Impact of Sleep and Dialysis Mode on Quality of Life in a Mexican Population

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Abstract

Background: Health-related quality of life (HR-QOL) is reduced with end-stage renal disease (ESRD) but little is known about the impact of sleep disorders, dialysis modality and demographic factors on HR-QOL of Mexican patients with ESRD.
Methods: 121 adults with ESRD were enrolled from 4 dialysis units in the state of Guanajuato, Mexico, stratified by unit and dialysis modality (hemodialysis [HD], continuous ambulatory peritoneal dialysis [CAPD] and automated peritoneal dialysis [APD]). Analysis included clinical information and data from the Sleep Heart Health Study Sleep Habits Questionnaire, the Medical Outcomes Study (MOS) short form (SF-36) HR-QOL measure and Epworth Sleepiness Scale.
Results: Overall, sleep symptoms and disorders were common (e.g., 37.2% insomnia). SF-36 scores were worse versus US and Mexican norms. HD patients reported better, while CAPD patients poorer HR-QOL for Vitality. With multivariate modelling dialysis modality, sleep disorders as a group and lower income were significantly associated with poorer overall SF-36 and mental health HR-QOL. Overall and Mental Composite Summary models showed HR-QOL was significantly better for both APD and HD with small to moderate effect sizes. Cost-effectiveness analysis demonstrated an advantage for APD.

Conclusions: Mexican ESRD patients have reduced HR-QOL, and sleep disorders may be an important driver of this finding. APD should be the preferred mode of dialysis in Mexico.

Introduction

The prevalence of end stage renal disease is increasing worldwide with an estimated prevalence in 2010 of 4.9 million persons. Unfortunately, only half receive dialysis; this need is projected to more than double by 2030 (1). End stage renal disease (ESRD) is associated with cardiovascular morbidity and mortality, type 2 diabetes, cognitive decline, and bone and mineral disorders. In Mexico, it is a significant health problem with annual prevalence and incidence rates of 1,564 and 412 per million persons respectively with over 65,000 individuals receiving dialysis (2). In addition, between 2000 and 2013, the incidence rate of ESRD has increased 122% (2). It has an annual mortality rate of 12.3 deaths per 100,000 inhabitants and is the second leading cause of years lost due to premature death (2). The most common treatment for ESRD in Mexico is hemodialysis (HD) performed at dialysis centers in over 50% of patients. The remainder receive peritoneal dialysis (PD) at home of which 70% are on continuous ambulatory peritoneal dialysis (CAPD) and 30% are on automated peritoneal dialysis (APD) (2). With CAPD, dialysis fluid is infused manually into the peritoneal cavity and then drained over a few hours usually four times per day. With APD, the process is automated with a device with alarms and safety features and is done at night. Kidney transplantation remains uncommon.

Treatment for ESRD has significant physiological, psychological and socio-economic implications for the individual, family, and community. Not surprisingly, persons with ESRD report poorer health-related quality of life (HR-QOL) compared with the general population (3, 4). Several studies have examined dialysis modality type on HR-QOL. Better HR-QOL scores have been noted for PD compared with HD treatment for ESRD (5, 6), but not always (7-9). A meta-analysis found better utility-based quality of life for APD compared to CAPD (10) and a recent study found APD associated with better physical health and milder dialysis-related symptoms than CAPD (11). Most of the studies used in the meta-analysis were from North America, Europe or Asia. There is little data available comparing HR-QOL among dialysis modalities for persons with ESRD in Latin American countries including Mexico.

Sleep disorders in persons with ESRD are common with prevalence estimates between 50 to more than 80%, and negatively influence HR-QOL (12-14). Among patients with ESRD, they include nightmares, excessive daytime sleepiness (EDS), restless leg syndrome (RLS), sleep apnea syndrome (OSA), insomnia and poor sleep quality (13). Whether the prevalence and severity of sleep disorders are similar among dialysis modalities is unclear; previous studies have been discordant with equivalent (15-17) and dissimilar rates and severity both reported (18-20). Only one study performed comparisons among HD, APD and CAPD (20). It found similar rates of insomnia, but less OSA with HD and more RLS with APD.

The purpose of this study was to determine the associations among HR-QOL and sleep disorders as a function of dialysis modality in a Mexican population with ESRD. A differential association may be an important factor in choice of dialysis modalities. We hypothesized that in this population, sleep disorders would be an important determinant of HR-QOL in ESRD, that APD would be associated with better QOL and be more cost-effective than HD or CAPD.

