Abstract. The dietary protein intake (DPI) of 766 patients (aged 7 to 88 yr) was determined from 24-h urinary urea and protein excretion by urea kinetic modelling. Five hundred sixty-five patients had a normal serum creatinine concentration, and of these 565, 385 patients had no dietary modification advised and 180 were advised to follow a low-protein diet. The remaining 201 patients had an increased serum creatinine concentration; 148 of these 201 patients had been advised to restrict their DPI. Patients with a normal serum creatinine concentration who had no dietary restriction had a significantly higher DPI than those advised to restrict their protein intake (1.08 ± 0.01 versus 0.96 ± 0.02 g/kg per day (mean ± SEM); \( P < 0.01 \)). Similarly, patients with abnormal renal function who were advised to follow a low-protein diet had a reduced DPI (0.93 ± 0.01 versus 0.87 ± 0.02 g/kg per day; \( P < 0.05 \)). A lower DPI correlated with level of renal dysfunction, independent of dietary advice (\( P < 0.0001 \)). In the overall population, DPI correlated with body mass index (BMI; \( P < 0.0001 \)) and serum albumin (\( P < 0.0001 \)), and inverse correlations were evident between age (\( P < 0.0001 \)), blood glucose level (\( P < 0.01 \)), serum cholesterol level (\( P < 0.0001 \)), and triglyceride levels (\( P < 0.0001 \)) independently of renal function. Fifty-two patients were assessed within the 3 months before the commencement of dialysis, and 47 were reassessed within 3 months after the commencement of dialysis. Despite advice regarding an increase in dietary protein after the commencement of dialysis, this increase failed to occur within the 3 months of commencement of dialytic therapy (0.79 ± 0.04 versus 0.82 ± 0.03 g/kg per day); \( P = 0.64 \). However, 6 to 9 months after the commencement of dialysis, a significant increase in protein intake was evident (1.04 ± 0.04 g/kg per day; \( P < 0.005 \) versus both prior measurements). Hence a low DPI in renal impairment occurs independently of dietary advice, but compliance with such advice is evident because patients advised to consume a low-protein diet had significantly lower protein intake than did patients receiving no dietary advice. Adaptation to a high-protein diet after instigation of dialysis is unsuccessful in the short term, irrespective of whether or not advice is given regarding a low-protein diet before dialysis is initiated. However, 6 to 9 months after the commencement of dialysis, a significant increase in protein intake occurs, which in the hemodialysis population correlates with dialysis delivery. (J Am Soc Nephrol 8: 777–783, 1997)

Although dietary protein restriction has generally been regarded as useful in retarding the progression of renal disease (1–6), recent evidence suggests that this may not be as uniformly beneficial as originally proposed (7–9). However, the spontaneous protein intake of patients with renal impairment has not been widely assessed. Such an assessment is clearly necessary before dietary advice is given to patients with kidney dysfunction.

The most vulnerable time for complications of end-stage renal failure to occur is just before the instigation of dialysis, when the initiation of dialysis is deferred, and in the period immediately after dialysis commences (10,11). Similarly, this is the period when patients are most likely to be malnourished. The reasons for this are manifold and include anorexia, acidosis, frequent hospitalizations, and insulin resistance, all of which contribute to a low energy intake and increased protein catabolism. Dialysis is well known to be a catabolic event (12), and, hence, a high dietary protein level with adequate caloric intake is recommended once dialysis is established. However, the usual situation is that a patient accustomed to a diet based on low amounts of protein may for many reasons find the adaptation from a low- to a high-protein diet difficult. We have recently shown that within the first 6 months of commencing dialysis, patients usually have suboptimal protein stores, as measured by total body nitrogen, and that severe malnutrition has an unacceptably high mortality (13). Such poor nutrition is, however, difficult to appreciate from serum protein levels, anthropometric markers, or dietary history. Although a low serum albumin level has been shown to predict morbidity and mortality in hemodialysis (14), its value as a prognostic marker in peritoneal dialysis is unclear because the serum level is affected by factors other than nutrition (15). Obviously the maintenance of adequate nutrition is mandatory, and the recognition of a poor dietary intake is essential in the management of these patients.

