Kidney International, Vol. 61 (2002), pp. 734–740

Peritoneal and hemodialysis: I. Differences in patient characteristics at initiation

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Peritoneal and hemodialysis: I. Differences in patient characteristics at initiation.

Background. Comparisons of mortality outcomes between peritoneal dialysis (PD) and hemodialysis (HD) patients have shown varying results, which may be caused by the unequally distributed clinical conditions of patients at initiation. To address this issue, we evaluated the clinical characteristics of 105,954 patients at the initiation of PD and HD, using the U.S. national incidence data on treated end-stage renal disease from the Medical Evidence Form, 1995 to 1997.

Methods. A general linear model was used to analyze differences of age, albumin, creatinine, blood urea nitrogen (BUN), and hematocrit; categorical data analysis to evaluate body mass index (BMI), grouped into four categories: <19, 19–25 (<25), 25–30 (<30), and 30+; and logistic regression to assess the likelihood of initiating PD versus HD. Diabetics (DM) were analyzed separately from non-diabetics (NDM). Explanatory variables in the logistic regression included incidence year, race, gender, age, BMI, albumin, creatinine, BUN, and hematocrit. Race included white and black. Age was categorized into four groups: 20–44, 45–64, 65–74, and 75+.

Results. At the initiation of dialysis PD patients were approximately 6 years younger ($P < 0.0001$) than HD patients. PD patients also had higher ($P < 0.0001$) albumin (+0.35 g/dL for DM and +0.23 g/dL for NDM) and hematocrit (+1.64% for DM and +1.71% for NDM) levels, and lower ($P < 0.04$) BUN (−8.75 mg/dL for DM and -5.24 mg/dL for NDM) and creatinine (−0.51 mg/dL for DM and −0.23 mg/dL for NDM) levels than HD patients. Whites had a higher ($P < 0.0001$) likelihood of starting PD than blacks, and patients with BMI <19 had a lower ($P < 0.0001$) chance of beginning on PD.

Conclusion. PD patients had favorable clinical conditions at the initiation of dialysis, which should be taken into consideration when comparing dialysis outcomes between the two modalities.

Key words: mortality outcome, dialysis modality, data analysis, end-stage renal disease, Medical Evidence Form, Health Care Financing Administration.

Received for publication June 8, 2001
and in revised form September 25, 2001
Accepted for publication September 27, 2001

The variability in clinical outcomes between peritoneal dialysis (PD) and hemodialysis (HD) was recently reviewed by Gokal and colleagues [1], who found that there is a wide variation in mortality outcomes between the therapies [1]. The contradictory results included (*1*) no differences in mortality between PD and HD [2–8], (*2*) PD having a lower mortality than HD [9, 10], and (*3*) PD having a higher mortality than HD [11–13]. Nelson et al found that diabetic PD patients had lower mortality than diabetic HD patients [14], while Held et al presented the opposite findings [15]. Neither study found a difference in mortality between non-diabetic PD and HD patients.

These inconsistent results raise concerns about the reliability of the mortality comparison itself. It has been suggested that, because of complex factors such as patient choice, comorbidity, failure of vascular access, and payment systems, the patients' clinical conditions at initiation are not equally distributed between PD and HD. Completion of the Medical Evidence Form 2728, updated in April 1995, is now required at the first service of end-stage renal disease (ESRD). The updated form includes data on patient comorbidity and biochemistry, providing an opportunity to compare clinical conditions of PD and HD patients upon initiation of treatment. Our study used the data from the Medical Evidence Form to evaluate the clinical characteristics, including body mass index and laboratory test values, of patients at the initiation of PD and HD between 1995 and 1997.

METHODS

Patient characteristics

Data from the Medical Evidence Form (HCFA 2728) for treated ESRD patients was obtained from the Health Care Financing Administration. We extracted information on laboratory tests, height, and weight for the years 1995 to 1997.

Each patient's initial dialysis modality, either PD or

Table 1. Percentage of patients on peritoneal dialysis (PD) and hemodialysis (HD) by race and gender

		Diabetics			Non-diabetics		
Race	Gender	*N* patients	PD %	HD %	*N* patients	PD %	HD %
White	Male	16,014	15.39	84.61	22,737	11.91	88.09
	Female	14,925	13.30	86.70	15,560	14.19	85.81
Black	Male	6,164	8.37	91.63	11,625	6.68	93.32
	Female	9,160	7.61	92.39	9,769	8.78	91.22

HD, was determined from the Medical Evidence Form. The clinical data elements included race, gender, age, diabetic status, height, weight, serum albumin, creatinine, blood urea nitrogen (BUN), and hematocrit at the initiation of dialysis. Body mass index (BMI) was calculated using the formula: body weight (kg) ÷ height (m^2). Creatinine clearance, hemoglobin, and urea clearance were not included in the data analysis because the creatinine clearance value recorded on the form was simply calculated from serum creatinine [16], because hemoglobin has the same indication as hematocrit, and because only 2.2% of patients had urea clearance data. Native Americans, Asians, and patients younger than 20 also were excluded due to the small number of patients.

