Original Article

Health status and quality of life reported by incident patients after 1 year on haemodialysis or peritoneal dialysis

Nancy G. Kutner[1], Rebecca Zhang[1], Huiman Barnhart[1] and Allan J. Collins[2]

[1]United States Renal Data System (USRDS), Rehabilitation/Quality of Life Special Studies Center, Emory University, Atlanta, GA and [2]United States Renal Data System (USRDS), Coordinating Center, Minneapolis, MN, USA

Abstract

Background. It has been suggested that there are no large differences in the quality of life of incident patients starting on haemodialysis (HD) and peritoneal dialysis (PD), but few studies have addressed this issue.
Methods. Association of modality with incident patients' health status and quality of life scores was investigated with propensity score (PS) analysis and also with traditional multivariable regression analyses. We compared patient reported health status and quality of life scores after 1 year of therapy in 455 HD and 413 PD patients who participated in a national study, stayed on the same modality and had complete socio-demographic and clinical information needed to create a PS indicating their expected probability of starting on PD.
Results. One year scores on the majority of health status and quality of life measures were not significantly different for HD and PD patients within propensity-matched quintiles. PD patients' scores were higher than HD patients' scores on effects of kidney disease, burden of kidney disease, staff encouragement and satisfaction with care in some quintiles, and traditional regression analyses confirmed that dialysis modality was associated with patients' scores on these variables.
Conclusions. This study provides support for making the choice of PD more widely available as an option to patients initiating chronic dialysis therapy. Patient lifestyle opportunities associated with use of PD, a home-based and self-care therapy, may also apply to home-based HD or in-centre self-care HD. Patients' expectations regarding treatment and their attitudes toward management of their health may interact with treatment modality to shape patient-reported experience on dialysis; this is an important focus for future studies.

Keywords: haemodialysis; health status; peritoneal dialysis; propensity score analysis; quality of life

Introduction

Renal patients' assessments of their health status and quality of life, including satisfaction with care, are critical markers of the value of delivered care. An important question for many years has been whether these assessments vary systematically among patients using different types of renal replacement therapy (RRT). In an early cross-sectional study of prevalent patients in the USA, Evans *et al.* concluded that transplant patients had a higher quality of life than patients on any form of dialysis, with home haemo-dialysis (HD) patients most resembling transplant recipients, and in-centre HD patients and continuous ambulatory peritoneal dialysis (CAPD) patients report-ing similar quality of life. The importance of controlling for differences in patient case mix when comparing patients on different treatment modalities was strongly emphasized by the authors [1].

A prominent topic in the recent literature is the rationale for wider availability of PD as a treatment option for patients beginning chronic dialysis therapy [2–7]. It is argued that the majority of incident patients have no contraindication to either HD or PD [5], that the risk of death is generally lower for PD during the first year or two of dialysis [7] and that costs are lower with PD compared with HD [3,6]. It is also suggested that no large differences in quality of life have been found between patients starting with HD or PD therapy [5], but few studies of incident patients have addressed this issue.

In a randomized trial of 38 patients starting HD and PD in 1997–2000, Korevaar *et al.* in The Netherlands found a small difference in patients' quality-adjusted life year (QALY) scores in the first 2 years of dialysis,

Correspondence and offprint requests to: Nancy G. Kutner, PhD, Director, USRDS Rehabilitation/QoL Special Studies Center, Emory University, CRM-1441 Clifton Rd. NE, Atlanta, GA 30322, USA. Email: nkutner@emory.edu

and this difference favoured HD over PD [8]. The Choices for Healthy Outcomes in Caring for End-stage Renal Disease (CHOICE) study of incident patients in the USA during 1995–1998 concluded that at 1 year patients on HD and PD generally reported similar health status but that patients on the two modalities had different assessments of several dimensions of disease-specific quality of life. Patients on HD scored higher on sexual functioning than did patients on PD, but patients on PD reported better quality of life than patients on HD as measured by perceived ability to travel, financial concerns, restrictions in eating and drinking, and dialysis access problems [9].

It is imperative to consider carefully differences among patients when treatment outcomes are analysed. It is difficult for case mix adjustments to account adequately for these differences in analyses that compare patient outcomes in relation to use of HD and use of PD because patients are differentially selected to RRT [10]. The ideal study design is a randomized clinical trial. Korevaar *et al.* attempted the only clinical trial in which patients were randomly assigned to HD and PD, but they were not able to recruit enough patients for an adequately powered study, and noted that after extensive patient education, many patients are likely to develop a preference for a particular modality, making random assignment difficult [8]. Observational studies therefore remain the primary source of information about patient outcomes associated with treatment by HD *vs* treatment by PD.

Here we report an analysis of health status and quality of life reported by patients after 1 year of HD or PD treatment. Our data source was a large cohort of incident patients who participated in the Dialysis Morbidity and Mortality Study (DMMS) Wave 2 conducted in 1996–1998 in the USA [11]. We used both propensity score (PS) analysis and traditional regression analyses to examine the data. PS analysis identifies patients who are similar on measured confounders who then can be compared on the outcomes of interest. Patients are given a score that represents their expected probability of receiving one treatment over another. This score can be estimated from a logistic regression model of the actual treatment received that is fit to the data. Outcomes can then be compared among patients who have been classified into strata (quintiles) based on their similar propensity to receive a particular treatment [12].