The study presented here was performed to determine the dietary protein intake in a large sample of patients with normal kidney function and varying degrees of renal dysfunction.
Compliance with advice regarding a low-protein diet was determined, as was the compliance with a high-protein diet after the initiation of dialysis. Finally, the metabolic consequences of a low dietary protein intake were assessed.

Materials and Methods

Patients

Patients were entered into the study after being referred by participating renal physicians. Plasma urea, creatinine, albumin, glucose, cholesterol, and triglyceride levels were measured, and a 24-h urine collection from the preceding day was assayed for urea, creatinine, and protein, from which the urea generation and creatinine clearance rates were determined. The dietary protein intake was assessed from urea nitrogen appearance, which was assumed to be equal to 24-h urinary urea nitrogen (UUN) appearance. Protein intake was then calculated according to the method of Maroni et al. (16) as follows:

\[
\text{Estimated protein intake (g/day)} = 0.25 \times \text{(UUN (g/day)) + ideal body weight (kg) \times 0.031} \]

+ urinary protein losses. Height and weight were recorded, from which body mass index (BMI) was calculated. For the purposes of comparative analyses, patients were divided into two groups: those patients with a serum creatinine concentration lower than 0.12 mmol/l and those with a serum creatinine concentration higher than 0.12 mmol/l.

At the time of inclusion into the study, patients were assessed as to whether or not they had been advised by a dietitian. Dietary advice and referral to a dietitian were given at the discretion of the treating physician. Advice regarding modification of dietary protein intake by the treating physician consisted of an assessment of protein intake by way of dietary food recall, advice regarding high- and low-protein foods, and advice regarding the spacing of protein intake throughout the day. Pamphlets containing advice about low-protein diets and maintenance of caloric intake, which detailed background information about diet and renal disease and the protein content of various foods and which were produced and distributed by the Australian Kidney Foundation, were routinely made available to all patients. Body weight was routinely measured at each visit, and compliance with diet was determined and reinforced at 3- to 6-month intervals. If compliance with dietary advice was unsatisfactory, then referral to a dietitian was undertaken. Dietitian review consisted of measurement of BMI, detailed assessment of food intake (protein and calories), and subsequent caloric and protein requirements based on ideal body weight (IBW), which was considered to be a BMI of 25. Advice regarding a diet containing 0.8 g/kg IBW protein, with 70% of the protein being of high biological value, was generally given, although in some circumstances a diet as low as 0.6 g/kg IBW was given. A meal plan was provided, and all patients were reassessed in 4 wk with respect to compliance and nutritional adequacy. Review thereafter was performed according to the individual need of each patient as determined by the patient, doctor, and dietitian.

Fifty-two patients were assessed within the 3 months before the commencement of dialysis and 50 within 3 months after the commencement of dialysis. Thirty-eight of these patients had been reviewed by a dietitian within the 12 months before the commencement of dialysis, with the remaining patients having been referred for treatment just before the need for dialysis. Thirty-nine patients were reassessed 6 to 9 months after the commencement of dialysis. All patients were uniformly reviewed by a dietitian at the commencement of dialysis and advised regarding a diet aimed to normalize BMI. This included a protein intake of 1.2 g/kg per day (for hemodialysis) and 1.5 g/kg per day (for continuous ambulatory peritoneal dialysis [CAPD]) and a total caloric intake of 35 to 45 kcal/kg per day, with an emphasis on polyunsaturated rather than saturated fats and on the remaining caloric intake’s being composed primarily of complex carbohydrates. Before dialysis, dietary protein intake was assessed by the method of Maroni et al. (16) and subsequent to the commencement of dialysis was determined by the method of Borah et al. (12) for hemodialysis patients and Bergstrom et al. (17) for CAPD patients. Dietary review occurred within 1 wk of commencement of dialysis and again within the next month. Detailed assessments of food intake, biochemistry, serum albumin level, anthropometric measurements, and total body nitrogen were undertaken at the commencement of dialysis and thereafter on an “as needed” or a regular 6-month basis.