After the exclusions 158,419 incidence patients in the data set had complete information for race, gender, age, and diabetic status. Of these patients 89.1% had BMI data, 72.6% had albumin data, 82.7% had BUN data, 88.4% had creatinine data, and 83.8% had hematocrit data. Because patients with missing information on any variables would be omitted in the process of statistical analysis (for example, logistic regression), we analyzed only those who had complete data for BMI, albumin, creatinine, and BUN as well as data for race, gender, age, and diabetic status. The final data set contained 105,954 patients, 66.9% of the total 158,419. The final data set was compared to the initial one using the χ^2 test, and no difference was found ($P > 0.1$) in the percentage of patients on PD and HD.

Statistical analysis

All data were analyzed using SAS® (SAS, Inc., Cary, NC, USA) [17]. Because diabetics are clinically different from non-diabetics [18–20], the two groups of patients were separated in our analysis. The proportion of patients on PD and HD at initiation was analyzed using the Mantel-Haenszel method, with race and gender as strata. Body mass index was grouped into <19, 19–25 (<25), 25–30, (<30), and 30+, representing underweight, appropriate weight, overweight, and obesity, respectively. We compared the proportion of patients between PD and HD within each BMI group using categorical data modeling [21]. Patient age, hematocrit, and serum concentrations of albumin, creatinine, and BUN at the initiation of ESRD were analyzed using the general linear model (GLM) [17] with dialysis therapies, race, and gender as independent variables.

Logistic regression analysis was used to evaluate the likelihood of initiating on PD or HD [22]. The explanatory variables were incidence year (1996 and 1997; 1995 was reference), race (white; black was reference), gender (male; female was reference), age (20–44, 45–64, and 65–74; age 75+ was reference), BMI (<19, 25–30 and 30+; BMI 19–25 was reference), albumin, BUN, creatinine, and hematocrit. The biochemical data were treated as continuous variables in the model. Odds ratios (OR) and their 95% confident limits (CL) were determined from the logistic procedure.

RESULTS

Racial and gender differences between PD and HD are reported in Table 1. A higher ($P < 0.0001$) percentage of whites started on PD than of blacks in both genders and for both diabetics and non-diabetics. Among diabetics there were higher ($P < 0.0001$) percentages of white and black females starting on PD than of their male counterparts. In diabetics, however, a lower ($P < 0.0001$) percentage of white females initiated on PD compared with their male counterparts. No difference ($P > 0.08$) was observed between black diabetic males and females.

After adjusting for other factors in the logistic regression model, the odds ratio (and its 95% CL) of whites versus blacks (blacks were reference, OR = 1.0) starting on PD was 1.863 (range 1.735–2.000, $P < 0.0001$) in diabetics (Fig. 1), indicating that diabetic whites had an 86.3% higher likelihood than diabetic blacks to initiate on PD. In non-diabetics, the odds ratio was 1.969 (1.847–2.098, $P < 0.0001$), that is, non-diabetic whites had a 96.9% higher likelihood than non-diabetic blacks to initiate on PD (Fig. 1). No difference (1.042, 0.981–1.107, $P > 0.18$) between genders was observed in diabetics (Fig. 2), while non-diabetic males (0.784, 0.741–0.828, $P < 0.0001$) had a lower chance of starting on PD than females (females were reference, OR = 1.0).

Body mass index by dialysis therapy is shown in Table 2. There was a clear pattern in which patients initiating on PD were less likely ($P < 0.0001$) to be underweight (BMI <19) than those on HD across all race, gender, and diabetic groups, except for white diabetic females.