We also used multivariable regression analyses to investigate the association of HD and PD with patients' 1 year health status and quality of life scores, adjusting for patients' socio-demographic and clinical characteristics (the measured confounders) as well as for the health status/quality of life scores that patients reported at treatment start. Findings with the two analysis approaches were expected to be consistent, as discussed in a recent commentary on the value of PS analysis [12]. An advantage of PS analysis is that it allows a visual comparison of HD and PD patient scores displayed within quintiles, where quintiles contain patients determined to be similar on a series of measured covariates.

Like the CHOICE study, PD patients were over-sampled in the DMMS Wave 2, and data were collected in the same time period (1996–1998). While the CHOICE study enrolled patients from 81 non-randomly selected dialysis centres, however, the DMMS Wave 2 enrolled patients from 799 clinics that were a 25% random sample of US centres at the time of the study [11]. We chose to focus on patients who were on HD or PD from treatment start to the end of the first year of treatment, when patients had 'had a chance to experience some of the complications of their chosen modality' [2]. Overviews of DMMS Wave 2 patient scores at treatment start have been reported [11,13], but there has been no previous analysis of the 1 year health status/quality of life data from the DMMS Wave 2. Patient scores should not be generalized to incident patients currently, given practice changes in delivery of both HD and PD, but the DMMS Wave 2 is a valuable source of data because it is the largest study of a national sample of patients initiating HD and PD in the USA.

Methods

Study design and sample

Dialysis centres included in the DMMS Wave 2 were a random selection of 25% of US centres on the Master List of Medicare Approved Dialysis Facilities as of December 31, 1993; all new dialysis centres opening after January 1, 1994 were also included. Incident patients (Medicare and non-Medicare) were defined by receipt of any type of PD or receipt of in-centre HD at least once weekly for the first time in 1996–1997. Patients were excluded if they were receiving intermittent dialysis treatment because of fluid overload or heart failure, if they were on home HD, if they had a previous transplant or if they were <18 years of age. Patients treated by or training for PD on day 60 of end-stage renal disease (ESRD) and patients treated by in-centre HD on day 60 of ESRD were recruited. All eligible incident PD patients were included, while 20% of all corresponding HD patients were included by selecting only those with social security numbers ending with 2 or 9. All enrolled patients provided written informed consent [11].

There were 3606 DMMS Wave 2 patients for whom modality information was available at baseline: 1820 patients who started on HD and 1786 patients who started on PD. Among patients who started on HD, at 1 year 64.8% were on HD, 2.0% were on PD, 2.5% had received a transplant, 13.6% were deceased and 17.1% were lost to follow-up. Among patients who started on PD, at 1 year 59.2% were on PD, 8.8% were on HD, 5.9% had received a transplant, 11.5% were deceased and 14.6% were lost to follow-up.

We used DMMS Wave 2 data with updated patient characteristics available on the 2001 USRDS Core Standard Analysis File. Our study includes 455 HD patients and 413 PD patients who provided information about their perceived health status and quality of life as requested in the patient questionnaire at baseline (60 days) and again after

1 year on dialysis and who had complete socio-demographic and clinical information for variables used to create a PS. These patients were similar with respect to modality, age, gender, diabetic ESRD and baseline cardiovascular co-morbidity to patients who did not answer the patient questionnaire or had missing socio-demographic and clinical information, but they were less likely to be black.

Measures and data collection

DMMS Wave 2 data collection instruments are available in the Researcher's Guide to the USRDS Database at www.usrds.org/research.htm. Dialysis centre personnel supplied demographic and medical history information for each patient, abstracting data from the patient's medical record. A questionnaire distributed to enrolled patients at baseline (day 60 after treatment start) and at 1 year asked about employment status and included scales from the Kidney Disease Quality of Life-Short Form (KDQOL-SF) instrument (http://www.gim.med.ucla.edu/kdqol/); the baseline questionnaire also asked about medical care received prior to chronic dialysis. The protocol specified that patients should self-complete the questionnaire at the dialysis centre whenever possible, but patients unable to complete the questionnaire because of their level of education or because of a physical disability such as impaired vision could receive assistance from a dialysis centre staff member or a family member.

Socio-demographic variables (age, gender, race, education, marital status and household status), dialysis start date, diabetes as primary cause of ESRD, cardiovascular co-morbidity and laboratory data were identified from information in the DMMS Wave 2 medical questionnaire completed by dialysis centre personnel. Cardiovascular co-morbidity included one or more of the following conditions documented from chart review: coronary heart disease/coronary artery disease, acute myocardial infarction, cardiac arrest, cerebrovascular accident/stroke, peripheral vascular disease or congestive heart failure. Serum creatinine values were reported for the day of the patient's first regular dialysis or the closest day prior to that date. Serum bicarbonate values were obtained from information closest to study start date, i.e. 60 days past the start of regular dialysis, 'from a period of up to 3 months before study start date' (www.usrds.org/research.htm). Early referral for pre-ESRD care by a nephrologist was defined in our study as 4 months or more before dialysis treatment start, consistent with prior research [14].

Reliability and validity have been demonstrated for the KDQOL-SF [15]. The KDQOL-SF includes generic measures of health status (the RAND 36-item health survey) and multiple disease-specific quality of life scales. The instrument also includes two scales that focus on the patient's assessment of dialysis care. Each scale is scored 0–100, with a higher score indicating a better rating. The program used to calculate the scores is available at http://www.gim.med.ucla.edu/kdqol/.

