

Quality of life and emotional distress between patients on peritoneal dialysis versus community-based hemodialysis

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Abstract

Purpose Patient-reported outcomes are important endpoints to evaluate new models of renal delivery. This is the first study to compare Quality of Life (QOL) and emotional adjustment outcomes between patients on community-based hemodialysis (HD) and those on peritoneal dialysis (PD).

Methods Data were collected between 2009 and 2011 from a cross-sectional sample of 232 HD patients and 201 PD patients recruited through community dialysis centers and outpatient PD clinics in Singapore. Participants completed the Hospital Anxiety and Depression Scale, World Health Organization Quality of Life Brief and the Short form for the Kidney Disease Quality of Life. Measures of ESRD severity, comorbidity and biochemistry were also collected.

Results Physical and emotional QOL impairments were noted for both dialysis groups. Case-mix-adjusted comparisons indicated higher symptoms of depression ($p = 0.027$),

and poorer physical health yet higher satisfaction with care ($p = 0.001$) in PD relative to community-based HD.

Conclusions Peritoneal dialysis regimes offer flexibility and autonomy under the support of PD teams. Although outcomes for most QOL domains measured were equivalent, PD patients are more satisfied with care but are at risk for emotional distress and provide poor ratings of physical health. Further research is needed to explore the expansion of standards of care to address psychosocial needs in PD populations.

Keywords Hemodialysis · Peritoneal dialysis · Quality of life · Depression

Abbreviations

APD	Automated peritoneal dialysis
CAPD	Continuous ambulatory peritoneal dialysis
HD	Hemodialysis
ESRD	End stage renal disease
NKF	National kidney foundation
PD	Peritoneal dialysis
QOL	Quality of life
RCT	Randomized clinical trial

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Background

Hemodialysis (HD) and peritoneal dialysis (PD) have been used for over 20 years to sustain life in end-stage renal disease (ESRD) patients on long transplantation waiting lists. HD is typically performed 3 times a week in an outpatient facility under the supervision of nurses using a dialysis machine. PD patients receive training by professional health care staff and typically administer dialysis at

home autonomously or with the help of a caregiver. PD is done either by manual exchanges of dialysate fluid 4–5 times a day (continuous ambulatory peritoneal dialysis, CAPD) or by using a machine that automatically fills and drains the peritoneum while the patient is asleep (automated peritoneal dialysis, APD).

Numerous studies have demonstrated equivalent survival and clinical outcomes with PD and HD [1–3]. Thus, in the absence of medical contra-indications, the decision as to which dialysis modality should be employed becomes a matter of personal choice. Such a decision requires thoughtful consideration of the value a patient, and potentially their family, places on the potential gains or losses in quality of life (QOL) associated with each treatment. Patient-reported outcomes such as QOL and emotional adjustment are important markers to evaluate effectiveness of treatment and have been shown to be associated with clinical outcomes in dialysis [4]. To date, however, the relative impact of these modalities on patients' satisfaction, quality of life and emotional adjustment remains unclear [1, 5]. While numerous studies set out to evaluate the impact of dialysis procedures on patient-reported outcomes, conclusions drawn are mixed and conflicted, favoring one or the other modality depending on metrics and instruments used. QOL outcomes are mostly comparable between modalities after adjustments for case-mix differences [6–11] or when dialysis groups were closely matched [7, 12, 13]. Differences emerge in specific subscales such as dietary restrictions, dialysis access problems, ability to travel in favor of PD or sexual functioning favoring HD, reflecting the procedural differences between the modalities [1]. Physical functioning outcomes also seem to favor HD [6, 9, 14], which has been attributed to the lower albumin levels in the PD [15] and the continuous physical burden of PD compared with the intermittent nature of HD.

Depression is common in patients on dialysis regimes [16, 17], yet comparisons between dialysis modalities have yielded contradictory findings. Some studies report no differences between modalities [3, 7, 18, 19], while other studies document lower depression for PD patients [20–24] interpreted as mainly due to PD affording greater opportunities for control and autonomy [25] and the convenience of home-based treatment [26]. On the other hand, the burden of daily commitment required by PD has been shown to adversely affect emotional well-being especially in CAPD patients and those with comorbid conditions [27]. The impact of dialysis modality on symptoms of depression clearly merits further study.

