed as means ± SD, the numbers of subjects are given in parenthesis, [a]indicates significant difference ($P < 0.0001$) versus hospital dialysis centre, [b]versus self-dialysis centre.

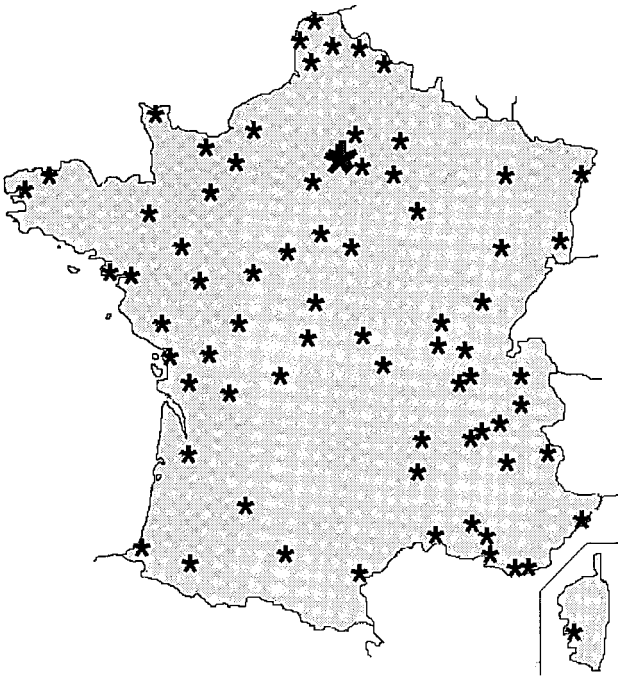

Fig. 1. Geographic distribution of dialysis centres included in the study.

nearly 60% of patients, whereas diabetes accounted for only 10% of the population. These figures are consistent with other data concerning age and primary renal disease evolution in patients starting haemodialysis in France between 1982 and 1992 [27]. Standard dialysis treatment in France consists mostly of three weekly sessions using bicarbonate buffer without the re-use of dialysers which is forbidden in France. Weekly dialysis duration was 12 h or more in 77.8% of the population studied and KtV was $\geqslant 1.1$ in 74.9%. Mean KtV was 1.28 ± 0.35 in males and 1.47 ± 0.34 in females ($P < 0.0001$).

Nutritional parameters

Nutritional parameters for the entire population studied and for the different categories of haemodialysis facilities are given in Table 2. Body mass was $<90\%$ of ideal in 22% of patients and BMI <20 kg/m^2 in 24%. Stratifying albumin data as performed by Lowrie and Lew [7], we observed values <40 g/l in 56%, <35 g/l in 20%, and <30 g/l in 5% of the whole population. Serum pre-albumin was <300 mg/l in 36%. nPCR was <1g/kg/day in 35% and >1.2 g/kg/day in 34.8%. Obs/exp LBM was $<90\%$ in 62% of patients. When compared with 'in-hospital'