All eight generic health status measures (Physical functioning, Role limitation physical, Pain, General health perceptions, Emotional well-being, Role limitation emotional, Social functioning and Vitality) had adequate internal consistency reliability estimates (≥ 0.7) in the DMMS Wave 2 data, as did seven disease-specific quality of life scales

(Symptoms/problems, Effects of kidney disease on daily life, Burden of kidney disease, Social support satisfaction, Cognitive function, Sleep and Sexual function) and the two dialysis care scales (Staff encouragement and Patient satisfaction). The effects of kidney disease, social support satisfaction, sleep, sexual function, staff encouragement and patient satisfaction scales used in the DMMS Wave 2 contained minor modifications in wording (see http://www.usrds.org/research.htm).

Data analysis

Socio-demographic and clinical characteristics of patients starting on HD and patients starting on PD were compared by t-test for continuous variables and by χ^2 test for categorical variables.

A PS representing the probability of receiving PD over HD at treatment start was estimated for each patient. Patient characteristics previously shown [14] to predict dialysis modality selection in the DMMS Wave 2 (listed in Table 1) were used to build the PS model. Logistic regression with backwards elimination was used to estimate the PS with baseline treatment modality (HD or PD) as the outcome. The c statistic of the PS model indicated good prediction

Table 1. Baseline characteristics of patients at the start of HD or PD

Patient characteristic	HD patients ($n = 455$)	PD patients ($n = 413$)	P-value
Age at enrolment, mean $\pm$ SD years	61.2 $\pm$ 15.6	56.1 $\pm$ 14.7	<0.0001
18–54	31.2	44.6	<0.0001
≥ 55	68.8	55.5	
Male, %	56.7	52.8	0.25
Black, %	29.9	19.9	0.0007
Educational status, %			<0.0001
< High school	40.2	22.8	
$\geq$ High school	59.8	77.2	
Employment status, %			<0.0001
Working full or part time	7.7	21.8	
Other (unemployed, retired, school, etc.)	92.3	78.2	
Marital status, %			0.0002
Single	14.5	12.8	
Married	53.4	65.6	
Widowed	16.9	10.4	
Divorced	9.9	9.7	
Separated	5.3	1.5	
Living alone, %			0.003
Yes	18.2	16.0	
No	78.0	83.5	
Nursing home	3.7	0.5	
Months on dialysis, mean $\pm$ SD	2.2 $\pm$ 0.9	2.2 $\pm$ 0.8	0.69
Pre-ESRD care, %			<0.0001
Early (referral ≥ 4 months pre-ESRD)	60.9	73.4	
Late or never	39.1	26.6	
Diabetic ESRD, %	44.4	44.3	0.98
Cardiovascular co-morbidity, %	63.3	54.7	0.01
Hypertension, %	29.7	24.7	0.10
Ever smoked, %	47.0	44.3	0.42
Haemoglobin, mean $\pm$ SD	8.4 $\pm$ 3.7	9.6 $\pm$ 4.7	<0.0001
Serum creatinine, mean $\pm$ SD	2.9 $\pm$ 4.8	3.9 $\pm$ 6.4	0.01
Serum albumin, mean $\pm$ SD	3.3 $\pm$ 0.6	3.5 $\pm$ 0.6	<0.0001
Serum bicarbonate, mean $\pm$ SD	21.0 $\pm$ 6.4	23.8 $\pm$ 7.3	<0.0001

of dialysis modality ($c = 0.74$) [16]. Patients were classified into quintiles defined by PS (quintile I = most likely to receive PD to quintile V = least likely to receive PD). Health status, quality of life and dialysis care scores reported at baseline and at 1 year by HD and PD patients were compared within quintiles, using *t*-tests (baseline analyses) and regression analyses with adjustment for patients' baseline scores (1 year analyses).

Traditional multivariable regression analyses, including the same patient characteristics used to build the PS model, were also used to investigate the association of patients' dialysis modality with their baseline and 1 year scores on each of the dependent health status and quality of life variables. In the analyses of the 1 year data, patients' baseline scores were included as covariates in the regression models.

Analyses were performed using SAS version 8e (SAS Institute, Cary, NC).

Results

Dialysis modality and patient characteristics

Patients in our study who started on PD, compared with patients who started on HD, were younger; more likely to be non-black; more likely to have completed high school; more likely to be employed; more likely to be married; less likely to be living alone or in a nursing home; more likely to have been referred to a nephrologist at least 4 months before starting ESRD treatment; and less likely to have cardiovascular co-morbidity at treatment start. Patients who started on PD had higher average values for laboratory measures of serum creatinine, serum albumin, haemoglobin and serum bicarbonate. The PD and HD groups did not differ in gender composition, percentage of patients for whom diabetes was the primary cause of kidney failure, prevalence of hypertension, smoking status or months since initiation of dialysis (Table 1).

After patients were classified into propensity-matched quintiles, there were no significant differences in characteristics of PD and HD patients within quintiles, with the exception of marital status in quintile III (PD patients less likely to be widowed compared with HD patients), vintage in quintile IV (PD patients had a longer time since initiation of dialysis compared with HD patients) and average serum bicarbonate in quintile II (PD patients had a higher average value compared with HD patients) (Table 2).

Dialysis modality and health status/quality of life scores

Scores of HD and PD patients at baseline and at 1 year did not differ significantly for the majority of health status and quality of life variables compared within PS quintiles (Tables 3 and 4). At baseline, significant differences between HD and PD patients in selected quintiles were evident for bodily pain, emotional well-being, social functioning, effects of kidney disease on daily life, burden of kidney disease, cognitive function, staff encouragement and satisfaction with care scales,

with PD patients in each case scoring higher than HD patients. At 1 year, significant differences between HD and PD patients in selected quintiles were evident for effects of kidney disease on daily life, burden of kidney disease, staff encouragement and satisfaction with care scales; again, PD patients evaluated their quality of life more favourably than HD patients.