Methods

Design. Participants were a convenience sample of 125 patients with ESRD selected among persons insured by the Insurance and Social Service Institute for State Workers (ISSSTE) who were living in the state of Guanajuato, Mexico. Participants were proportionately selected by clusters. The sample included 30 patients from each geographic location of dialysis treatment units in the cities of Celaya, Irapuato, Guanajuato and Leon; ten patients were selected per dialysis modality (CAPD, APD, and HD). Patients were included if they were 18 years of age or older, Spanish-speaking, receiving dialysis and had not been hospitalized for the immediate 3 months prior to recruitment. Patients with cognitive or other mental health deficits that would preclude them from completing survey questionnaires were excluded from the study. They were recruited for participation during their monthly meetings, or in the waiting room for their specialist appointment. At the time of initial contact or a later appointment, the patient was asked to provide written informed consent, and to complete an individual interview and surveys that included information about their health, sleep and HR-QOL. They were also asked to give consent for chart review. The study was approved by the University of Guanajuato Ethics Committee and the Arizona State University Institutional Review Board.

Data Collection. Trained interviewers obtained information regarding age, sex, marital status, socioeconomic status (SES), educational level, number of hospitalizations, and time since first treatment. Participants also completed the Spanish translated and validated Sleep Heart Health Study Sleep Habits Questionnaire, and the Spanish version of the 36-item Medical Outcomes Study (MOS) short form (SF-36) HR-QOL measure. Height and weight were obtained to determine body mass index (BMI). Recent glucose, albumin, creatinine, urea, and hematocrit/hemoglobin blood levels were extracted from the patient's medical record within the past three months. Additional clinical data collected to calculate the financial cost were ESRD etiology, hospitalizations within the past year, type of catheter, dialysis dose, number of anti-hypertensive drugs, use of erythropoietin, number of HD sessions per week and last home visit by the dialysis team.

Measurement Tools

Sleep Heart Health Sleep Study (SHHS), Sleep Habits Questionnaire (SHQ). The SHQ instrument has typically been used with patients with unidentified sleep disorders. The questionnaire addresses nine aspects of sleep disorders: 1) Snoring; 2) Breathing pauses (apnea); 3) Witnessed apneas; 4) Daytime sleepiness; 5) Insufficient sleep; 6) Insomnia symptoms including unrefreshing or nonrestorative sleep; 7) Nightmares, 8)

Restless legs syndrome; and 9) Self-reported weekday and weekend sleep duration. Sleep symptoms questions were rated on a 5-point Likert-type scale from ‘Never’ to Almost Always.’ The SHQ, developed for the SHHS, has been used in a variety of investigations and is accepted as an appropriate means of characterizing sleep health. The Spanish version of the SHQ was cross-language validated by Baldwin and colleagues and shows excellent agreement with the English version (21).

Epworth Sleepiness Scale. The Epworth Sleepiness Scale (ESS) is a validated self-completion tool that asks subjects to rate the likelihood of falling asleep in eight common situations using four ordinal categories ranging from 0 (no chance) to 3 (high chance) (22). Scores range from 0 to 24 with a score >10 suggesting EDS (22). The Spanish version of the ESS was incorporated into the SHQ and has demonstrated equivalent reliability and validity as the English version (23).

Medical Outcomes Survey (MOS) Short Form SF-36 (Spanish version). The MOS SF-36 is a widely-used measure of health status and HR-QOL (24). It measures variations in health care practices and outcomes in a self-administered survey that assesses eight health dimensions. Scores for each subscale range from 0–100, with higher scores representing better QOL (24). Subscales measure the following eight general health concepts: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), mental health (MH) and role emotional (RE). The Spanish version was validated in a Mexican population (25).

SF-6 D scores. The short-form-6D is a preference-based health state classification developed from the SF-36. All participants who complete the SF-36 can be assigned an SF-6D score (26). The SF-6D is a continuous measure, scored on a 0.29-1.0 scale, with 1.00 indicating optimal health. It has been used in economic evaluations of interventions for ESRD (27).

Data Analysis

Continuous variables are reported as means and standard deviations and categorical variables by percentages. A chi-square test was used to assess the association of demographic characteristics with dialysis modality. Comparisons between HR-QOL scores and the treatment groups were performed by analysis of variance (ANOVA). Effect sizes were estimated using Cohen’s *d*. Multiple linear regression analysis was performed controlling for socio-demographic factors, income (SES) and sleep disorders. SAS (V9.1) and IBM SPSS (V25) were used for data analysis. P <0.05 was considered statistically significant unless otherwise stated.

A cost effectiveness analysis utilizing the quality-adjusted life year (QALY) method examined the cost-effectiveness of each dialysis modality group. Cost data was obtained from data available online from Mexican governmental sources. The QALY was computed as the number of years on dialysis/hemodialysis x SF-6D score. A ratio of the difference in cost to the difference in effectiveness (QALY) was computed for each of the three therapies which yielded the incremental cost-effectiveness ratio (ICER).