Statistical Analyses

Statistical analyses were made with Statview II software (Abacus Concepts Inc., Berkeley, CA). Correlation testing was performed using the Pearson correlation coefficient. Univariate and multivariate analysis was used to determine independent effects of the study variables. Comparisons between two groups were made using unpaired t tests, or paired t tests if repeated comparisons were made in the same individual. Analysis of variance was used to detect differences between multiple groups. A P value less than 0.05 was considered a significant difference.

Results

Seven hundred sixty-six patients (aged 7 to 88 yr) were enrolled in the study. Six hundred seventy-eight (89%) of the patients were enrolled by one renal physician, which represented 100% of his practice. The remaining 88 (11%) patients were enrolled by four renal physicians and comprised a small percentage of their patient practice. Although the latter patients had significantly worse renal function when compared with the entire group overall, subsequent analyses showed no differences in the results on the basis of treating physician. Five hundred sixty-five patients (326 male, 239 female), aged 51.7 ± 0.71 yr had a serum creatinine concentration less than 0.12 mmol/l. The primary reasons for referral in those patients with a serum creatinine concentration less than 0.12 mmol/l were as follows: biopsy-proven glomerulonephritis, 119; presumed glomerulonephritis although not confirmed by biopsy, 101; urinary tract infection (with and without vesicoureteric reflux), 79; hypertension/renovascular disease, 74; renal calculi, 56; analgesic nephropathy, 36; cystic renal disease, 23; obstructive uropathy, 17; diabetes mellitus, 19; and miscellaneous causes, 41 patients. One hundred eighty of these patients had been advised regarding a low-protein diet because of either significant urinary protein loss or the expectation by the treating physician of progressive renal impairment. Of these patients, 41 (23%) had been seen by a dietitian on at least one occasion to reinforce dietary compliance.

Two hundred one patients (111 male, 90 female), aged 61.9 ± 1.1 yr, had a serum creatinine concentration greater than 0.12 mmol/l. The primary reasons for referral in these patients were as follows: biopsy-proven glomerulonephritis, 53; hypertension/renovascular disease, 41; analgesic nephropathy, 26; urinary tract infection (with and without vesicoureteric reflux), 15; diabetes mellitus, 11; cystic renal disease, 9; obstructive uropathy, 7; presumed glomerulonephritis
although not confirmed by biopsy, 7; renal calculi, 6; and miscellaneous causes, 26. One hundred forty-seven of these patients had been advised about a low-protein diet; 93 (63%) of these 147 had been reviewed by a dietician.

The patient characteristics, biochemical parameters, and estimated dietary protein intake of the entire study population, and differences between the groups with serum creatinine concentrations greater or less than 0.12 mmol/l, are detailed in Table 1. As shown, patients with the higher serum creatinine concentration were older and had a lower BMI than did those with a serum creatinine concentration less than 0.12 mmol/l. As expected, plasma glucose and triglyceride levels were higher in those patients with a higher plasma creatinine concentration, and the serum albumin level was lower in this group. However, the mean plasma albumin level remained within the normal reference range. The estimated dietary protein intake was significantly lower in those patients with abnormal renal function, which was independent of age.

Dietary protein intake in the overall study population independently correlated most strongly with the level of renal function as measured by the creatinine clearance rate, independently of dietary advice ($r = 0.50; P < 0.0001$; Figure 1) but also with BMI ($r = 0.23; P < 0.0001$) and—to a lesser extent—serum albumin level ($r = 0.14; P < 0.0001$; Figure 2). Inverse correlations were observed between dietary protein intake and age ($r = 0.19; P < 0.0001$), plasma cholesterol level ($r = 0.15; P < 0.0001$), triglyceride levels ($r = 0.15; P < 0.0001$), and blood sugar level ($r = 0.09; P < 0.01$). No correlation was observed with urinary protein excretion rate. An identical pattern of correlation with dietary protein intake occurred both in the patients with serum creatinine concentration above or below 0.12 mmol/l, with the exception that age was less likely to correlate with protein intake in patients with a serum creatinine concentration $>0.12$ mmol/l ($r = 0.07; P < 0.05$).