Traditional regression models indicated that dialysis modality was a significant predictor at baseline of scores for role limitation physical, bodily pain, emotional well-being, role limitation emotional, social functioning, symptoms/problems, effects of kidney disease on daily life, burden of kidney disease, social support satisfaction, staff encouragement and satisfaction with care scales, with patients on PD scoring higher than patients on HD. After 1 year on HD or PD, dialysis modality was a significant predictor of scores for effects of kidney disease on daily life, burden of kidney disease, staff encouragement and satisfaction with care scales, with patients on PD scoring higher than patients on HD (Table 5). As was true in the PS analyses, for most of the measures, the regression analyses showed no differences in HD and PD patients' scores at 1 year.

Discussion

Our findings using PS analysis and traditional regression analysis were consistent in showing that (i) after 1 year of dialysis treatment, scores of patients on HD and patients on PD did not differ for the majority of health status and quality of life domains that were investigated; and (ii) after 1 year of dialysis treatment, incident patients on PD reported more favourable evaluations of selected quality of life domains than did patients on HD. At their baseline assessment, which was obtained ~2 months after patients began regular dialysis, PD patients reported more favourable evaluations of several health status as well as quality of life domains compared with the evaluations reported by HD patients. Our adjustment for baseline differences in the analyses of the 1 year data could have reduced differences between scores of patients on PD and HD at 1 year, although when the 1 year regression analyses were repeated without including adjustment for patients' baseline scores, the results were very similar. Because baseline data in the DMMS Wave 2 were obtained at ~2 months after treatment start, the baseline data may be viewed as representing response to therapy. The DMMS Wave 2 investigators identified day 60 as the study start date (i.e. baseline date) because most patients stabilize on one modality by that date, but they noted that a patient might still be changing back and forth between HD and PD up to that date (www.usrds.org/research.htm).

Approximately one-third of patients who started on HD and of patients who started on PD were not included in our analyses because of transplantation, death, modality change or loss to follow-up at 1 year. It is important to consider whether there were

Table 2. Baseline characteristics of patients on HD and PD grouped in quintiles by PS

Patient characteristic	Quintile I		Quintile II		Quintile III		Quintile IV		Quintile V	
	HD (n=32)	PD (n=141)	HD (n=73)	PD (n=101)	HD (n=100)	PD (n=74)	HD (n=114)	PD (n=60)	HD (n=136)	PD (n=37)
Age, mean±SD	50.4±18.0	49.8±12.8	58.9±16.2	58.1±14.9	63.4±15.4	60.5±14.3	60.8±15.8	57.1±14.8	63.8±13.4	63.8±13.6
18–54	72	70	42	39	26	28	32	32	19	19
≥55	28	31	58	61	74	72	68	68	81	81
Male, %	50	45	55	51	55	61	60	55	58	65
Black, %	13	13	14	16	19	16	31	32	50	46
Educational status, %										
<High school	9	6	14	12	26	31	45	42	68	68
≥High school	91	94	86	88	74	69	55	58	32	32
Employment status, %										
Working full/part time	44	51	15	12	5	5	4	3	0	0
Other	56	49	85	88	95	95	96	97	100	100
Marital status										
Single	13	18	16	8	8	11*	18	12	15	11
Married	53	66	58	66	59	70	54	63	47	57
Widowed	6	4	12	17	22	8	14	10	21	22
Divorced	25	11	10	8	6	11	11	12	8	3
Separated	3	0	4	1	5	0	3	3	9	8
Living alone, %										
Yes	22	12	19	8	16	19	15	20	21	27
No	78	88	78	92	80	80	80	80	75	70
Nursing home	0	0	3	0	4	1	5	0	4	3
Months on dialysis, mean±SD	2.2±0.5	2.1±0.3	2.1±0.3	2.2±1.4	2.2±1.2	2.0±0.4	2.0±0.4	2.3±0.8*	2.3±1.2	2.3±0.5
Pre-ESRD care, %										
Early referral	75	86	84	80	66	70	61	57	41	41
Late or never	25	14	16	20	34	30	39	43	59	59
Diabetic ESRD, %	44	39	53	47	41	45	41	53	45	43
Cardiovascular co-morbidity, %	56	45	53	57	66	59	62	63	69	62
Hypertension, %	22	18	22	28	33	23	27	28	35	41
Ever smoked, %	28	38	41	47	48	47	50	48	51	49
Haemoglobin, mean±SD	11.2±3.7	11.0±6.8	9.0±4.2	9.7±2.7	9.6±2.7	8.9±2.6	8.3±3.2	9.0±2.7	6.8±3.6	6.8±4.0
Serum creatinine, mean±SD	4.1±5.0	4.4±8.5	2.5±5.7	3.1±4.7	3.1±4.7	4.3±5.0	2.8±4.5	4.1±5.6	2.8±4.4	2.6±4.2
Serum albumin, mean±SD	3.6±0.5	3.7±0.6	3.6±0.5	3.1±0.6	3.4±0.7	3.4±0.5	3.2±0.6	3.2±0.6	3.0±0.7	3.1±0.6
Serum bicarbonate, mean±SD	29.5±16.6	27.0±9.4	22.4±3.0	24.5±4.0*	21.9±4.0	22.6±4.8	20.4±3.4	20.1±4.8	18.1±4.6	18.7±6.1

*$P < 0.05$.