Results

Of 125 patients approached for recruitment, 121 fulfilled the inclusion criteria, and all agreed to voluntarily participate and provide written informed consent. Socio-demographic and clinical characteristics of the consenting patients are shown in Table 1.

Table 1. Socio-demographic and Clinical Characteristics of Study Participants by Dialysis Modality.

Characteristics	CAPD			APD			HD			TOTAL		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Age*	39	64.2	8.9	42	53.1	13.4	40	60.8	14.7	121	59.3	13.4
Education (years)†	39	8.2	7.4	42	11.4	6.4	40	8.7	5.9	121	9.5	6.7
BMI (kg/m²)	32	27.7	5.6	38	26.0	4.0	34	24.8	5.4	104	26.1	5.1
Systolic BP	25	148	32	27	140	17	29	145	31	81	144	27
Diastolic BP	25	79	17	27	85	141	29	75	19	81	80	17
Creatinine (mg/dl) ‡	27	8.3	3.2	31	11.8	4.3	29	6.7	3.7	88	9.0	4.3
Hg (g/dl)	26	10.8	2.1	27	11.5	2.9	28	11.3	3.9	81	11.2	3.0
	n	%		n	%		n	%		n	%	
Gender												
Female	22	56.4		14	33.3		18	45.0		54	44.6	
Male	17	43.6		28	66.7		22	55.0		67	55.4	
Age 65 or Older	21	43.8		10	23.8		17	35.4		48	39.7	
Marital Status												
Widowed	8	20.5		5	11.9		8	20.0		21	17.4	
Single	4	10.3		4	9.5		5	12.5		13	10.7	
Divorced	3	7.7		1	2.4		2	5.0		6	5.0	
Married	24	61.5		32	76.2		25	62.5		81	66.9	
Smoking												
Never	17	43.6		19	45.2		23	57.5		59	48.7	
Current	1	2.6		4	9.5		0	0		5	4.1	
Past	21	53.9		19	45.2		17	42.5		57	47.1	
Alcohol*												
Never	18	69.2		12	37.5		16	59.3		46	54.1	
Current	0	0		0	0		0	0		0	0	
Past	8	30.8		20	62.5		11	40.7		39	45.9	
Income(per year USD)*												
None	7	17.6		10	23.8		4	10.0		21	17.4	
< $1,608	5	12.8		0	0		8	20.0		13	10.7	
$1,608-3,215	7	17.9		5	11.9		6	15.0		18	14.9	
$3,216-4,823	4	10.3		3	7.1		10	25.0		17	14.1	
$4,824-6,431	4	10.3		9	21.4		4	10.0		17	14.1	
$6,432-8,040	2	5.1		4	9.5		2	5.0		8	6.6	
> $8,040	10	25.6		11	26.2		6	15.0		27	22.3	
Working*												
Yes	2	5.3		14	33.3		3	7.5		19	15.8	
No	35	92.1		26	61.9		33	82.5		94	78.3	
Occasional	1	2.6		2	4.7		4	10.0		7	5.8	
Etiology of ESRD												
Diabetes	31	79.5		32	76.2		24	60.0		87	72.0	
Hypertension	6	15.4		5	11.9		6	15.0		17	14.0	
Other	2	5.1		5	11.9		10	25.0		17	14.0	

Note: ‡$p<0.01$; *$p \leq 0.05$; †$p<0.10$. APD (Automated Peritoneal Dialysis); CAPD (Continuous Ambulatory Peritoneal Dialysis); HD (Hemodialysis).

There was a slightly greater percentage of males (55.4%) and 39.7% were 65 years of age or older. Clinical characteristics were not available on all patients. However, patients dialyzed with APD were younger, more highly educated, had higher incomes, consumed less alcohol and were more likely to be working. There was a trend for APD patients to have a higher creatinine. Otherwise, there were no differences among the 3 groups.

The prevalence of self-reported sleep disorders or symptoms overall, as well as stratified by dialysis modality are presented in Table 2.