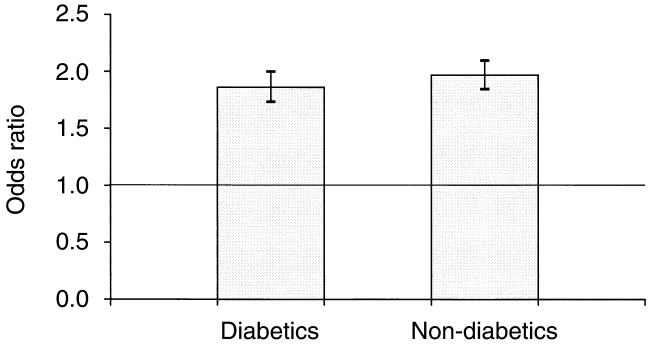

Fig. 1. Odds ratios of whites versus blacks for peritoneal dialysis (PD; black was reference; OR = 1). Whites had a higher likelihood of initiating therapy on PD than blacks in both diabetics and non-diabetics. Lines at the top of bars indicate the range of 95% confidence limits of the odds ratios.

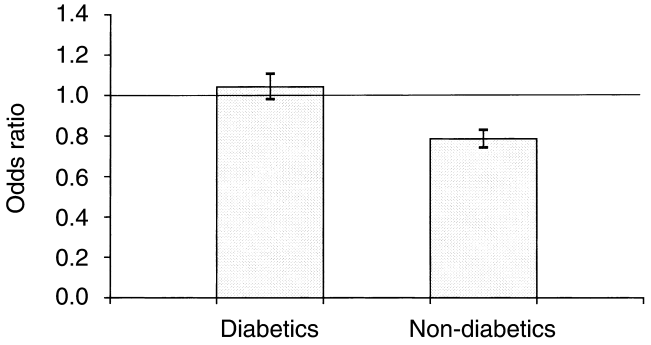

Fig. 2. Odds ratio of males versus females for PD (female was reference; OR = 1.0). In non-diabetics, males had a lower likelihood of initiating on PD than females. Lines at the top of bars indicate the range of 95% confidence limits of the odds ratios.

Table 2. Percentage of body mass index by modality, race, and gender

					Body mass index			
	Race	Gender	Modality	*N* patients	<19	19–25	25–30	30+
Diabetics	White	Male	PD	2,465	3.20	42.23	37.12	17.44
			HD	13,549	4.86	43.70	32.61	18.82
		Female	PD	1,985	4.94	39.04	29.32	26.70
			HD	12,940	4.93	34.16	28.13	32.78
	Black	Male	PD	516	1.74	34.11	38.37	25.78
			HD	5,648	5.67	37.92	32.22	24.19
		Female	PD	697	2.30	31.42	29.56	36.73
			HD	8,463	5.40	29.42	28.61	36.57
Non-diabetics	White	Male	PD	2,709	4.02	45.74	36.14	14.10
			HD	20,028	9.25	51.44	27.60	11.71
		Female	PD	2,208	9.38	45.92	27.31	17.39
			HD	13,352	14.89	45.88	22.34	16.89
	Black	Male	PD	776	5.93	44.20	32.60	17.27
			HD	10,849	10.79	47.70	26.59	14.91
		Female	PD	858	8.51	38.58	23.66	29.25
			HD	8,911	12.91	41.13	23.15	22.81

However, white female PD patients with diabetes had a higher ($P < 0.0001$) proportion of appropriate weight (BMI 19–25) than HD patients. After adjusting for other factors in the logistic regression model, the odds ratios indicated that patients with BMI <19 had a 34.3% (0.657, 0.561–0.769, $P < 0.0001$) and 36.8% (0.632, 0.567–0.704, $P < 0.0001$) lower chance of starting on PD compared with those having BMI 19–25 (BMI 19–25 was reference, OR = 1.0) in diabetics and non-diabetics, respectively (Fig. 3). In diabetics, patients with BMI 30+ had a lower (0.808, 0.748–0.872, $P < 0.0001$) chance and those with BMI 25-30 had a higher (1.079, 1.007–1.156, $P = 0.03$) chance of starting on PD compared with BMI 19–25. In non-diabetics, patients with BMI 25–30 had a higher (1.172, 1.101–1.248, $P < 0.0001$) chance of starting on PD than those with BMI 19–25. No difference was observed between BMI 30+ (0.945, 0.876–1.020, $P = 0.15$) and BMI 19–25.