Table 3. Mean (SE) health status, quality of life and dialysis care scores of HD and PD patients at baseline within PS quintiles

	Quintile I		Quintile II		Quintile III		Quintile IV		Quintile V	
	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD
Health status										
Physical functioning	45.9 (5.1)	56.8 (2.5)	43.8 (3.4)	45.3 (2.8)	38.0 (2.7)	44.2 (3.1)	40.1 (2.7)	45.7 (3.9)	36.8 (2.4)	32.7 (4.5)
Role limitation physical	18.5 (7.0)	31.7 (3.3)	20.8 (4.4)	31.7 (3.8)	14.5 (3.0)	23.6 (3.6)	22.8 (3.1)	18.1 (4.4)	17.2 (2.7)	20.3 (5.1)
Bodily pain	58.5 (4.8)	63.3 (2.3)	62.6 (3.1)	62.5 (2.6)	58.8 (2.8)	67.5 (3.2)*	55.3 (2.8)	62.0 (3.9)	52.5 (2.5)	61.8 (4.7)
General health	38.9 (3.7)	46.3 (1.8)	38.0 (2.3)	41.7 (2.0)	40.0 (2.1)	43.1 (2.5)	38.8 (1.9)	36.8 (2.6)	36.3 (1.6)	37.9 (3.0)
Emotional well-being	65.8 (3.2)	72.9 (1.5)*	66.2 (2.4)	69.4 (2.0)	64.6 (2.1)	70.3 (2.4)	63.0 (2.0)	70.5 (2.8)*	66.0 (1.8)	65.7 (3.5)
Role limitation emotional	54.2 (7.5)	66.8 (3.6)	51.4 (5.3)	61.9 (4.5)	42.0 (4.5)	46.9 (5.2)	41.1 (4.1)	51.7 (5.7)	46.5 (3.9)	45.5 (7.4)
Social functioning	49.6 (4.6)	63.8 (2.2)*	56.2 (3.4)	60.3 (2.9)	57.3 (2.9)	56.6 (3.4)	52.1 (2.6)	57.9 (3.6)	55.6 (2.4)	55.7 (4.6)
Vitality	38.6 (4.2)	45.8 (2.0)	41.9 (2.8)	43.5 (2.3)	38.6 (2.3)	42.0 (2.6)	42.0 (2.1)	44.4 (2.9)	39.5 (1.8)	40.6 (3.4)
Quality of life										
Symptom/problems	70.7 (2.6)	72.9 (1.3)	70.1 (1.9)	74.3 (1.6)	71.4 (1.5)	74.2 (1.8)	70.5 (1.6)	72.5 (2.2)	70.8 (1.3)	73.6 (2.5)
Effects on daily life	58.3 (3.3)	69.0 (1.6)*	57.2 (2.5)	70.8 (2.1)*	56.9 (2.2)	68.0 (2.6)*	56.4 (2.2)	67.5 (3.0)*	60.2 (1.8)	67.3 (3.4)
Burden of kidney disease	41.4 (5.0)	51.8 (2.4)	41.6 (3.5)	52.6 (2.9)*	38.5 (2.8)	46.3 (3.3)	39.7 (2.6)	42.8 (3.6)	41.5 (2.3)	47.8 (4.4)
Social support	68.4 (4.1)	76.3 (2.0)	70.7 (2.8)	73.9 (2.4)	67.9 (2.4)	75.3 (2.7)*	66.3 (2.3)	76.5 (3.2)*	65.9 (2.3)	70.3 (4.5)
Cognitive function	72.3 (3.3)	81.1 (1.5)*	77.0 (2.4)	83.5 (2.0)*	77.6 (2.2)	75.6 (2.6)	74.9 (2.1)	76.9 (2.8)	74.7 (1.9)	76.9 (3.6)
Sleep	50.3 (4.4)	59.4 (2.1)	61.0 (2.8)	63.0 (2.4)	58.6 (2.5)	64.6 (3.0)	59.3 (2.4)	60.7 (3.4)	59.7 (2.3)	65.7 (4.4)
Sexual function	62.5 (6.5)	55.4 (3.1)	51.5 (4.7)	58.3 (3.9)	58.8 (4.2)	54.7 (4.6)	55.2 (3.9)	57.2 (5.4)	59.5 (3.5)	52.3 (6.6)
Dialysis care										
Staff encouragement	79.7 (2.4)	94.8 (1.2)*	81.1 (2.0)	92.6 (1.7)*	79.4 (2.0)	93.1 (2.3)*	80.5 (1.6)	92.9 (2.4)*	82.1 (1.5)	91.9 (2.8)*
Satisfaction	79.7 (2.5)	91.5 (1.2)*	78.3 (2.2)	87.3 (1.9)*	75.0 (1.9)	88.1 (2.3)*	78.0 (1.6)	87.2 (2.3)*	75.6 (1.8)	83.8 (3.3)*

*$P < 0.05$.