Table 2. Prevalence of Self-reported Sleep Disorders and Symptoms by Dialysis Type

Sleep Disorders	Total (N=121)	CAPD (n=39)	APD (n=42)	HD (n=40)
	n (%)	n (%)	n (%)	n (%)
Obstructive sleep apnea	3 (2.7)	1 (2.8)	2 (5.1)	0
Witnessed apnea*	12 (10.0)	4 (10.3)	6 (14.3)	2 (5.1)
Snoring†	23 (21.1)	7 (19.4)	10 (25.6)	6 (17.6)
Insomnia	45 (37.2)	13 (33.3)	13 (30.9)	19 (47.5)
Excessive Tiredness	25 (20.7)	8 (20.5)	8 (19.0)	9 (22.5)
Unrefreshing or Nonrestorative sleep†	42 (34.7)	16 (41.0)	9 (21.4)	17 (42.5)
Insufficient sleep	34 (28.1)	10 (25.6)	12 (28.6)	12 (30.0)
Restless legs syndrome	23 (19.0)	9 (23.1)	7 (16.7)	7 (17.5)
EDS (Epworth >10)	25 (19.0)	10 (25.6)	5 (11.9)	10 (25.0)

Note: *p < 0.05, †p <0.10. EDS (Excessive Daytime Sleepiness); APD (Automated Peritoneal Dialysis); CAPD (Continuous Ambulatory Peritoneal Dialysis); HD (Hemodialysis).

Notably, all patients reported at least one sleep symptom in the past year (data not shown). Insomnia was the most frequently reported disorder and was particularly prevalent for patients receiving HD although not statistically significant. There also was a trend for HD (42.5%) and CAPD (41.0%) patients to report higher rates of non-restorative (unrefreshing) sleep compared to APD patients (19%). In contrast, APD patients reported higher rates of witnessed apnea and snoring (14.3% and 25.6%, respectively) compared to CAPD (10.3%, 19.4%) and HD (5.1%, 17.5%) patients. Patients receiving APD were less likely to report EDS (11.9%) on the ESS but this was not statistically significant compared to CAPD (25.6%) and HD (25.0%). The prevalence of sleep disorders was the same for those younger than 65 years of age in comparison to those older than 65 years (data not shown) except for problems with waking up too early and not being able to fall back asleep (younger: 32.9% vs. older 51.2%, p=0.05)

Table 3 presents the comparison of the eight SF-36 domains and the Physical and Mental Component Summary (PCS and MCS) scores for the three dialysis modality groups with effect sizes for pairwise comparisons.

Table 3. Mean Scores and Standard Deviations for SF-36 Domains, Physical and Mental Composite Scores and SF-6D Scores by Dialysis Modality

SF-36 domain	CAPD Mean (SD)	CAPD-APD Effect Size	APD Mean (SD)	APD-HD Effect Size	HD Mean (SD)	CAPD-HD Effect Size	Total Mean
Physical Function†	30.38 (29.3)	0.46	43.69 (28.9)	.01	43.50(29.20)	0.45	39.34(29.1)
Role Physical†	17.95 (42.6)	0.40	35.12 (42.2)	0.06	37.50 (42.7)	0.46	30.37(42.5)
Bodily Pain	61.79 (36.4)	0.28	71.90 (36.0)	0.32	60.44 (36.5)	0.04	64.85(36.3)
General Health	42.31 (24.5)	0.09	44.52 (24.1)	0.35	53.12 (24.5)	0.44	46.65(24.4)
Vitality*	43.72 (29.0)	0.35	53.81 (28.7)	0.26	61.25 (29.0)	0.60	53.02(28.9)
Social Functioning‡	58.01 (32.6)	0.39	70.53 (32.3)	0.34	81.56 (32.7)	0.72	70.14(32.5)
Role Emotional	59.83 (42.9)	0.25	70.63 (42.4)	0.13	76.25 (43.0)	0.38	69.01(42.8)
Mental Health	65.23 (24.5)	0.28	72.00 (24.2)	0.03	72.80 (24.5)	0.31	70.08(24.4)
PCS	30.13 (11.4)	0.43	34.65 (9.8)	0.06	34.02 (12.5)	0.33	32.98(11.3)
MCS*	48.10 (15.6)	0.24	51.59 (13.4)	0.29	55.05 (9.8)	0.53	51.61(13.3)
SF-6D Score‡	0.59 (0.1)	1.0	0.69 (0.1)	0.06	0.68 (0.2)	0.57	0.65 (0.2)

Note: ‡p<0.01; *p < 0.05; †p <0.10. PCS (Physical Composite Score); MCS (Mental Composite Score); SD (Standard Deviation); APD (Automated Peritoneal Dialysis); CAPD (Continuous Ambulatory Peritoneal Dialysis); HD (Hemodialysis). Cohen's d effect sizes were calculated examining the differences between dialysis type groups (small effect size ~0.2, medium effect size ~0.5, large effect size ~0.8).