Hitherto, most studies comparing patient-reported outcomes between dialysis modalities have been performed in tertiary HD centers (i.e., hospital-based HD). Data on

QOL and emotional adjustment outcomes in HD patients dialyzing in community/satellite dialysis centers compared to PD are still largely lacking. Evaluation of patient-reported outcomes between these modalities is important as community-based models of dialysis delivery are increasing in many settings in response to increasing demands to expand dialysis capacity in a more cost-effective manner and to improve geographic accessibility. The move is further underscored by recent evidence on increased risk of death and low QOL with longer time travel to dialysis centers [28]. It is important to note that hospital-based HD remains the norm in most countries. The majority of HD patients in Singapore undergo dialysis in community-based dialysis centers, in contrast to out-patient hospital-based dialysis units in other countries [29]. These community dialysis centers are located in several parts of Singapore, housed in neighborhood residential estates across the island where care is managed by nurses with a small team of nephrologists working on rotation across the units. They are run by charitable organizations rather than being attached to hospitals and have no interventional facilities. Patients usually begin treatment in hospital-run units for about 2–4 weeks before they are eligible to transfer to community dialysis centers. These units have been developed to provide affordable dialysis close to patients' communities, but are not really intended as fully self-care satellites where patients are fully responsible for dialysis procedures. As such, community dialysis centers cater to a more diverse cohort of HD patients including patients who are elderly and have comorbidity and/or dependency issues.

The patient composition for the PD population in Singapore also includes elderly and non-ambulatory patients. In contrast to other countries [30, 31], in Singapore, there is not much variation of PD utilization rates across different age groups (13.8, 14.3 and 15.6 % for patients aged <60, between 60 to 69 and >69 years, respectively) [29]. Patients' self-care capability is carefully considered but is not a major prerequisite for PD since it is relatively affordable for patients to hire foreign domestic live-in helpers [32]. Hence, Singapore provides a unique setting to explore QOL outcomes for community HD and PD in a more diverse patient population including elderly and younger patients as well as patients with various levels of self-care/dependency.

The aims of the study were as follows:

1. To compare QOL and emotional adjustment between patients on home-based PD regimes and patients on community HD programs
2. To evaluate outcomes across dialysis modalities, namely PD and community HD for elderly versus younger patients.

Methods

Participants

The study was cross sectional and participants were recruited from the PD Center, Singapore General Hospital and 14 National Kidney Foundation (NKF) HD centers. NKF Singapore is a non-profit charitable organization that provides dialysis nationwide in community-based dialysis centers. Catering for over 2,400 patients, these centers contribute to the majority of HD patients in Singapore [29]. NKF caters to patients with lower to middle incomes, who are admitted into the program based on financial considerations [33]. All HD patients recruited for the purposes of this study have been on community-based HD. Data on HD were part of the baseline assessment in a randomized controlled trial of a self-management intervention for HD patients [27].

Patients participating in two concurrent but separate studies were recruited to this investigation if they met the following criteria:

1. Receiving PD for a minimum of 3 months OR Receiving HD for a minimum of 6 months. Dialysis vintage, (i.e., time on dialysis) was therefore controlled in all comparisons.
2. Aged 21 years or over
3. Able to communicate verbally with research assistants
4. Able to provide informed consent.

Recruitment process

Eligible participants were identified by health care professionals and were subsequently approached by research assistants either while awaiting consultation with nephrologists at the PD center or while receiving HD. All patients received detailed written and verbal information regarding the study aims and signed informed consent prior to questionnaire administration. The questionnaires were either self-completed, taken home and subsequently mailed back or administered in a home visit.

The study was approved by Centralized Institutional Review Board, Singhealth Research Facilities and the NUS Institutional Review Board, Singapore.

Measures

Sociodemographic information including age, ethnicity, education, marital and work status and perceived ability to work, income and living arrangements were collected using a self-report questionnaire.

Clinical information was collected from medical records including laboratory results obtained at time of assessment: Serum concentrations of potassium, phosphate, albumin,

and hemoglobin; indices of dialysis adequacy (i.e., Kt/V); primary kidney disease diagnosis; dialysis vintage (i.e., time on dialysis) and comorbid conditions were used to generate the Charlson comorbidity index score as per methodology described by Beddhu et al. [34].