Patients advised regarding a low-protein diet had a significantly lower protein intake than did patients who received no dietary advice. This effect was more marked in patients with a serum creatinine concentration $<0.12$ mmol/l (0.96 $\pm$ 0.02 versus 1.08 $\pm$ 0.01 g/kg per day; $P < 0.01$) than in those patients with more abnormal renal function (0.87 $\pm$ 0.02 versus 0.93 $\pm$ 0.01 g/kg per day; $P < 0.05$). However, the patients who had been reviewed by a dietician had a dietary protein intake similar to that of those patients within each patient group who had been advised primarily by their physician regarding a low-protein intake. Additionally, no significant difference was observed in plasma albumin, cholesterol, triglyceride, or glucose levels in patients advised about a low-protein intake with the aid of a dietician, compared with other patients maintaining a low-protein intake.

Patients with biopsy-proven glomerulonephritis had, as expected, a higher urinary protein excretion rate (1.05 $\pm$ 0.13 versus 0.46 $\pm$ 0.04 g/24 h; $P < 0.0001$) and a lower serum albumin level (43.5 $\pm$ 0.3 versus 44.2 $\pm$ 0.15 g/dl; $P < 0.05$). Their creatinine clearance rate was similar to that of other patients enrolled in the study (86.2 $\pm$ 2.9 versus 82.8 $\pm$ 1.9 ml/min; $P = 0.35$), as was their protein intake (0.99 $\pm$ 0.05 versus 0.96 $\pm$ 0.04 g/kg per day; $P = 0.21$). Forty-eight patients included in the study had a 24-h urinary protein excretion rate in excess of 3 g (mean, 5.3 $\pm$ 0.4; range, 3.01 to 15.7 g/day). These patients were more likely to have renal impairment, which was reflected in their creatinine clearance rate (52.2 $\pm$ 0.8 ml/min). Their dietary protein intake, 0.91 $\pm$ 0.05 g/kg per day, was similar to that of patients with comparable degrees of renal dysfunction.

Fifty-two patients included in the study commenced dialysis within 3 months of the initial assessment. Forty-nine patients were reassessed 6 to 11 wk (9.5 $\pm$ 0.1 wk) after dialysis was established. Sixteen patients commenced CAPD, and the remaining patients commenced hemodialysis. Dietary protein intake in this group before the instigation of dialysis was significantly lower than that observed in the remaining patients with an abnormal serum creatinine concentration (0.79 $\pm$ 0.04 versus 0.91 $\pm$ 0.02 g/kg per day; $P < 0.05$) and still correlated strongly with renal function. However, in this patient population, the correlation between dietary protein intake and serum

<table>
<thead>
<tr>
<th>Parameter</th>
<th>All Patients</th>
<th>Serum Creatinine &lt;0.12 mmol/l</th>
<th>Serum Creatinine &gt;0.12 mmol/l</th>
<th>$P$ Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>54.4 $\pm$ 0.6</td>
<td>51.8 $\pm$ 0.7</td>
<td>61.8 $\pm$ 1.1</td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>Body mass index</td>
<td>25.2 $\pm$ 0.2</td>
<td>25.7 $\pm$ 0.2</td>
<td>24.2 $\pm$ 0.3</td>
<td>$&lt;0.05$</td>
</tr>
<tr>
<td>Urea (mmol/l)</td>
<td>8.8 $\pm$ 0.3</td>
<td>5.6 $\pm$ 0.1</td>
<td>17.7 $\pm$ 0.7</td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>Creatinine (mmol/l)</td>
<td>0.15 $\pm$ 0.01</td>
<td>0.08 $\pm$ 0.001</td>
<td>0.35 $\pm$ 0.02</td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>43.9 $\pm$ 1.4</td>
<td>44.8 $\pm$ 0.1</td>
<td>41.7 $\pm$ 0.3</td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>5.8 $\pm$ 0.1</td>
<td>5.6 $\pm$ 0.1</td>
<td>6.3 $\pm$ 0.2</td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>5.40 $\pm$ 0.4</td>
<td>5.37 $\pm$ 0.04</td>
<td>5.47 $\pm$ 0.08</td>
<td>0.26</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>1.82 $\pm$ 0.05</td>
<td>1.69 $\pm$ 0.04</td>
<td>2.31 $\pm$ 0.13</td>
<td>$&lt;0.0001$</td>
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<tr>
<td>Creatinine clearance (ml/min)</td>
<td>83.6 $\pm$ 1.6</td>
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<td>36.1 $\pm$ 2.1</td>
<td>$&lt;0.0001$</td>
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<tr>
<td>24-h urinary protein (g/day)</td>
<td>0.60 $\pm$ 0.50</td>
<td>0.32 $\pm$ 0.04</td>
<td>1.4 $\pm$ 0.13</td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>Dietary protein intake (g/kg per day)</td>
<td>0.98 $\pm$ 0.01</td>
<td>1.05 $\pm$ 0.01</td>
<td>0.89 $\pm$ 0.02</td>
<td>$&lt;0.0001$</td>
</tr>
</tbody>
</table>