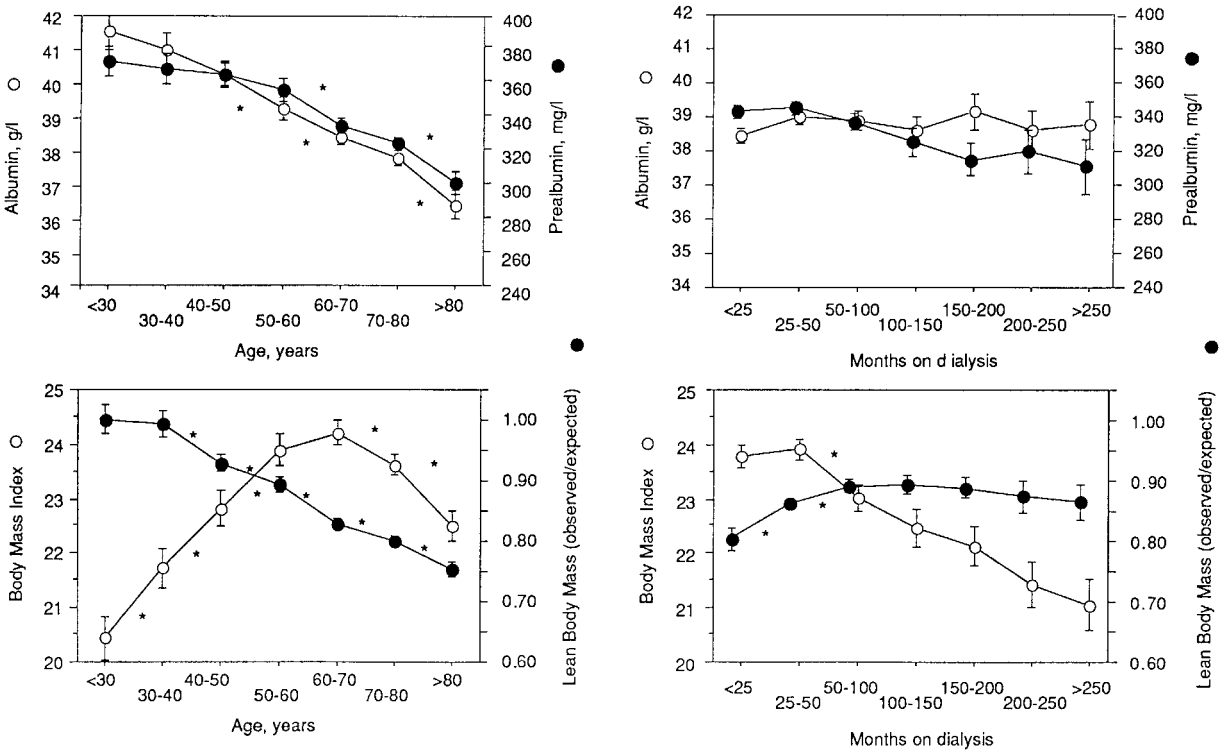

Fig. 2. Nutritional parameters according to age and dialysis duration. Values are means $\pm$95% confidence intervals. Categories include the lower limit value. Relationships (ANOVA, $P < 0.0001$) were age versus albumin, pre-albumin, BMI, obs/exp LBM and months on dialysis versus pre-albumin, BMI and obs/exp LBM. Variations between adjacent categories were tested by PLSD Fischer's *post hoc* test ($^*P < 0.0001$).