The hospital anxiety and depression scale (HADS)

Symptoms of depression and anxiety were assessed with HADS—English version [35] and the linguistically validated Mandarin version [36, 37]. The HADS is specifically designed for use in somatically ill populations and therefore does not contain somatic items. Higher scores in the depression and anxiety subscales (7 items each, score range 0–21) indicate higher symptom levels [38]. In addition to continuous scores, clinical cutoffs were applied to classify severity of symptoms [normal (0–7), borderline (8–10) and abnormal (11–21) and identify ‘possible’ and ‘probable’ cases of depressive or anxiety disorder (i.e., values > or = 8 and > or = 11, respectively) [39]. The HADS has been shown to have good psychometric properties and discriminatory value for anxiety and depressive disorders in various health settings and in the general population [40]. It has also been validated as a depression-screening instrument for ESRD patients [19, 34] although the utility of the instrument for screening of anxiety in ESRD has been questioned [41].

Quality of life measures

Disease-specific QOL was assessed with the Kidney Disease Quality of Life Short Form (KDQOL-SF) [42] validated in ESRD population in Singapore [43]. To minimize burden of completion, the SF-36 in the original KDQOL-SF was replaced by SF-12, which was added to the kidney disease-specific subscales. Two summary scores, the physical component summary score (PCS) and mental component summary score (MCS) were calculated based on the 12 items of SF-12 (28). PCS and MCS scores have been shown to be equivalent in full SF-36 and SF-12 versions hence comparisons with Singapore SF-36 norms (age, gender and race specific) were possible [44, 45]. The Kidney disease component summary score (KDCS) was also calculated. Scores in all summary and individual subscales range from 0 to 100, with higher scores signifying better QOL. The KDQOL-SF has been used widely in ESRD populations [46].

Subjective global QOL was evaluated with the World Health Organization Quality of Life Instrument, Short Form (WHOQOL-BREF) [47]. This 26-item instrument has been validated in many countries [48]. The mean of the first two items indicates patients’ overall QOL/health, ranging from 1 to 5. The remaining 24 items measure patients’ QOL in four domains: physical health,

psychological health, social relations and environment. All domain scores range from 4 to 20, with higher scores indicating better QOL.

Data analysis

Descriptive statistics included means and standard deviations for continuous variables and frequencies and percentages for categorical variables.

ANCOVAs and χ^2 analyses were used to calculate differences between mean scores and proportions of groups. All case-mix group differences were controlled for in comparative analyses. Effect sizes were calculated using Cohen's *d*.

We initially performed separate analyses to compare CAPD and APD patients. As study outcomes were equivalent (data not shown), we have merged CAPD and APD patients into one PD group in all subsequent comparative analyses. When normative data were available, comparisons with general population normative controls were undertaken to place the results into context.

Results

Study participants

The final sample consisted of 201 PD and 232 HD patients (Table 1).

Of the 263 PD patients approached, 21 failed to meet the selection criteria and were excluded. Of the remaining 242 eligible patients, 41 refused to participate. Thus, our final PD sample consisted of 201 PD patients ($N = 80$ on APD and $N = 121$ on CAPD) (consent rate = 83 %). Our PD cohort appears representative of the PD population in Singapore in terms of age, gender, race, PD modality and rates of ESRD caused by diabetes and glomerulonephritis [29]. However, prevalence of hypertension as primary cause of ESRD (20 vs. 13.3 %, $p = 0.004$) and the proportion of patients requiring assisted care (30 vs. 17.8 %, $p < 0.001$) were higher in the current sample. In addition, fewer patients were employed full time or part time in our study than the whole PD population in Singapore (27 vs. 50.6 %, $p < 0.001$) [29].

Of the 424 eligible HD patients, $N = 273$ patients declined while $N = 24$ patients withdrew before questionnaire administration. The final HD sample comprised 232 patients (consent rate = 48 %) whose sociodemographic and clinical profile is comparable to Singaporean HD renal registry [29], with the exception of lower prevalence of Diabetic Nephropathy (29.8 vs. 62.9 %,

Table 1 Sociodemographic and clinical characteristics of peritoneal dialysis and hemodialysis patients