The average age of patients initiating on PD was approximately six years younger ($P < 0.0001$) than that of HD patients across all race, gender, and diabetic groups (Table 3 and Fig. 4). Compared with diabetic patients aged 75+ (age 75+ was reference, OR = 1.0), diabetics aged 20–44, 45–64, and 65–74 were 457% (5.570, 4.891–6.344, $P < 0.0001$), 229% (3.288, 2.924–3.697, $P < 0.0001$), and 66% (1.659, 1.465–1.880, $P < 0.0001$), respectively, more likely to start on PD. The same pattern was observed in non-diabetics, in whom odds ratios were 3.851 (3.505–4.231, $P < 0.0001$) for patients aged 20–44, 3.017 (2.773–3.283, $P < 0.0001$) for those aged 45–64, and 1.501 (1.368–1.647, $P < 0.0001$) for those aged 65–74.

Patients initiating on PD had higher ($P < 0.0001$) serum concentrations of albumin and hematocrit and lower levels of BUN ($P < 0.0001$) and creatinine ($P < 0.04$) than those on HD across all races, genders, and diabetic groups (Table 3). In general, diabetic PD patients had 0.35 g/dL (10.7%) higher albumins, 1.64% (5.9%) higher hematocrits, 8.75 mg/dL (9.1%) lower

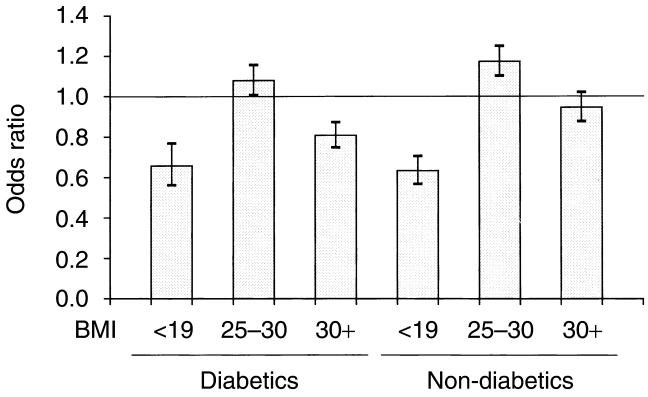

Fig. 3. Odds ratio of body mass index for PD (body mass index, BMI, 19–25 was reference; OR = 1.0). Among diabetics, patients with BMI <19 and 30+ had lower and those with BMI 25–30 had higher likelihoods of initiating on PD than those with BMI 19–25. In non-diabetics, patients with BMI <19 had a lower and those with BMI 25–30 a higher likelihood of initiating on PD compared with those with BMI 19–25. Lines at the top of bars indicate the range of 95% confidence limits of the odds ratios.

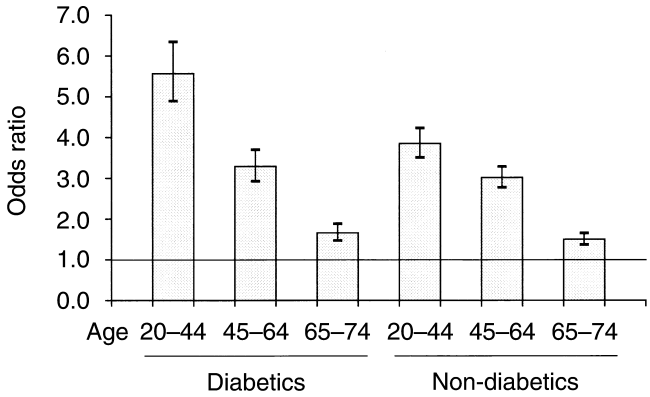

Fig. 4. Odds ratio of age for PD (age group 75+ was reference; OR = 1.0). Patients aged 20–44, 45–64, and 65–74 had higher likelihoods of initiating on PD than those aged 75+. Lines at the top of bars indicate the range of 95% confidence limits of the odds ratios.

Table 3. Average age and serum biochemicals and their standard deviations at initiation of dialysis