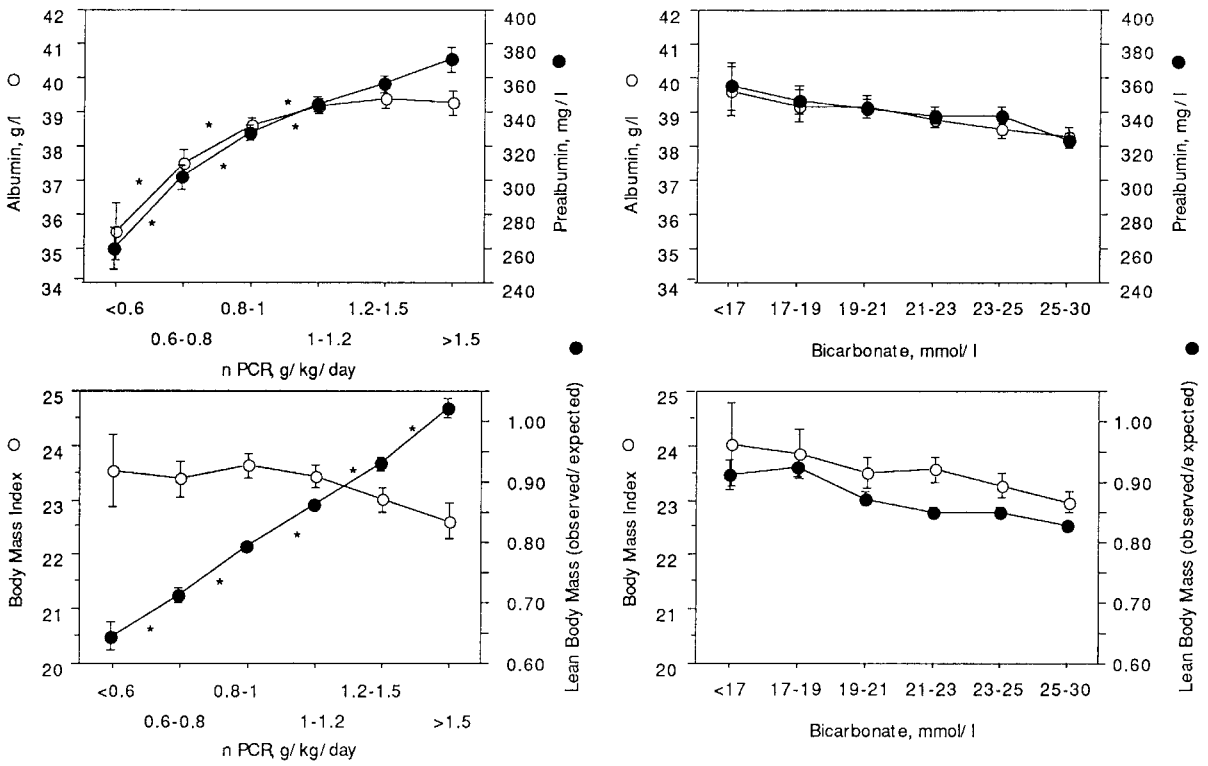

Fig. 3. Nutritional parameters according to nPCR and bicarbonate categories. Values are means ±95% confidence intervals. Categories include the lower limit value. Significant relationships (ANOVA, $P<0.0001$) were nPCR versus albumin, pre-albumin, BMI, obs/exp LBM and bicarbonate versus prealbumin and obs/exp LBM. Variations between adjacent categories were tested by PLSD Fischer's *post hoc* test (*$P<0.0001$).

dialysis, self-dialysis patients showed significantly higher serum concentrations of albumin, pre-albumin, creatinine and haemoglobin, as well as higher LBM. Among the different groups of primary renal disease and after adjustment for age, patients with primary chronic glomerulonephritis exhibited the highest values of protein metabolism parameters, i.e. albumin, pre-albumin, serum creatinine and obs/exp LBM, whereas the lowest values were observed for patients with nephrosclerosis and diabetes (data not shown). Table 3 shows the Pearson intercorrelation matrix within nutritional parameters. Although highly significant ($P<0.0001$) these relationships were not very strong. Among the selected parameters, only pre-albumin correlates with each of the others, exhibiting higher correlation coefficients than albumin.

Patients were stratified in different categories according to age, time on dialysis, nPCR, plasma bicarbonate, weekly dialysis time and KtV. Four selected nutritional parameters (BMI, serum albumin, pre-albumin and obs/exp LBM) were analysed according to these categories and are presented in Figure 2 (epidemiological data: age and time on dialysis), Figure 3 (metabolic data: nPCR and plasma bicarbonate) and Figure 4 (quality of dialysis: weekly dialysis time and KtV). Nutritional parameters according to age and time on dialysis are presented in Figure 2. Albumin and pre-albumin levels decreased with age after 40 years but were unaffected by time on dialysis. BMI increased with age from 30 to 50 years and decreased significantly after 70 years, whereas obs/exp LBM decreased continuously after 40 years. Decreasing BMI values were observed for categories of 'time on dialysis' >50 months. LBM values increased for 'time on dialysis' in categories between 12 and 100 months, but no difference was found for categories longer than 100

Table 3. Pearson's intercorrelation matrix of nutritional parameters. Values were presented when $P<0.0001$

	Albumin	Creatinine	Pre-albumin	Cholesterol	Haemoglobin	nPCR	BMI
Creatinine	0.273						
Pre-albumin	0.391	0.354					
Cholesterol	0.116	—	0.257				
Haemoglobin	0.211	0.156	0.124	—			
nPCR	0.134	0.368	0.238	0.056	—		
BMI	—	0.102	0.114	0.156	—	−0.081	
obs/exp LBM	0.211	0.843	0.298	—	0.073	0.523	—

months. Nutritional parameters according to protein catabolic rate and predialysis serum bicarbonate are shown in Figure 3. Albumin and pre-albumin levels were significantly lower in patients with a protein intake (estimated by nPCR) below the recommended value of 1.2 g/kg/day. LBM was strikingly correlated with nPCR. Albumin, pre-albumin, BMI and LBM declined progressively with plasma bicarbonate. Nutritional parameters according to weekly dialysis time and KtV are shown in Figure 4. Patients in categories of 'weekly dialysis time' >12 hours exhibited significantly higher levels of albumin and pre-albumin independent of KtV. LBM and BMI values increased with weekly dialysis time for categories between 10–12 and 14–16 h/week. BMI was inversely related to KtV for values ranging between 0.9 and 2.1 ($P<0.0001$) and LBM was higher in patients with KtV >1.1 ($P<0.0001$).