	Peritoneal dialysis $N = 201$	Hemodialysis $N = 232$	<i>p</i> value
Age (years)	58.92 ± 12.59	53.52 ± 10.47	<0.001
Gender (female)	90 (44.8)	154 (65.5)	0.005
Married (%)	146 (72.6)	154 (65.5)	
Ethnicity			<0.001
Chinese	151 (75 %)	139 (57 %)	
Non-Chinese	50 (25 %)	103 (43 %)	
Education level			0.084
Primary	78 (33.8)	71 (30.6)	
Secondary	81 (40.3)	118 (50.9)	
Tertiary and above	42 (20.9)	43 (18.5)	
Employed (full/part time)	46 (22.9)	78 (34.1)	
Housing			<0.001
1 to 4 room HDB flat ^a	10 (4.9)	20 (8.6)	
HDB 5 room executive flat ^a	114 (56.7)	169 (72.8)	
Private residence	51 (25.4)	39 (16.8)	
Time on dialysis			<0.001
<1 year	57 (28.4)	20 (8.5)	
1–2 years	27 (13.4)	34 (14.5)	
More than 2 years	117 (58.21)	181 (77)	
Average years on dialysis ^b	3.51 ± 3.23	8.03 ± 5.08	<0.001
Previous treatment			>0.05
Switched dialysis			
Modality (either PD or HD before)	12 (5.9)	9 (3.8)	
Never switched	178 (88.5)	219 (94.5)	
Previous transplant	1 (0.6)	4 (1.7)	
CCI	5.60 ± 1.92	5.07 ± 2.91	
PKD diagnosis			0.008
Diabetes	84 (41.7)	80 (37.3)	0.233
Hypertension	38 (18.9)	21 (9)	0.001
Glomerulonephritis	58 (28.8)	85 (39.7)	0.001
Other	21 (10.6)	28 (13)	0.188
Albumin (g/dl)	2.93 (0.51)	3.44 (0.29)	<0.001
Potassium (meq/l)	4.74 (0.79)	4.80 (0.66)	0.389
Phosphate (mmol/l)	1.88 (0.51)	1.83 (0.48)	0.294
Hemoglobin (g/dl)	10.83 (1.62)	11.54 (2.03)	<0.001
Kt/V	2.40 (0.32)	2.44 (0.22)	<0.001

Data expressed as $M \pm SD$ or n (%)

CCI Charlson comorbidity index, PKD primary kidney disease

^a Public apartments developed by the Housing and Development Board (HDB) in Singapore that are available to Singaporeans with subsidy rates and housing loans

^b Discounting time lapses from modality switches

$p < 0.001$) and a higher prevalence of glomerulonephritis (41 % vs. 17.5 %, $p < 0.001$) as the primary kidney disease diagnosis.

There were some differences in socioeconomic and clinical profile of PD and HD subgroups in that PD participants were older; less likely to be employed; lived in higher value residences [as indicated by size and type of residence (i.e., Housing Development Board flats vs. private condominium flats and larger-size flats reflect an increase in value)]; have been on treatment for less time; had more comorbidity, lower albumin and hemoglobin; and were more likely to have hypertension as primary kidney disease diagnosis compared to HD patients. HD sample included a greater percentage of Non-Chinese (i.e., Malay and Indian Singaporeans) and was more likely to have glomerulonephritis as primary kidney disease diagnosis (see Table 1) and were m. These case-mix differences were subsequently controlled for in all comparative analyses.

QOL outcomes between PD and community-based HD

Observed QOL levels (SF-12 PCS, SF-12 MCS) in both PD and HD patients were significantly lower than normative means ($p < 0.001$), signifying QOL impairments in both groups. Mean PCS and MSC scores were more than 1 SD lower than Singapore norms.

ANCOVA comparisons (controlling for case-mix differences) in QOL scores between dialysis modalities indicated higher patient satisfaction with care ($p = 0.02$; Cohen's $d = .24$), yet lower ratings for physical health in PD ($p = 0.007$; Cohen's $d = .27$) compared to community HD patients (see Table 2). Levels of QOL in all other domains were equivalent between HD and PD groups.

Symptoms of anxiety and depression

Mean depression levels were in the range of borderline depression (HADS depression 8–10). The opposite is true for scores on anxiety, with mean scores within the normal range (HADS depression 0–7).

ANCOVA comparisons showed that PD patients reported significantly higher symptoms of depression than HD patients ($p = 0.024$; Cohen's $d = .23$) (see Table 2).

Severity of symptoms of emotional distress and prevalence rates of what are considered to be scores reflecting clinical cases are depicted in Table 3.

The percentage of patients scoring above the cutoff for probable cases of depression in HADS Depression (case-mix-adjusted scores) (i.e., a score ≥ 11) was as 39 % ($N = 77$) and 28 % ($N = 64$) for PD and HD, respectively (see Table 3). Rates of depression were substantially greater in PD relative to HD patients ($\chi^2 = 15.06$; $p < 0.01$; Cohen's $d = .22$).