* $P$ value refers to the comparison between patients with a serum creatinine concentration <0.12 mmol/l versus those with serum creatinine concentrations >0.12 mmol/l.
Figure 1. Correlation between dietary protein intake and renal function, measured by creatinine clearance rate.

Figure 2. Correlation between dietary protein intake and serum albumin level (P < 0.001).

albumin level was not as strong as that in the remaining patient groups (P < 0.05). Similarly, age no longer correlated with protein intake. No difference in protein intake was observed between those patients advised regarding a low-protein diet and those who had received no formal dietary advice. A reassessment of protein intake within 3 months of the commencement of dialysis demonstrated that the mean protein intake had not significantly increased (0.83 ± 0.03 g/kg per day; P = 0.64 versus predialysis protein intake). No significant difference in protein intake after the commencement of dialysis was observed between patients who had been advised regarding a low-protein diet before dialysis, compared with those who had received no predialysis dietary advice. Patients who commenced CAPD tended to have a higher protein intake than did those who commenced hemodialysis (0.83 ± 0.05 versus 0.79 ± 0.03 g/kg per day), although this difference did not reach statistical significance (P = 0.51). The mean weekly Kt/V (including the contribution from residual renal function) in these patients 3 months after commencement of dialysis was 3.96 ± 0.16 in the hemodialysis and 2.34 ± 0.09 in the CAPD populations, respectively. Correlations between the Kt/V and the protein catabolic rate within 3 months of dialysis initiation is shown for both hemodialysis and CAPD patients in Figures 3A and 4A, respectively. Three patients died within 12 wk of commencing dialysis; the protein intake of these patients had been 0.59 ± 0.05 g/kg per day.

In the 39 patients who were reassessed 6 to 9 months (7.2 ± 0.2 months) after dialysis had commenced, a significant increase in protein intake had occurred to 1.04 ± 0.04 g/kg per day (P < 0.005 versus predialysis and at 3 months). This increase was largely accounted for by the 26 patients on hemodialysis whose protein intake increased to 1.19 ± 0.04 g/kg per day (P < 0.0001 versus within 3 months). No significant increase in delivered dialysis dose was observed, with a weekly Kt/V 6 to 9 months after dialysis had commenced of 4.02 (P = 0.29 versus within 3 months). A correlation now existed between Kt/V and the protein intake (P < 0.002; Figure 3B), whereas no correlation between dialysis delivery and protein intake was observed when these parameters were studied within 3 months after the start of dialysis (Figure 3A).