Discussion

Studies on the nutritional status of 'large numbers of patients (>5000) on maintenance dialysis have previously been reported for the population of the USA [7,11,28] and Japan [2,3]. There are nevertheless important differences between countries regarding prevalence and causes of end-stage renal disease, dialysis treatments and dietary habits. It thus seemed to be of prime interest to perform a similar nutritional study on a large body of European patients. The present study analysed data on one-third of the French haemodialysis population, estimated to be approximately 21 000 patients according to the 1995 survey of the French Ministry of Health. The population characteristics of the 7000 patients studied are consistent with projections based on the French 1991–1992 Registry as well as the 1994 EDTA files [27,29], for age, geographical distribution (Figure 1), dialysis facilities (in-centre 80%, self-care dialysis 20%) and primary renal disease. The prevalence of diabetic and vascular nephropathies is particularly low compared with data from the USA and Japan [30]. Owing to the large number of participating centres, we used locally measured parameters. Centralization of measurements would have provided more accuracy but so far this has rarely been achieved except for large multicentric studies from health organizations [7,11]. Moreover, as reported below, the lack of centralization did not preclude the expression of the relationships between relevant nutritional parameters.

The KtV calculated using the Garred equation [24,25] is practically equivalent to the latest generation Daugirdas equations [22] used in the USRDS data report and to the Shinzato equations used in the Japanese report [3]. According to the 1996 USRDS report [28], the mean KtV was 1.22 in 3072 randomly selected US patients, whereas it was 1.31 in the 88 693 Japanese patients reported by Shinzato *et al.* [3] and is 1.36 in the present series. To our knowledge there are no other KtV data from large series in Europe and according to the most recent EDTA report, only 49% of French centres routinely use urea kinetic modelling for the prescription of haemodialysis with a goal of at least 1.2 [29]. In our series, mean weekly dialysis time (12.4 h) was similar to the value reported for Japanese patients (12.4 h) but was higher than the 9.9 h reported in the US study. One might consider that the better survival rate reported in French and Japanese patients compared with US patients is, at least in part, due to higher values of KtV and weekly dialysis duration.

Home haemodialysis is rare in the USA ($<1\%$) and in Japan (0.1%) but was 7.1% in the present study. It has recently been reported that self-care haemodialysis is associated with a lower mortality risk even when adjusted for comorbid conditions [31]. In accordance with the EDTA registry, and representative of French practice, $>18\%$ of patients were on self-care (home and 'self-dialysis' centers combined) facilities in the present report. They were significantly younger and presented with a better nutritional status. The present study cannot distinguish between patient characteristics and/or dialysis facilities, which were recently reported to improve the quality of treatment as well as the subjective quality of life [31,32] to account for observed differences in nutritional status. Indeed haemoglobin was significantly higher in patients on self-dialysis or home dialysis compared with hospital dialysis patients.

Diabetic patients showed the lowest values of albumin, pre-albumin, creatinine and LBM as previously reported in the US population [7]. The highest values of plasma proteins, creatinine and LBM were found in primary glomerulonephritis, whereas the lowest values concerning indicators of muscle mass were observed in nephroangiosclerosis. These differences are partly explained by an effect of age between these groups: patients with glomerulonephritis being younger than nephroangiosclerosis patients. However, significant differences persisted after adjustment for age (not shown).

As reported previously [6,7,33], this study underlines the prevalence of protein malnutrition in haemodialysis patients; in spite of normal values for body mass and BMI, the reduction of obs/exp LBM ratio shows a widespread reduction in muscle mass (obs/exp LBM was <1 in 80% of the patients). The prognosis value of the protein status is well established; both serum albumin [8–11] and pre-albumin [6,15,34] have been shown to be independent indicators of survival in dialysed patients. In the present series, the mean albumin was 38.3 ± 5.3 g/l, a value similar to that reported in a large retrospective US study [7]. Albumin was <40 g/l in 56% of the patients and 20% of them had a value below the high-risk threshold of 35 g/l [9,35]. This hypoalbuminaemia could be related to factors other than malnutrition as recently emphasized by Kaysen [36]. Unfortunately, the data collected did not permit an analysis of the role of either inflammation or dialysis losses. High serum pre-albumin concentrations, similar to those achieved in this series, have been reported in other haemodialysis series [6,37–40]. Such high values have been attributed to changes in circulating pre-albumin–retinol binding protein–retinol com-