Table 2 Study outcomes in peritoneal dialysis and hemodialysis patients

Study variables	PD	HD	<i>p</i> value ^a
	Mean \pm SD	Mean \pm SD	
SF12			
PCS	35.98 \pm 8.85	36.84 \pm 8.47	0.656
MCS	43.73 \pm 11.17	43.44 \pm 9.86	0.779
KDQOL			
KDCS	63.04 \pm 13.88	60.83 \pm 14.20	0.246
Symptoms	69.43 \pm 19.24	67.99 \pm 9.90	0.443
Effects of kidney disease	66.98 \pm 21.96	64.17 \pm 21.47	0.461
Burden of kidney disease	32.24 \pm 26.25	31.65 \pm 26.20	0.815
Patient satisfaction	65.51 \pm 22.02	58.04 \pm 22.29	0.02
Staff encouragement	73.76 \pm 29.15	72.84 \pm 23.29	0.533
Social support	70.24 \pm 21.24	70.76 \pm 7.02	0.464
WHOQOL			
Overall	3.07 \pm 0.87	3.14 \pm 0.84	0.408
Physical health	11.83 \pm 3.23	12.77 \pm 2.48	0.007
Psychological health	12.92 \pm 3.06	12.70 \pm 2.63	0.315
Social relations	13.17 \pm 3.17	13.33 \pm 2.99	0.172
Environment	13.43 \pm 2.54	12.72 \pm 2.27	0.097
HADS			
Anxiety	6.99 \pm 5.14	6.70 \pm 4.33	0.531
Depression	9.00 \pm 4.64	8.07 \pm 4.00	0.024

Data expressed as M \pm SD

PCS physical component scale, MCS mental component scale, KDQOL Kidney Disease Quality of Life scale, KDCS kidney disease component summary score, WHOQOL World Health Organization Quality of Life, HADS hospital anxiety and distress scale

^a Significance levels for case-mix-adjusted comparisons. Covariates included age, ethnicity, housing, dialysis vintage, Charlson comorbidity index, albumin, hemoglobin and primary kidney disease diagnosis

Table 3 Symptom severity for HADS depression and anxiety (based on case-mix-adjusted scores)

Symptom severity	Depression		Anxiety	
	PD	HD	PD	HD
Normal [0–7]	81 (40 %)	108 (46 %)	118 (58 %)	105 (45 %)
Borderline [8–10]	43 (21 %)	60 (26 %)	32 (16 %)	54 (23 %)
Abnormal [11–21]	77 (39 %)	64 (28 %)	57 (26 %)	74 (32 %)

Data expressed as *n* (%)

There were no differences between the dialysis modalities in anxiety symptoms or rates of possible cases of anxiety.

A similar pattern of results, that is, increased rates of depression in PD patients was found when unadjusted scores were used ($p < 0.001$).

QOL and emotional adjustment outcomes between elderly and younger patients

A series of 2×2 ANCOVAs (controlling for case-mix differences except for age) were conducted to explore QOL and emotional distress outcomes in patients aged 60 years versus patients aged 60 years and above between HD and PD ($N = 70$ patients over 60 years of age on PD and $N = 111$ HD patients over the age of 60).

These analyses revealed comparable outcomes, that is, QOL, and anxiety and depression symptoms in both younger and elderly patients on PD and HD indicating that dialysis modalities do not confer differential outcomes for age subgroups.

Discussion

This is the first large-scale study of patient-reported outcomes in community HD and home PD patients. To strengthen the comparisons in the absence of a randomized design, we recruited a large and diverse sample of dialysis patients including the elderly and medically frail. PD and HD patients were assessed using a combination of measures of disease-specific and general QOL and of emotional distress. We also adjusted for all known case-mix differences in the comparative analyses.

Study findings suggest that there is no simple answer to the question of which dialysis modality can be expected to provide better QOL and emotional adjustment. PD and HD patients reported equivalent QOL for the majority of domains, yet there were differences in satisfaction with care which favored PD while satisfaction with physical health and symptoms of depression favored HD. Previous studies have similarly shown a lack of uniform QOL advantage for a particular dialysis modality, with some studies documenting better mental outcomes and care satisfaction in PD compared to in-center HD [49–51], whereas in other studies, HD patients fared better in physical health and functioning [9]. What is unique in the study findings is the observed pattern of QOL differences. PD patients were more satisfied with care despite poorer physical health and higher symptoms of depression compared to HD patients—findings that seem paradoxically at odds with each other. It may be that poor physical health and emotional distress in PD patients may elicit more individualized attention and interpersonal care by renal health care professionals, which may result in patients' higher satisfaction with care. It is also possible that these patients have different expectations

of their care and/levels of functioning. More work is needed to explore patients' perceptions and expectations of care under different models of delivery of renal treatment (hospital, home and community) and in particular explore patient satisfaction in the context of satellite community dialysis care. It is nevertheless encouraging that home-based therapies seem to generate high care satisfaction ratings.