					Age *years*		Albumin *g/dL*		Creatinine *mg/dL*		BUN *mg/dL*		Hematocrit *%*	
	Race	Gender	Modality	*N* patient	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Diabetics	White	F	PD	1,985	55.6	13.6	3.30	0.58	6.50	2.27	83.4	27.4	29.8	5.5
			HD	12,940	62.5	12.6	3.06	0.60	6.52	2.36	89.2	30.9	28.3	5.2
		M	PD	2,465	55.3	13.3	3.39	0.58	7.51	2.46	89.5	27.3	30.0	5.5
			HD	13,549	60.7	13.3	3.17	0.61	7.69	2.77	96.2	31.8	28.4	5.3
	Black	F	PD	697	56.4	12.3	3.23	0.60	7.67	2.79	79.1	25.5	28.4	5.4
			HD	8,463	61.6	12.2	3.07	0.61	7.84	2.87	83.3	28.9	27.1	5.2
		M	PD	516	55.2	11.5	3.36	0.58	9.08	3.05	85.2	25.0	29.0	5.6
			HD	5,648	58.9	12.2	3.12	0.63	9.16	3.62	93.5	32.0	27.4	5.5
Non-diabetics	White	F	PD	2,208	56.2	15.9	3.66	0.61	7.75	2.97	83.9	28.4	29.7	5.5
			HD	13,352	64.9	16.0	3.27	0.60	7.84	3.41	92.2	34.2	28.0	5.5
		M	PD	2,709	58.8	15.9	3.69	0.62	9.01	3.42	93.0	29.8	29.8	5.8
			HD	20,028	64.5	16.0	3.35	0.65	9.07	3.80	100.0	35.0	28.5	5.7
	Black	F	PD	858	48.6	14.8	3.46	0.69	8.74	3.93	80.8	27.4	27.6	5.7
			HD	8,911	56.9	17.3	3.20	0.71	9.81	4.38	89.7	33.1	26.3	5.7
		M	PD	776	46.9	14.8	3.44	0.80	11.73	4.91	89.6	30.5	28.6	5.9
			HD	10,849	52.9	16.1	3.19	0.75	12.13	5.45	101.7	36.2	26.9	5.9

BUNs and 0.51 mg/dL (5.7%) lower creatinines compared with diabetic HD patients. Non-diabetic PD patients had 0.23 g/dL (7.4%) higher albumins, 1.71% (6.1%) higher hematocrits, 5.24 mg/dL (5.8%) lower BUN values, and 0.23 mg/dL (3.0%) lower creatinine values compared with non-diabetic HD patients.

Odds ratios from the logistic regression indicated that each 1 g/dL increase in serum albumin was associated with a 100.7% (2.007, 1.910–2.110, $P < 0.0001$) and 104.4% (2.044, 1.958–2.134, $P < 0.0001$) increase in the odds of the initiation on PD in diabetics and non-diabetics, respectively (Fig. 5). Each 1% increase in hematocrit was associated with a 4.8% (1.048, 1.042–1.054, $P < 0.0001$) and 3.0% (1.030, 1.025–1.035, $P < 0.0001$) increase, each 1 mg/dL increase in BUN was associated with a 0.6% (0.994, 0.993–0.995, $P < 0.0001$) and 0.7% (0.993, 0.992–0.994, $P < 0.0001$) decrease, and each 1 mg/dL increase in creatinine was associated with a 1.4% (0.986, 0.974–0.998, $P = 0.02$) and 2.2% (0.978, 0.970–0.987, $P < 0.0001$) decrease in the odds of the initiation on PD in diabetics and non-diabetics, respectively.

DISCUSSION

This study clearly demonstrates the unequally distributed clinical conditions of patients at initiation between the two dialysis therapies. Compared with HD patients, both diabetic and non-diabetic PD patients had a higher likelihood of being white and younger, a lower likelihood

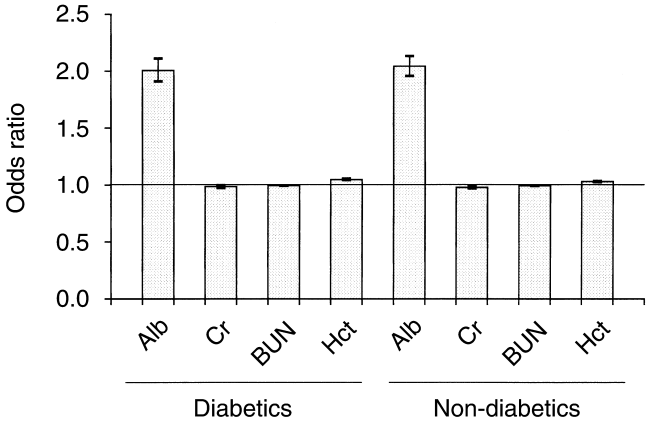

Fig. 5. Odds ratio of albumin, creatinine, blood urea nitrogen (BUN), and hematocrit levels (as continuous variables) for PD. An increase in albumin and hematocrit was associated with an increase in the likelihood of initiation on PD, while an increase in BUN and creatinine was associated with a decrease in the likelihood of initiation on PD. Lines at the top of bars indicate the range of 95% confidence limits of the odds ratios.

of being underweight, and had higher serum albumin and hematocrit values, and lower BUN and creatinine levels.