Table 4. Adjusted mean (SE) health status, quality of life and dialysis care scores of HD and PD patients at 1 year within PS quintiles

	Quintile I		Quintile II		Quintile III		Quintile IV		Quintile V	
	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD
Health status										
Physical functioning	55.0 (3.8)	53.4 (2.0)	44.8 (2.8)	41.7 (2.4)	43.9 (2.7)	37.3 (3.2)	40.35 (2.9)	33.24 (4.1)	39.1 (2.8)	41.0 (5.4)
Role limitations physical	44.5 (6.6)	36.8 (3.4)	33.4 (4.7)	27.9 (4.0)	27.3 (4.3)	24.6 (5.3)	27.9 (3.9)	22.3 (5.5)	27.0 (3.6)	21.0 (7.0)
Bodily pain	61.8 (4.3)	64.6 (2.2)	57.8 (3.2)	62.0 (2.8)	58.1 (3.0)	66.4 (3.7)	56.4 (2.9)	54.2 (4.1)	58.3 (2.6)	61.9 (5.0)
General health	43.7 (2.8)	42.1 (1.4)	43.3 (2.4)	40.9 (2.1)	40.0 (1.9)	43.4 (2.3)	38.5 (1.9)	38.8 (2.7)	42.2 (1.9)	42.7 (3.7)
Emotional well-being	72.6 (2.3)	70.8 (1.2)	70.4 (2.0)	68.9 (1.7)	68.8 (2.0)	68.4 (2.4)	65.4 (1.9)	66.3 (2.7)	64.8 (1.8)	67.7 (3.5)
Role limitation emotional	67.8 (6.4)	60.3 (3.4)	66.0 (5.3)	65.6 (4.4)	52.7 (5.5)	47.5 (6.5)	51.7 (4.9)	46.1 (6.9)	54.9 (4.4)	48.3 (8.4)
Social functioning	69.5 (4.0)	65.5 (2.1)	65.4 (3.0)	61.6 (2.6)	61.5 (3.0)	56.2 (3.6)	59.0 (2.8)	54.5 (4.0)	61.4 (2.7)	60.0 (5.1)
Vitality	46.8 (3.3)	42.7 (1.7)	45.2 (2.5)	42.4 (2.2)	42.0 (2.2)	41.7 (2.6)	43.2 (2.0)	38.8 (2.8)	42.5 (2.0)	36.8 (3.9)
Quality of life										
Symptoms/problems	74.7 (2.5)	71.7 (1.3)	74.1 (1.6)	73.4 (1.4)	71.4 (1.6)	72.4 (1.9)	72.6 (1.4)	68.4 (2.1)	69.6 (1.6)	72.6 (3.1)
Effects on daily life	63.5 (2.8)	66.9 (1.4)	62.4 (2.3)	68.2 (1.9)	62.5 (1.9)	65.3 (2.4)	60.5 (2.1)	62.2 (3.1)	57.9 (2.0)	68.4 (3.9)*
Burden of kidney disease	47.5 (4.4)	49.9 (2.2)	42.7 (3.4)	52.0 (2.9)*	40.5 (2.7)	42.3 (3.2)	42.5 (2.6)	41.1 (3.7)	42.0 (2.2)	46.3 (4.4)
Social support	72.4 (3.4)	73.8 (1.8)	68.1 (2.8)	72.2 (2.4)	67.7 (2.6)	72.0 (3.3)	69.4 (2.2)	68.2 (3.1)	65.5 (2.4)	66.1 (4.5)
Cognitive function	80.9 (3.3)	80.1 (1.6)	77.8 (2.4)	81.4 (2.0)	78.7 (2.2)	77.9 (2.6)	77.6 (2.0)	74.9 (3.2)	76.7 (2.0)	78.7 (4.0)
Sleep	51.1 (3.8)	53.2 (2.0)	55.4 (3.4)	56.5 (2.9)	57.4 (2.3)	56.3 (2.8)	54.4 (2.6)	54.7 (3.6)	57.1 (2.1)	60.9 (4.1)
Sexual function	58.6 (5.7)	54.9 (2.9)	55.1 (4.7)	49.5 (3.8)	52.1 (4.3)	53.4 (4.8)	51.3 (4.3)	55.9 (6.1)	52.7 (4.1)	62.5 (7.5)
Dialysis care										
Staff encouragement	83.0 (2.8)	91.9 (1.4)*	81.2 (2.2)	91.0 (1.9)*	82.3 (1.9)	90.0 (2.3)*	83.6 (1.8)	87.2 (2.4)	78.0 (2.0)	89.0 (4.0)*
Satisfaction	82.6 (3.2)	86.0 (1.6)	72.0 (2.6)	88.4 (2.2)*	78.0 (1.9)	79.6 (2.4)	77.5 (2.2)	82.0 (3.1)	72.7 (2.0)	80.7 (3.9)

*Significant modality effect (HD *vs* PD; $P < 0.05$), after adjusting for baseline score.

systematic differences by modality with regard to baseline health status/quality of life values among patients who were included and not included. Among patients who started on HD, patients included in our analyses scored higher at baseline on 10 of the 17 dependent health status/quality of life measures than did patients who started on HD but who were not included in our analyses. Among patients who started on PD, patients included in our analyses scored higher at baseline on 11 of the 17 dependent health status/quality of life

Table 5. *P*-values for HD/PD effect in regression analyses predicting health status, quality of life and dialysis care scores at baseline and 1 year after treatment start[a]

	Baseline	1 Year
Health status		
Physical functioning	0.08	0.28
Role limitation physical	0.04	0.27
Bodily pain	0.01	0.08
General health	0.17	0.76
Emotional well-being	0.005	0.93
Role limitation emotional	0.03	0.36
Social functioning	0.04	0.05
Vitality	0.11	0.07
Quality of life		
Symptoms/problems	0.01	0.54
Effects on daily life	<0.0001	0.002
Burden of kidney disease	0.0004	0.03
Social support satisfaction	0.001	0.64
Cognitive function	0.06	0.80
Sleep	0.11	0.80
Sexual function	0.81	0.84
Dialysis care		
Staff encouragement	<0.0001	<0.0001
Satisfaction	<0.0001	<0.0001

[a]Adjusted for age, gender, race, education, employment, marital status, living arrangement, vintage, early referral, diabetic ESRD, cardiovascular co-morbidity, hypertension, smoking history, haemoglobin, serum creatinine, serum albumin and serum bicarbonate; 1 year data also adjusted for baseline score.

measures than did patients who started on PD but who were not included in our analyses. Moreover, the measures on which patients included in our analyses scored higher than those not included in our analyses were almost identical. Included patients on both modalities scored higher on physical functioning, bodily pain, emotional well-being, role limitation emotional, social functioning, vitality, symptoms/problems, effects of kidney disease on daily life and burden of kidney disease. In addition, HD patients included in our analyses scored higher on sleep than did those HD patients not included, and PD patients included in our analyses scored higher on general health and cognitive function than did those PD patients not included.