The patients on HD reported significantly better HR-QOL for Vitality and a trend towards higher Social Functioning compared to persons on CAPD and APD; the patients on CAPD experienced the poorest quality of life on these two scales. There was a trend for patients on APD and HD to indicate better Physical Functioning and Role Physical HR-QOL compared to the CAPD patients. There was a tendency for better mental health on the MCS for patients receiving HD and APD compared to patients on CAPD. Importantly, effect sizes for the various domains and subdomains showed that they were generally small to moderate for contrasts between CAPD and either APD or HD. However, they were trivial to small between APD and HD. No other notable differences were observed among groups on the SF-36.

Determinants of HR-QOL was further investigated using multivariate modelling with socio-demographic factors, co-morbidities and self-reported sleep disorders and symptoms as potential explanatory variables. Dialysis modality (CAPD associated with worse HR-QOL in comparison to HD and APD, F=4.87, p<.02), sleep disorders and symptoms as a group (i.e., any of symptoms consistent with obstructive sleep apnea, insomnia, insufficient sleep and restless legs syndrome, F=17.79, p<.0001) and lower income (F=4.48, p<.04) were significantly associated with worse HR-QOL on the Mental Composite Summary of the SF-36, accounting for 34% of the variance (F=4.02, p=.0004). In contrast, the model for the Physical Composite Summary was not statistically significant. HR-QOL was significantly better for both APD (Least Square Mean=52.0 ± 2.3) and HD (51.4 ± 2.6) in comparison to CAPD (43.0 ± 2.5, p<.025 vs. APD/HD) in the Mental Composite Summary, but not the Physical Composite Summary models (Least Square Means: CAPD: 31.4 ± 2.5, APD: 33.7 ± 2.3, HD: 34.8 ± 2.5; p>.05 for all comparisons).

Cost effectiveness analyses for each dialysis modality are in Table 4.

Table 4. Dialysis Modalities Cost Analysis

	Cost	Effectiveness (QALY)	Incremental Cost (IC)	Incremental Effectiveness (QALY)	ICER (IC/IE)
CAPD	$286	0.71			
APD	$606	2.05			
HD	$825	1.44			
APD vs. CAPD			$320	1.34	$429/QALY
HD vs. CAPD			$539	0.71	$759/QALY
HD vs. APD			$219	-0.61	APD DOMINATED

Note: APD (Automated Peritoneal Dialysis); CAPD (Continuous Ambulatory Peritoneal Dialysis); HD (Hemodialysis). QALY (quality-adjusted life year), ICER (Incremental Cost-Effectiveness Ratio); IE (Incremental effectiveness); IC (Incremental Cost).

Although CAPD was the least costly, it was the least effective (QALY=0.71); APD was less costly than HD, but was more effective (APD QALY: 2.05 vs. HD QALY 1.44) and HD was the most costly with moderate effectiveness. Comparing the incremental cost effectiveness ratios among APD, CAPD and HD, APD was superior to both CAPD and HD, and HD was better than CAPD.

Discussion

In this study, we found that there is a high prevalence of sleep disorders and symptoms among Mexican patients with ESRD with differences in prevalence among dialysis modalities. Like other chronic medical conditions, HR-QOL, particularly mental health aspects, was poor in these patients and notably, the presence of sleep disorders was an important determinant of poorer HR-QOL.

Consistent with previous reports (12, 13, 28), we observed that sleep disorders and symptoms of sleep disorders were common among Mexican patients on dialysis. The explanation for the high rate of sleep disorders and symptoms in ESRD is likely multifactorial including metabolic issues, medications, poor sleep hygiene and dysfunction in ventilatory control (13). In addition, we found that there were differences in prevalence rates for some sleep disorders and symptoms among dialysis modalities. Previous investigations comparing the prevalence of sleep disorders among dialysis modalities have not been consistent. Some studies comparing only APD to CAPD have found no differences (15-17). In others, sleep problems as a generic symptom tended to be more common among APD compared to CAPD (18), and more frequent among HD in comparison with PD (19). To our knowledge, there is one other study that compared the rates of sleep disorders and symptoms among all 3 dialysis modalities (20). In that study, the rates of insomnia were high (>80%), but not different among dialysis modalities. Obstructive sleep apnea was the least common in HD patients (36% vs 60% [APD] and 65% [CAPD]). Furthermore, they observed less RLS in HD patients (23%) in comparison to APD (50%) and CAPD (33%). In contrast, we observed that unrefreshing sleep, a symptom of insomnia, was more common in HD and CAPD, snoring and witnessed apneas to be more frequent in APD, and no differences in the prevalence rates of RLS. The explanation for the large amount of discrepancy among various studies is unclear. However, possibilities include differences in the socio-demographic characteristics of the study populations and the questions used to elicit information. Further studies are required, particularly ones that use overnight polysomnography and standardized questionnaires.