In the 13 patients on CAPD who were reassessed 6 to 9 months after commencing dialysis, protein intake was somewhat lower than it was when assessed within 3 months after the initiation of dialysis (0.83 ± 0.05 g/kg per day; P = 0.09 versus within 3 months). The weekly Kt/V was also lower at 2.16 ± 0.08, although this was not significantly different from the Kt/V measured within 3 months of the commencement of dialysis (P = 0.11). In contrast to the hemodialysis population, a significant correlation existed between the Kt/V and protein intake in CAPD patients soon after the commencement of dialysis (P < 0.05; Figure 4A), but this correlation was no longer significant when reassessed 6 to 9 months after initiation of CAPD (P = 0.11; Figure 4B).

Discussion
The study presented here provides evidence in a large cohort of patients that a decline in renal function is associated with an adverse impact on nutritional status, reflected in parameters such as dietary protein intake, serum albumin level, and BMI, which is independent of dietary advice. A reduction in dietary protein intake parallels the loss of renal function in the vast majority of patients. However, this decrease in protein intake is not well-reflected in any single marker of nutrition, such as the serum albumin level in any individual patient. In addition to reaching end-stage renal failure with a spontaneously low-level ingestion of protein, patients are unable to alter their eating habits in the short term immediately after commencing dialysis to accommodate the recommendations of a high-protein diet. Hence the catabolic stresses of dialysis are likely to result in a negative nitrogen balance and contribute to an unacceptably high mortality in the period immediately after the commencement of dialysis. Because we and other investigators have conclusively demonstrated the extremely adverse effect of malnutrition on prognosis in end-stage renal failure (13,18,19),
the surveillance of nutrition in progressively impaired renal function becomes paramount.

Information regarding the spontaneous protein intake in the community is limited and obviously cannot be extrapolated from one population to another. The most recent data available in Australia is from dietary surveys conducted in 1983 (20). These surveys estimated a protein intake of between 1.2 to 1.5 g/kg per day. A more recent study determining the amount of food used by a community suggested a somewhat higher value of 1.45 g/kg per day (21). The study presented here demonstrates that the spontaneous dietary intake in the subjects with a normal serum creatinine concentration is somewhat lower than these prior estimates. This confirmation of a trend toward a lower dietary protein intake over the last decade would be expected, given the increasing proportion of wheat products in the Australian diet and the Asian influence on our food patterns. However, the precise reasons for any alteration in patterns of food intake is beyond the scope of this study.

![Figure 3](image)

**Figure 3.** (A) Kt/V versus normalized protein catabolic rate (nPCR) in hemodialysis patients within 3 months of commencing dialysis. (Kt/V expressed per dialysis treatment). (B) Kt/V versus nPCR in hemodialysis patients 6 to 9 months after commencing dialysis (Kt/V expressed per dialysis treatment).

![Figure 4](image)

**Figure 4.** (A) Kt/V versus nPCR in CAPD patients within 3 months of commencing dialysis (Kt/V expressed as weekly Kt/V/2.33 to equate with thrice-weekly hemodialysis). (B) Kt/V versus nPCR in CAPD patients 6 to 9 months after commencing dialysis (Kt/V expressed as weekly Kt/V/2.33 to equate with thrice-weekly hemodialysis).

Few other studies have addressed the spontaneous protein intake in patients with renal impairment. The findings of our study have been confirmed by a recent study of 90 patients, where a progressive decline in protein intake of 0.06 ± 0.007 g/kg per day occurred for each 10-ml/min reduction in GFR (22). Laxton et al. (23) assessed the dietary protein intake of 34 patients with a mean serum creatinine concentration of 0.14 mmol/l and found the mean protein intake to be 1.2 g/kg per day. Determination by food surveys correlated well with the protein catabolic rate. However, a wide variation in protein consumption was evident. Indeed, the Modification of Diet in Renal Disease study specifically excluded patients from entry to their study of protein restriction in moderate renal impairment (GFR of 25 to 55 ml/min per 1.73 m²) if their dietary protein intake was less than 0.9 g/kg per day (24). Hence the usual protein intake of both the general community and the individual patient needs to be taken into account when the applicability of studies assessing alterations in dietary protein intake is to be determined.