Inferences about patients' quality of life are influenced by the specific measurement tools used in a study as well as by the ability of researchers to control for potential confounding variables. Patient responses to questions in a standardized instrument may or may not effectively capture aspects of quality of life that are of most importance to individual patients. The KDQOL-SF is an instrument with demonstrated reliability and validity and includes measures of perceived health status, quality of life and satisfaction with care, all of which comprise important dimensions of patient experience on dialysis. Other instruments, however, may capture additional elements of the effects of illness and effects of treatment that are salient for patients.

Selection bias is a major concern in studies comparing patient outcomes in relation to RRT [1,7,9,10, 15,18,19]. The PS helps to balance observed baseline covariates between exposure groups, but unmeasured characteristics remain unbalanced. The nature of the education and modality orientation that patients receive pre-dialysis (not simply whether or not patients receive pre-ESRD care) and patient attitudes toward managing their disease are two examples of important unmeasured variables that may influence both selection of a dialysis modality and subjective experience on dialysis [7]. The randomized clinical trial balances unmeasured and measured covariates. This ideal design for investigating the association of dialysis modality with patient experience and outcomes is an elusive goal, however, when modalities differ in their requirements for the patient's capability and willingness to participate [10]. In the absence of an ideal design, it is crucial to make efforts to adjust adequately for confounding variables. Winkelmayer and Kurth [12] note that the 'success' of PS analysis can be gleaned from a table comparing baseline covariates between exposure groups within PS strata. Although DMMS Wave 2 patients starting treatment on HD and PD differed on a large number of characteristics at baseline, Table 2 demonstrates that almost no significant socio-demographic or clinical differences were evident between HD and PD patients within propensity-matched quintiles.

Most of the research examining the association of treatment modality with dialysis patients' health status and quality of life consists of cross-sectional studies of prevalent patients. Studies investigating health status and quality of life reported by incident patients have the advantage of being able to compare HD and PD patients who are at a similar point in their treatment experience, thereby controlling for an important source of potential variation in patient response. Relative risk of death with HD and PD varies by the length of time that patients have been on dialysis [7]. Patients' reported quality of life is also likely to differ by the length of time that patients have been on dialysis as patients adapt to their changing life circumstances and/or experience change in co-morbidity.

Information about health outlook and quality of life among incident patients has come primarily from investigators in The Netherlands [8,17] and from the CHOICE study in the USA [2,9]. Merkus *et al.* [17] examined SF-36 responses from 84 HD and 55 PD patients in The Netherlands who remained on their initial modality. At 12 months after start of dialysis, stay on HD patients had a higher physical summary score than did stay on PD patients, while mental summary scores were very similar for the two groups. Among 18 patients randomized to HD and 20 patients randomized to PD by these investigators, the mean QALY score after 2 years was 59.1 ± 12.0 for HD patients and 54.0 ± 19.0 for PD patients when the investigators used the EuroQol to derive a single valuation of patients' overall health [8].

In the CHOICE study, 452 HD patients and 133 PD patients supplied health status and quality of life data near treatment start and again 1 year later [9]. Age, gender, race, education, albumin, creatinine and

haematocrit were adjusted in analyses investigating the association of treatment modality with health status/quality of life; an additional covariate was a co-morbidity score based on multiple disease and physical impairment categories graded by level of severity. Patients' employment status, marital status, living situation, timing of pre-ESRD care and serum bicarbonate were not adjusted. Because the number of PD patients who provided data at 1 year was relatively small, the study had limited power to detect differences by patients' dialysis modality in the various subdomains of health status and quality of life, but the data indicated that patients on HD had better sexual functioning while patients on PD had better quality of life as measured by perceived ability to travel, financial concerns, restrictions in eating and drinking, and dialysis access problems [9]. Similarly, we found that DMMS Wave 2 patients on PD evaluated the effects of kidney disease on daily life more positively than did HD patients, and the effects of kidney disease on daily life scale includes items asking about dietary restriction and ability to travel. Positive assessment of these aspects of dialysis experience may influence prevalent PD patients to want to remain on their current modality [18].

Especially important, at baseline, DMMS Wave 2 PD patients in all five quintiles rated their encouragement from staff and their satisfaction with care higher than did HD patients (see Table 3), consistent with the results of the CHOICE study reported by Rubin *et al.* in which PD patients rated their dialysis care higher at treatment start than did patients initiating HD [2]. After 1 year of dialysis, PD patients in the DMMS Wave 2 continued to be more likely than HD patients to evaluate staff encouragement and satisfaction with care positively, as Table 5 highlights.