We found there were few differences in the prevalence of sleep disorders or their symptoms between older and younger patients with ESRD. The only exception was early morning awakenings which are a common complaint among the elderly and may reflect a phase advance in sleep timing (29). Otherwise, in contrast to our findings, older persons in general population cohorts report more problems with their sleep (30, 31). We propose that the negative impact of ESRD on sleep quality had greater impact on younger patients thus negating any age differences in prevalence rates.

Despite the availability of dialysis to treat ESRD, HRQOL remains low compared to the general population (3, 4). Our findings in a cohort of Mexican patients with ESRD being treated with 3 different dialysis modalities is no different and are generally consistent with data from a large study of US patients with ESRD (32). Compared to the previous study in Mexican patients with ESRD, all of whom were receiving HD (28), however, we found lower scores on the Physical Function and higher scores on the Role Emotional scales. One-third of the current study was comprised of patients on CAPD, and thus our finding of worse Physical Function can be attributed to lower scores among this subgroup. The discrepancy in the Role Emotional scale, however, remains unexplained. International comparisons of HRQOL in patients with ESRD exhibit considerable heterogeneity (32). This may be related to cultural diversity, social determinants of health, health inequality or differences in health delivery systems across countries. In

Mexico, availability and adequacy of dialysis varies considerably according to the insurance status of the patient (2). Irrespective of potential cross-cultural and international differences, it is important for clinicians and health care workers to realize that HR-QOL is reduced in ESRD and comparable to other chronic medical conditions despite the use of dialysis. Our findings support the recommendation by Jha et al. that national programs for chronic diseases include strategies to reduce burden and costs relevant to kidney disease (33).

Importantly, we found that in multivariate analyses, the presence of sleep disorders was a major factor in adversely affecting HR-QOL with the primary impact on the mental health component of HR-QOL. Other studies also have found negative associations between various sleep disorders and HR-QOL in patients with ESRD (12, 14). Our findings, however, extend these previous observations to a Latin American population. They further highlight the importance of sleep as a determinant of HR-QOL in ESRD and suggest that screening for poor sleep and sleep disorders should be an essential part of the care of patients undergoing chronic dialysis. As well, sleep health promotion strategies should be developed and implemented relevant to this patient population and examined germane to improving HR-QOL, further reducing health care cost, sequelae from ESRD, and dialysis type.

In addition to sleep disorders, we observed that mode of dialysis was an important determinant of HR-QOL. Several extant studies also have examined dialysis modality type on HR-QOL and most report better HR-QOL for PD compared to HD treatment for ESRD (5, 6). One study in elderly patients, however, observed no difference between PD and HD (7). It is suggested that travel and dietary restrictions are fewer, and recreation opportunities and dialysis access are improved with PD resulting in better HR-QOL (34). In addition, indices of depression may be higher in comparisons of HD to PD (5). Comparisons of APD to CAPD are fewer (3, 16, 18, 35), with most showing that APD is associated with better HR-QOL (3, 18, 35). Our study extends these previous studies by being one of the few to examine quality of life among all three dialysis modalities simultaneously (36). Our results suggest that in comparison to HD and APD, CAPD is associated with worse HR-QOL with small to moderate effect sizes; there was little difference between HD and APD with trivial to small effect sizes. The burdensome requirement for continuous dialysate exchanges in CAPD compared to only nightly automated exchanges with APD or scheduled visits to a dialysis center for HD likely explains this finding. Furthermore, our cost-effectiveness analysis indicates that for the socio-economic landscape in Mexico, APD should be the preferred dialysis modality.

Our study has some important limitations. First, the study population was not prospectively selected or randomized with respect to dialysis modality. Unfortunately, choice of dialysis modality in Mexico and elsewhere is dictated frequently by health insurance, patient income and availability of resources. Thus, it is possible that our findings related to HR-QOL and sleep disorders may have been impacted by an assignment bias. For example, CAPD may have been differentially provided to patients with lower income, thus accounting for worse HR-QOL. We attempted to mitigated this by controlling for some of these potential biases with our multivariate analysis. Nevertheless, residual confounding may have been present. Second, our analyses are cross-sectional and causality cannot be confirmed. Third, the presence of sleep disorders and symptoms was self-reported; there may have been some misclassification. Any misclassifications, however, were likely non-differential. Last, our study sample is relatively small; some non-statistically significant differences may represent type II error. Conversely, use of multiple comparisons may have resulted in type I error in some cases.