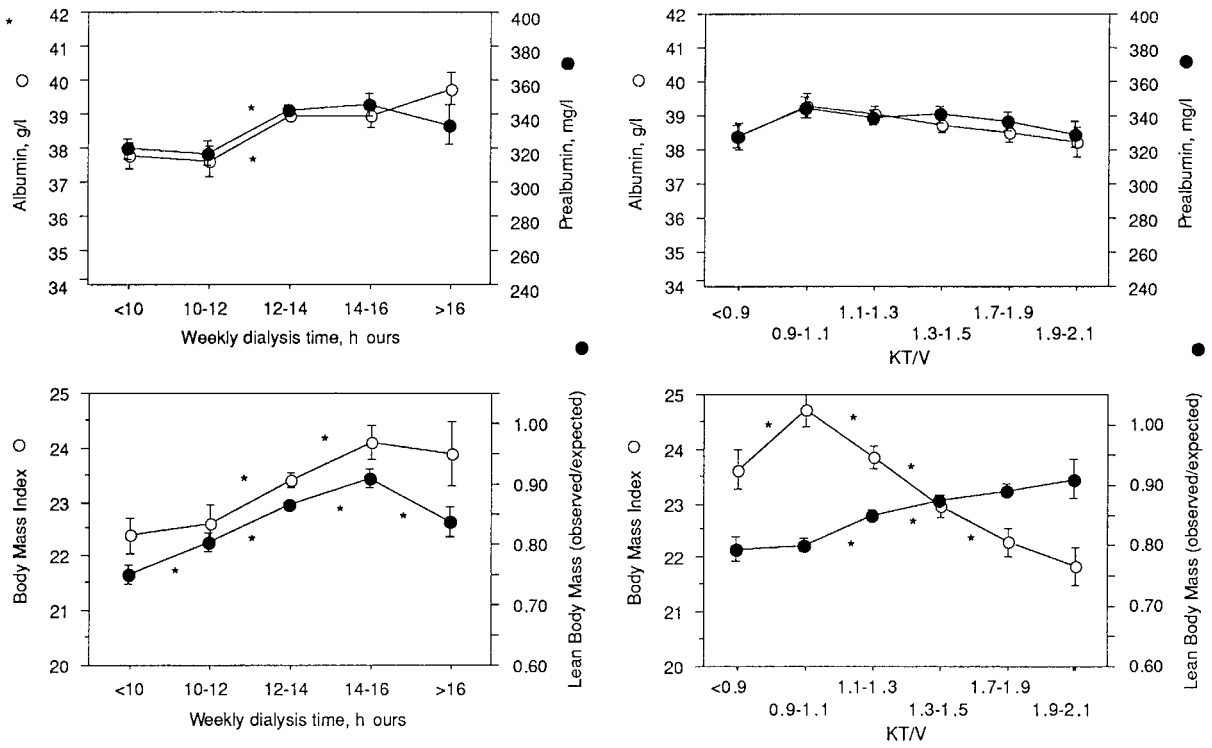

Fig. 4. Nutritional parameters according to KT/V and dialysis duration. Values are means ± 95% confidence intervals. Categories include the lower limit value. Relationships (ANOVA, $P<0.0001$) were weekly dialysis time versus albumin, prealbumin, BMI, obs/exp LBM and KT/V versus BMI and obs/exp LBM. Variations between adjacent categories were tested by PLSD Fischer's *post hoc* test (*$P<0.0001$).

plex during chronic renal failure [40]. Nevertheless, given a stable degree of renal insufficiency, such as that observed in haemodialysis patients, pre-albumin appears as a reliable nutritional marker [6,39,40]. In the present study, serum pre-albumin was found to be less than the threshold of 300 mg/l for an increased risk of morbidity and mortality [6] in 36% of the population. Because of the high percentage of serum albumin <35 g/l and of serum pre-albumin <300 mg/l, we consider that the prevalence of severe malnutrition in our population, as in previous series [7], is much higher than the usual estimate of 6–8% [41]. Mean protein catabolic rate was 1.13 ± 0.32 g/kg/day. These data are close to previously reported French data [26,42]. To our knowledge, the only other large study, performed on the Japanese haemodialysis population, showed nPCR values of 1 ± 0.2 g/kg/day [43]. A protein catabolic rate below 1 g/kg/day, which was demonstrated to be associated with increased morbidity and mortality [44], was found in 35% of the studied population.