Individuals' work status (employed/not employed) can be viewed as one dimension of their quality of life; work status can also be viewed as a socio-demographic characteristic likely to influence individuals' self-assessed quality of life. In this study, we included patients' work status in the model that was developed to define patients' propensity for being selected to PD. Almost half of the patients in quintile I were working, regardless of modality. In quintile V, no patients on either modality were employed. As Hirth *et al.* also demonstrated [19], it is reasonable to conclude that patient characteristics drive labour force participation more than dialysis modality selection drives labour force participation. At the same time, using a therapy that does not require going regularly to a dialysis clinic for treatments makes employment more feasible, and patients may select or be recommended for PD to facilitate their ability to work [19].

We believe that our study provides support for making the choice of PD more widely available as an option to patients initiating chronic dialysis therapy. Patients who initiate PD may be able to enjoy a valued period of time when they are largely independent of the dialysis facility, and they are more likely to be able to continue jobs held prior to dialysis. Patient

lifestyle opportunities and the overall cost advantages associated with use of PD, a home-based and self-care therapy, may also apply to home-based HD or in-centre self-care HD [2,10].

Vonesh *et al.* argue that valid comparisons of survival outcomes associated with HD and PD therapy require patient stratification according to major risk factors known to interact with treatment modality to influence patient survival [7]. We did not consider interactions of specific patient characteristics with treatment modality in this study, but we did consider a large number of potential confounders in our analyses. Dialysis adequacy, for which we did not have measures, would be an additional potential clinical confounder to consider [17]. Moreover, it would be informative to investigate reported health status and quality of life after stratifying patients on variables such as expectations regarding treatment [20] and attitudes toward self-management of health. Measuring variables such as these in addition to socio-demographic and clinical covariates, and determining how they may interact with treatment modality to shape patient experience, are important objectives for continued study.

Conflict of interest statement. None declared.

References

1. Evans RW, Manninen DL, Garrison LP Jr *et al.* The quality of life of patients with end-stage renal disease. *N Engl J Med* 1985; 312: 553–559
2. Rubin HR, Fink NE, Plantinga LC *et al.* Patient ratings of dialysis care with peritoneal dialysis vs hemodialysis. *J Am Med Assoc* 2004; 291: 697–703
3. Heaf J. Underutilization of peritoneal dialysis. *J Am Med Assoc* 2004; 291: 740–742
4. Wauters J-P, Uehlinger D. Non-medical factors influencing peritoneal dialysis utilization: the Swiss experience. *Nephrol Dial Transplant* 2004; 19: 1363–1367
5. Jager KJ, Korevaar JC, Dekker FW *et al.*, for the Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD) Study Group. The effect of contraindications and patient preference on dialysis modality selection in ESRD patients in The Netherlands. *Am J Kidney Dis* 2004; 43: 891–899
6. Mendelssohn DC. Empowerment of patient preference in dialysis modality selection. *Am J Kidney Dis* 2004; 43: 930–932
7. Vonesh EF, Snyder JJ, Foley RN, Collins AJ. The differential impact of risk factors on mortality in hemodialysis and peritoneal dialysis. *Kidney Int* 2004; 66: 2389–2401
8. Korevaar JC, Feith GW, Dekker FW *et al.*, for the NECOSAD Study Group. Effect of starting with hemodialysis compared with peritoneal dialysis in patients new on dialysis treatment: a randomized controlled trial. *Kidney Int* 2003; 64: 2222–2228
9. Wu AW, Fink NE, Marsh-Manzi JVR *et al.* Changes in quality of life during hemodialysis and peritoneal dialysis treatment: generic and disease specific measures. *J Am Soc Nephrol* 2004; 15: 743–753

10. Saner E, Nitsch D, Descoeudres C, Frey FJ, Uehlinger DE. Outcome of home haemodialysis patients: a case–cohort study. *Nephrol Dial Transplant* 2005; 20: 604–610

11. US Renal Data System. The USRDS Dialysis Morbidity and Mortality Study: Wave 2. *USRDS 1997 Annual Data Report*. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD; 1997: 49–68

12. Winkelmayer WC, Kurth T. Propensity scores: help or hype? *Nephrol Dial Transplant* 2004; 19: 1671–1673

13. US Renal Data System. *USRDS 2003 Annual Data Report: Atlas of End-Stage Renal Disease in the United States*. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD; 2003: 152–155

14. Stack AG. Determinants of modality selection among incident US dialysis patients: results from a national study. *J Am Soc Nephrol* 2002; 13: 1279–1287

15. Korevaar JC, Merkus MP, Jansen MA *et al.*, for the Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD) Study Group. Validation of the KDQOL-SF: a dialysis-targeted health measure. *Qual Life Res* 2002; 11: 437–447

16. Hosmer DW, Lemeshow S. *Applied Logistic Regression*. Wiley, New York: 1989

17. Merkus MP, Jager KJ, Dekker FW, deHaan RJ, Boeschoten EW, Krediet RT, for the NECOSAD Study Group. Quality of life over time in dialysis: The Netherlands Cooperative Study on the Adequacy of Dialysis. *Kidney Int* 1999; 56: 720–728

18. Bass EB, Wills S, Fink NE *et al.*, for the CHOICE study. How strong are patients' preferences in choices between dialysis modalities and doses? *Am J Kidney Dis* 2004; 44: 695–705

19. Hirth RA, Chernew ME, Turenne MN *et al.* Chronic illness, treatment choice and workforce participation. *Int J Health Care Finance Econ* 2003; 3: 167–181

20. Carr AJ, Gibson B, Robinson PG. Measuring quality of life: is quality of life determined by expectations or experience? *Br Med J* 2001; 322:1240–1243