This study further suggests an association between a reduced
protein intake and elevated blood sugar, serum cholesterol, and triglyceride levels, which occur independently of the degree of renal dysfunction. Review by a dietitian did not appear to enhance compliance with a low-protein diet or reduce the adverse metabolic consequences of a low-protein diet. However, because the study was not randomized, it is possible that patients who were more noncompliant were advised formally by dietitians, and their noncompliance has biased the results. Although these correlations are not particularly strong, given that the majority of deaths in end-stage renal failure occur as a result of vascular causes (25,26), any contribution of spontaneously ingested or prescribed diets to the atherogenic profile needs review.

Prior studies have largely assessed the benefit of low-protein diets in renal disease with end points being either the rate of deterioration in renal function or the time to commencement of dialysis (1–6,8,27). Data on the follow-up of these patients on dialysis, particularly with respect to their adaptation to a high-protein diet and subsequent prognosis, is lacking. The study presented here provides evidence that adaptation from a low-to a high-protein diet after the initiation of dialysis is almost uniformly unsuccessful in the short term. Disappointingly, the provision of adequate dialysis and nutritional support from a trained dietitian does not necessarily stimulate protein intake in the short term. After 6 months of dialysis therapy, with no alteration in dialysis dose, protein intake increases to values near those recommended. At this stage, an increase in dialysis delivery correlates with improved protein intake, particularly in the hemodialysis population. The reasons for this increase have not been assessed by this study but are likely to be the result of delayed removal of “uremic toxins,” improved wellbeing after a period of dialysis, improved cognition (and hence ability to comply with altered dietary regimens), and also the expected time-lag in altering dietary habits to accommodate a high-protein diet.

We have previously shown that a low protein catabolic rate in hemodialysis patients is associated with an increased risk of morbidity and mortality (28), and thus these patients are clearly at risk of infectious complications and hospitalization. Poor nutrition at entry to dialysis programs has similarly been believed to contribute to the high initial mortality of patients with end-stage renal failure in the United States (10,11,19). Many studies assessing the nutritional adequacy of patients focus on nutritional parameters such as change in body weight, anthropometric measurements, or serum albumin level (1,2,5). The study presented here confirms that in population studies, these markers reflect the poor nutrition inherent in progressive renal disease. However, although these parameters may be of value in determining the severely malnourished patient, they are not sensitive markers of nutrition in ESRD in the individual patient because they frequently fall into the normal reference range despite significant and progressive nutritional depletion.

Several studies have suggested differential effects of a low-protein diet in retarding the progression of renal disease on the basis of the underlying renal pathology (2,7). Our results would suggest that spontaneous ingestion of protein is not different in patients with glomerulonephritis, compared with those with other renal diseases, and the presence of proteinuria has no effect on the dietary protein intake. Indeed, a recent workshop convened to develop management recommendations for the prevention of chronic renal disease (29) concluded that “the evidence that prescription of a low protein diet slows the progression of renal disease is inconclusive.” Hence their present recommendations are that a standard protein intake should be advised, but if progressive renal impairment occurs or if uremic symptoms occur, a reduction to 0.8 g/kg per day should be implemented. Our study would suggest that the protein intake of patients with progressive renal impairment is likely to fall within these parameters spontaneously, and if uremic symptoms occur, dialysis should be initiated before malnutrition becomes established, rather than an advocacy of a further reduction in protein intake. Indeed, a recent editorial by Hakim and Lazzarus (30) concurred with these findings and suggested that a spontaneous dietary intake below 0.7 to 0.8 g/kg per day, measured by urinary nitrogen appearance, may be “objective criteria for the commencement of dialysis.”

Thus we conclude that a low dietary protein intake in renal impairment occurs independently of dietary advice, although compliance with dietary advice is evident. The proportionately higher carbohydrate and fat intake required for maintenance of energy intake results in an adverse lipid profile, which may contribute to the already high cardiovascular risk in this population. Attempts to improve protein intake in the first 3 months after dialysis commences, independent of prior dietary recommendations, are unsuccessful and may contribute to the early morbidity and mortality in these patients. However, 6 to 9 months after the commencement of dialysis, a significant increase in protein intake does occur.

Acknowledgments

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