In summary, HR-QOL is reduced in Mexican patients with ESRD and the presence of sleep disorders may be an important driver of this finding. Interventions targeted at improving sleep quality and treating sleep disorders may improve HR-QOL in this population. Differences in HR-QOL among dialysis modalities suggest that in Mexico, APD should be the preferred mode of dialysis.

Acknowledgements

Financial support was provided to Dr. Reynaga-Ornelas by the Bardewick Scholarship from Arizona State University and the PROMEP Scholarship from the University of Guanajuato. Dr. Quan was partially supported by AG009975 from the National Institute of Aging.

References

1. Liyanage T, Ninomiya T, Jha V, *et al.* Worldwide access to treatment for end-stage kidney disease: a systematic review. Lancet. 2015;385(9981):1975-82. [CrossRef] [PubMed]
2. García-García G, García-Bejarano H, Breien-Coronado H, *et al.* Chapter 9 - End-Stage Renal Disease in Mexico. In: Chronic Kidney Disease in Disadvantaged Populations. García-García G, Agodoa LY and Norris K, eds. Cambridge, MA: Academic Press, 2017; 77-83. [CrossRef] [PubMed]
3. Reina Neyra M, Cirera Segura F, Martín Espejo J. Salud Percibida por los Pacientes en DPCA y DPA. Rev Soc Esp Enferm Nefrol. 2008;11(2):26-33. [CrossRef]
4. Guerini Rocco D, Mercieri A, Yavuzer G. Multidimensional health-status assessment of chronic hemodialysis patients: the impact on quality of life. Eura Medicophys. 2006;42(2):113-9. [PubMed]
5. Ginieri-Coccossis M, Theofilou P, Synodinou C, Tomaras V, Soldatos C. Quality of life, mental health and health beliefs in haemodialysis and peritoneal dialysis patients: investigating differences in early and later years of current treatment. BMC Nephrol. 2008;914-2369-9-14. [CrossRef] [PubMed]
6. Chen JY, Wan EYF, Choi EPH, *et al.* The health-related quality of life of chinese patients on hemodialysis and peritoneal dialysis. Patient. 2017;10(6):799-808. [CrossRef] [PubMed]
7. Harris SA, Lamping DL, Brown EA, Constantinovici N, North Thames Dialysis Study (NTDS) Group. Clinical outcomes and quality of life in elderly patients on peritoneal dialysis versus hemodialysis. Perit Dial Int. 2002;22(4):463-70. [PubMed]
8. Queeley GL, Campbell ES. Comparing treatment modalities for end-stage renal disease: A meta-analysis. Am Health Drug Benefits. 2018;11(3):118-27. [PubMed]

9. Manavalan M, Majumdar A, Harichandra Kumar KT, Priyamvada PS. Assessment of health-related quality of life and its determinants in patients with chronic kidney disease. Indian J Nephrol. 2017;27(1):37-43. [CrossRef] [PubMed]
10. Wyld M, Morton RL, Hayen A, Howard K, Webster AC. A systematic review and meta-analysis of utility-based quality of life in chronic kidney disease treatments. PLoS Med. 2012;9(9):e1001307. [CrossRef] [PubMed]
11. Yang F, Luo N, Lau T, Yu ZL, Foo MWY, Griva K. Health-related quality of life in patients treated with continuous ambulatory peritoneal dialysis and automated peritoneal dialysis in Singapore. Pharmacoecon Open. 2018;2(2):203-8. [CrossRef] [PubMed]
12. Brekke FB, Amro A, Hortemo Osthus TB, Dammen T, Waldum B, Os I. Sleep complaints, depression and quality of life in Norwegian dialysis patients. Clin Nephrol. 2013;80(2):88-97. [CrossRef] [PubMed]
13. Hanly P. Sleep disorders and end-stage renal disease. Curr Opin Pulm Med. 2008;14(6):543-50. [CrossRef] [PubMed]
14. Edalat-Nejad M, Qlich-Khani M. Quality of life and sleep in hemodialysis patients. Saudi J Kidney Dis Transpl. 2013;24(3):514-8. [CrossRef] [PubMed]
15. Turkmen K, Yazici R, Solak Y, *et al.* Health-related quality of life, sleep quality, and depression in peritoneal dialysis and hemodialysis patients. Hemodial Int. 2012;16(2):198-206. [CrossRef] [PubMed]
16. Guney I, Solak Y, Atalay H, *et al.* Comparison of effects of automated peritoneal dialysis and continuous ambulatory peritoneal dialysis on health-related quality of life, sleep quality, and depression. Hemodial Int. 2010;14(4):515-22. [CrossRef] [PubMed]
17. Eryavuz N, Yuksel S, Acarturk G, *et al.* Comparison of sleep quality between hemodialysis and peritoneal dialysis patients. Int Urol Nephrol. 2008;40(3):785-91. [CrossRef] [PubMed]
18. Bro S, Bjorner JB, Tofte-Jensen P, *et al.* A prospective, randomized multicenter study comparing APD and CAPD treatment. Perit Dial Int. 1999;19(6):526-33. [PubMed]
19. Eghbali M, Shahqolian N, Nazari F, Babaee S. Comparing problems of patients with chronic renal failure undergoing hemodialysis and peritoneal dialysis referring to medical university's hospitals. Iran J Nurs Midwifery Res. 2009;14(1):1-5.
20. Losso RL, Minhoto GR, Riella MC. Sleep disorders in patients with end-stage renal disease undergoing dialysis: comparison between hemodialysis, continuous ambulatory peritoneal dialysis and automated peritoneal dialysis. Int Urol Nephrol. 2015;47(2):369-75. [CrossRef] [PubMed]
21. Baldwin CM, Choi M, McClain DB, Celaya A, Quan SF. Spanish translation and cross-language validation of a sleep habits questionnaire for use in clinical and research settings. J Clin Sleep Med. 2012;8(2):137-46. [CrossRef] [PubMed]
22. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep. 1991;14(6):540-5. [CrossRef] [PubMed]
23. Ferrer M, Vilagut G, Monasterio C, Montserrat JM, Mayos M, Alonso J. Measurement of the perceived impact of sleep problems: the Spanish version of the functional outcomes sleep questionnaire and the Epworth sleepiness scale. Med Clin (Barc). 1999;113(7):250-5. [PubMed]