The interrelations between the nutritional parameters tested (Table 3) were assumed to be due to a mutual dependency on nutritional status. This assumption made it possible to assess the ability of each variable to reflect the nutritional status. Serum pre-albumin, which was recently proposed as the gold standard for assessing visceral protein status by the US Nutritional Care Consensus Group [45], presented the highest number of significant correlations with other tested parameters. In particular, as shown previously in smaller series [6,15,34,46], pre-albumin was linked more tightly to nPCR, serum creatinine and LBM than albumin. Protein catabolic rate was correlated with all the other nutritional parameters although its relationships with albumin and cholesterol were weak. Predialysis serum creatinine, which was well correlated with serum albumin and pre-albumin as well as with nPCR and lean body mass, also appeared to be of interest for nutritional evaluation as reported previously [6,7,47]. In agreement with recent data and with Tarng *et al.* [48], we observed that haemoglobin, albumin, pre-albumin and creatinine, as well as obs/exp-LBM, were significantly interrelated.

As observed in the general population, BMI increased until the seventh decade and decreased thereafter, whereas the obs/exp LBM ratio decreased continuously after the fourth decade. It should be noted however that the loss of muscle mass is much more pronounced in haemodialysis patients than it is in the general population, reaching 75% of ideal values after 80 years of age (Figure 2). As reported in the general population, serum albumin [49] and pre-albumin [46] levels decreased with age. The decrease of BMI with the duration of dialysis treatment together with the increase in obs/exp LBM ratio until a plateau is reached after the 50–100 months of dialysis, suggest a progressive loss of fat mass. These initial changes in obs/exp LBM ratio related to time on dialysis may be explained by the progressive increase in protein intake after dialysis initiation [50] and also by the early mortality of those patients with poor initial nutritional

status. Serum albumin and pre-albumin levels, as well as obs/exp LBM, were related directly to protein intake as estimated by nPCR. It is noticeable that nPCR was inversely correlated with age (data not shown) explaining, at least in part, the evolution of the nutritional parameters with age. Patients with a mean weekly haemodialysis duration of <12 h displayed the lowest serum protein levels and the lowest BMI and LBM values. A clear gain in these nutritional markers was observed in patients with a weekly dialysis duration of 12 h. Although no clear correlation was observed between KtV and nutritional markers, patients with KtV <0.9 displayed the lowest serum albumin, pre-albumin and obs/exp LBM ratio confirming the influence of inadequate dialysis on nutritional status.

Conclusion

The nutritional assessment data obtained in this study underline the prevalence and the severity of undernutrition in this population. Considering the protein markers of undernutrition, 20–36% of haemodialysis patients presented with an increased risk of mortality due to undernutrition. A londitudinal survey of the studied population is, however, required to better acknowledge the prognostic value of the tested variables.