Serum albumin concentrations reflect nutritional status as well as clinical disease, chronic inflammatory conditions, and disease severity at the initiation of dialysis. A change in serum albumin concentrations is a slow process [23]. When protein and caloric malnutrition exists, catabolism of body protein accelerates. Muscle breakdown occurs to maintain the amino acid supply for the synthesis of visceral protein such as albumin. When malnutrition continues, the concentrations of serum proteins, including albumin, fall [24]. Previous studies have demonstrated that the serum concentration of albumin is one of the strongest predictors of mortality outcomes in both PD and HD patients, and that a high serum albumin is associated with a low risk of mortality [20, 25–28]. In addition, more recent data have shown that a low serum albumin value may reflect a response to chronic inflammation [29]. PD patients with the higher initial serum concentration of albumin demonstrated in this study therefore would be expected to have a lower risk of mortality compared with HD patients.

Weight loss, particularly loss of muscle mass, is a consequence of long-term protein malnutrition. It is well known that obesity is associated with a high death rate in the general population because excess body fat is associated with cardiovascular disease, cancers, and other medical conditions [30]. However, excess body weight in certain age groups may not necessarily be associated with high mortality [31, 32]. Underweight also is associated with high mortality in the general population [33]. Underweight dialysis patients are more likely to fall ill and recover more slowly from illness than patients who have appropriate weight or who are overweight [34]. Underweight was observed as a risk factor for first-year mortality of dialysis patients, but overweight (BMI >27.5) was not [34]. Since both diabetic and non-diabetic PD patients in this study were less likely to be underweight, they would be expected to have a lower risk of mortality than HD patients.

Serum creatinine levels at the initiation of dialysis may reflect the stage of referral to a nephrologist for uremia treatment. A number of studies have reported that patients with late referral to nephrologists had higher serum concentrations of creatinine and BUN compared with those referred early [35, 36]. Serum creatinine or estimated creatinine clearance may not be a reliable marker of residual renal function at the initiation of dialysis. A trend of lower serum creatinine levels at the initiation of dialysis has been reported in the United States between 1963 and 1996, from 14.5 mg/dL during 1963–1977 to 8.5 mg/dL during 1995–1996 [37], suggesting that patients with renal disease have started dialysis earlier in recent years. We also observed decreased serum creatinine levels in the study period. The relationship between creatinine and BUN levels and the severity of renal disease could not be determined in this retrospective study because many factors such as nutrition, metabolism rate of muscle mass, and secretion of creatinine by renal tubules could affect concentrations of serum creatinine and BUN [38, 39]. High serum creatinine and BUN levels, for instance, can be related to a high protein or creatine diet or to high lean body mass.

Biochemical and body mass index data have not been included in many previous studies comparing mortality outcomes between PD and HD. Most studies include race, age, gender, and diabetic status, and report that whites and younger patients are more likely to initiate on PD than patients who are blacks or older. Many studies, in addition, have demonstrated that blacks have a lower mortality than whites and young patients have lower mortality than older ones in both PD and HD therapies [19, 40–42]. The number of blacks and younger patients starting on PD may, therefore, affect the comparison of mortality outcomes between the modalities.

Our consistent finding that non-diabetics had higher levels of albumin, creatinine, and BUN at initiation than diabetics has been reported previously [19, 20], and suggests that diabetic and non-diabetic ESRD patients are clinically different at initiation.

This study did not include co-morbid conditions recorded on the Medical Evidence Form because we found that they did not closely match those recorded in the HCFA Medicare claims [abstract; Xue, *Perit Dial Int* 21 (Suppl 1):S84, 2001]. The same findings were reported from the CHOICE Study using medical records [43].

In summary, we observed clear unequally distributed clinical conditions of patients at initiation with regard to

dialysis therapies. Patients on PD had more favorable clinical conditions at initiation than those on HD. It is reasonable, therefore, to expect that mortality outcomes in PD patients would be better, at least initially, than those in HD patients, even if the two therapies were exactly the same. These factors should be carefully evaluated when comparing the mortality and morbidity of PD and HD patients.

ACKNOWLEDGMENTS

This project has been funded in whole or in part with federal funds from the National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, under Contract No. N01-DK-9-2343. The authors wish to thank Mr. Tom Arnold, Mr. Mike Hadad, and Mr. Roger Milam from the Health Care Financing Administration for their assistance with the HCFA data. We also thank Ms. Beth Forrest for her help in manuscript preparation and regulatory assistance. Dataset construction was provided by Roger Johnson and C. Daniel Sheets.

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