24. Ware JE,Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care. 1992;30(6):473-83. [CrossRef] [PubMed]
25. Zúniga AM, Carrillo-Jiménez TG, Fos JP, Gandek B, Medina-Moreno M. Evaluación del estado de salud con la Encuesta SF-36: resultados preliminares en México. Salud Pública de México. 1999;41(2):110-8. [CrossRef] [PubMed]
26. Brazier J, Roberts J, Deverill M. The estimation of a preference-based measure of health from the SF-36. J Health Econ. 2002;21(2):271-92. [CrossRef]
27. Davison SN, Jhangri GS, Feeny DH. Comparing the health utilities index mark 3 (HUI3) with the short form-36 preference-based SF-6D in chronic kidney disease. Value Health. 2009;12(2):340-5. [CrossRef] [PubMed]
28. Dehesa-Lopez E, Correa-Rotter R, Olvera-Castillo D, Gonzalez-Parra C, Baizabal-Olarte R. Clinical, dialytic, and laboratory factors associated with poor health-related quality of life in Mexican patients on hemodialysis. Rev Invest Clin. 2016;68(4):192-200. [PubMed]
29. Kim JH, Duffy JF. Circadian rhythm sleep-wake disorders in older adults. Sleep Med Clin. 2018;13(1):39-50. [CrossRef] [PubMed]
30. Klink M, Quan SF. Prevalence of reported sleep disturbances in a general adult population and their relationship to obstructive airways diseases. Chest. 1987;91(4):540-6. [CrossRef] [PubMed]
31. Ohayon MM, Zulley J, Guilleminault C, Smirne S, Priest RG. How age and daytime activities are related to insomnia in the general population: consequences for older people. J Am Geriatr Soc. 2001;49(4):360-6. [CrossRef] [PubMed]
32. Fukuhara S, Lopes AA, Bragg-Gresham JL, *et al.* Health-related quality of life among dialysis patients on three continents: the Dialysis Outcomes and Practice Patterns Study. Kidney Int. 2003;64(5):1903-10. [CrossRef] [PubMed]
33. Jha V, Garcia-Garcia G, Iseki K, *et al.* Chronic kidney disease: global dimension and perspectives. Lancet. 2013;382(9888):260-72. [CrossRef] [PubMed]
34. Wu AW, Fink NE, Marsh-Manzi JV, *et al.* Changes in quality of life during hemodialysis and peritoneal dialysis treatment: generic and disease specific measures. J Am Soc Nephrol. 2004;15(3):743-53. [CrossRef] [PubMed]
35. de Wit GA, Merkus MP, Krediet RT, de Charro FT. A comparison of quality of life of patients on automated and continuous ambulatory peritoneal dialysis. Perit Dial Int . 2001;21(3):306-12. [PubMed]
36. Caballero-Morales S, Trujillo-Garcia JU, Welsh-Orozco U, Hernandez-Cruz ST, Martinez-Torres J. Calidad de vida en pacientes con hemodiálisis, diálisis peritoneal continua ambulatoria y automatizada. Arch Med Fam. 2006;8(3):163-8.