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Appendix

Dialysis centres involved in this study, Figure 1

Centre Hospitalier Général, Aix en Provence; Centre Hospitalier, Agen; Centre Hospitalier, Ajaccio; Centre Hospitalo-Universitaire, Angers; Centre Hospitalier, Annecy; Centre Hospitalier Général, Annonay; Centre d'Hémodialyse Michel Basse, Aressy; Centre d'Hémodialyse de Provence, Aubagne; Clinique de l'Orangerie, Aubervilliers; Clinique d'Aulnay, Aulnay-sous-Bois; Centre Hospitalier, Avignon; Clinique Delay, Bayonne; Centre Hospitalier Côte Basque, Bayonne; Centre Hospitalier, Bethune; Centre d'Hémodialyse, Blois; Hôpital Avicenne, Bobigny; Hôpital de la Croix Rouge, Bois Guillaume; Polyclinique Bordeaux-Nord-Aquitaine, Bordeaux; Hôpital St-André, Bordeaux; Hôpital Pellegrin, Bordeaux; CTMR-St Augustin, Bordeaux; Centre Hospitalo-Universitaire—Pellegrin, Bordeaux; Centre Hospitalier Duchenne, Boulogne sur Mer; Centre Hospitalier, Bourg en Bresse; Centre Hospitalier Régional, Brest; Centre Hospitalier, Briançon; Centre Hospitalo-Universitaire—Clémenceau, Caen; Centre Hospitalier, Cambrai; Centre Hospitalier, Chalon sur Saone; Centre d'Hémodialyse, Chateauroux; Centre Hospitalier Pasteur, Cherbourg; Centre Hospitalier, Cholet; Polyclinique St Côme, Compiegne; Centre Hospitalier Général—Louis Pasteur, Dole; Centre Hospitalier Général, Dunkerque; Centre Hospitalier Général, Flers; Centre d'Hémodialyse Jeanne d'Arc, Gien; Centre Hospitalo-Universitaire Régional, Grenoble; Centre de Dialyse des Eaux-Claires, Grenoble; Centre Jean Hamburger, Hyeres; Centre d'Hémodialyse des Oudairies, La Roche sur Yon; Centre Hospitalier, La Rochelle; A.G.D.U.C., La Tronche; Centre Hospitalier E. Roux, Le Puy-en-Velay; Hôpital R. Boulin, Libourne; Cabinet Médical Duchatelle, Lille; Hôpital Calmette, Lille; Clinique de la Louvière, Lille; A.L.U.R.A.D., Limoges; Centre Hospitalo-Universitaire Dupuytren, Limoges; Centre Hospitalier E. Bisson, Lisieux; Hôpital E. Herriot, Lyon; A.U.R.A.L., Lyon; Centre Hospitalier, Macon; Clinique de Toutes Aures, Manosque; Hôpital Ste-Marguerite, Marseille; Hôpital de la Conception, Marseille; Clinique La Résidence du Parc, Marseille; Centre Hospitalier, Meaux; Hôpital Lapeyronie, Montpellier; A.I.D.E.R., Montpellier; Centre d'Hémodialyse du Languedoc Méditerranéen, Montpellier; Centre Hospitalier Intercommunal, Montreuil; Centre Hospitalier, Moulins; Hôpital E. Müller, Mulhouse; Polyclinique de Gentilly, Nancy; Centre Hospitalo-Universitaire, Nantes; Clinique Les Genêts, Narbonne; Hôpital Pasteur, Nice; Centre Hospitalier Georges Renon, Niort; Centre d'Hémodialyse de l'Archette, Olivet; Hôpital de la Pitié-Salpêtrière, Paris; Hôpital Broussais, Paris; Hôpital Trousseau, Paris; ANDRA, Paris; Centre d'Hémodialyse de l'Alma, Paris; C.M.C. II, Paris; Centre Médical E. Rist, Paris; Hôpital du Val de Grâce, Paris; Clinique St-Martin, Pessac; Centre Hospitalier Lyon-Sud, Pierre Benite; Centre Hospitalier, Poissy; Centre Hospitalo-Universitaire, Poitiers; Centre Hospitalo-Universitaire, Reims; Centre Hospitalo-Universitaire Régional Pontchaillou, Rennes; Centre de Dialyse, Romans; C.H.M., Roscoff; Centre Hospitalo-Universitaire, Rouen; Centre Hospitalier, Saintes; Centre Hospitalier, Saint Nazaire; Centre Hospitalier d'Angoulême, Saint Michel; Centre Hospitalier, Sens; Hôpital Départemental de Felleries Liessies, Solre le Chateau; Hôpital Civil, Strasbourg; Centre Hospitalo-Universitaire Régional Hautepierre, Strasbourg; Centre du Rein Artificiel, Tassin; Hôpital Font-Pré, Toulon; Hôpital des Armées Ste Anne, Toulon Naval; Clinique Néphrologie St-Exupéry, Toulouse; Centre Hospitalier, Troyes; Centre Hospitalier, Valenciennes; Hôpital de Brabois, Vandœuvres; Clinique Maison-Blanche, Vernouillet; Centre Hospitalier Paul Morel, Vesoul; Aura-Auvergne, Vichy; Centre Hospitalier, Vichy; Clinique du Tonkin, Villeurbanne.