What is, however, disconcerting is that symptoms of depression and prevalence of cases of depression were greater in PD compared to community-based HD patients. Although findings of emotional distress in PD patients are not unprecedented [i.e., 16, 52, 53, 27], they do contrast with previous findings of lower depression in PD [i.e., 14, 49]. It is likely that the continuous burden of PD compared with the intermittent nature of HD may place patients at risk for emotional distress. PD may be stressful on a more sustained basis due to the daily responsibility that patients must take for their health and well-being [15], especially for the more frail and dependent patients on PD regimen or those with more comorbidities [54]. Emotional distress is also likely to arise in those PD patients who rely on caregivers for performance of PD as they may feel like a 'daily' burden to the family. This may particularly be the case with patients from Asian background as cultural values of interdependence and collectivism mean that family stability and well-being are often more highly esteemed than the individual [55]. Besides burden to the caregiver, PD treatment may impact more on marital and family dynamics [56], such as constraints imposed in family living space, medicalization of family environment and lack of compartmentalization of dialysis/non-dialysis life that may trigger tension and emotional distress.

Moreover, the greater time requirements especially in relation to manual CAPD exchanges may be more likely to cause disruption in valued activities and hence lead to burnout, exhaustion and emotional distress [54]. Closely related are issues related to social support and social isolation. PD patients may have limited opportunities for social activities, by virtue of the nature of PD being a home-based daily intensive therapy. In contrast, HD affords more opportunities for social networking and support among patients, and also possibly the reassurance of regular contact with renal health care professionals [57]. HD, especially when undertaken in patients' communities may afford even more free time for social engagement and maintenance of lifestyle activities that are conducive to emotional well-being. The proximity of patients' residences to HD centers may obviate lengthy commuting to and from hospitals. Furthermore, the more regular contact of HD patients with health care providers may serve to alleviate treatment- or illness-related concerns and hence explain the lower symptoms of depression. Connecting to

this, the greater involvement and interaction with health care providers in community HD setting might also mean that patients' medical needs and health complaints are more promptly addressed, which may explain the higher ratings of physical health by HD patients.

It is of note that differences in ratings of physical health were observed despite adjustments for clinical case-mix variables. This suggests that these ratings reflect more than comorbidity and/or clinical severity. Previous work has similarly noted that biomedical measures of health status are often unable to capture the perspective of what matters most to patients and correlate poorly with and subjective ratings of health [58–60]. This suggests that QOL ideally needs to be assessed by self-report rather than inferred from laboratory data or comorbidity. Other factors not measured in the study such as health expectations, frailty or nutritional status may also explain the observed effects and should, therefore, be explored in future research. The low levels of albumin may reflect malnutrition and/or inflammation yet as no specific nutritional/inflammatory biomarkers (e.g., C-reactive protein, interleukin-6) were collected, it is not clear whether malnutrition may be driving the lower physical health in PD patients.

Issues related to disclosure of illness in the context of the different dialysis modalities may also explain findings. Cultural norms may mean that patients may be more reticent in disclosing disease identity to others. As such PD may restrict social activities at home or may make it harder for patients to conceal their condition from their immediate social environment given the regular delivery of medical supplies. The intrusiveness of PD may contribute to feelings of losing face and thereby cause emotional distress. These issues, however, were not directly measured in this study or received systematic research attention. All these tentative yet plausible explanations for the observed differences between dialysis modalities need to be carefully explored in future studies.

Finally, it is important to note that levels of depression were generally higher in both HD and PD patients compared to those in the general population in Singapore [29]. This emphasizes the difficulty in recognizing depression in daily practice in the dialysis population. There is a need for regular screening to identify cases and guide subsequent appropriate psychopharmacological and psychotherapeutic interventions [61] for patients on both dialysis modalities.

There are several study limitations. First, the cross-sectional nature of our study does not allow us to draw conclusions about temporal or causal relationships between dialysis modality and QOL or exclude possible residual bias that may influence modality selection. Although we have carefully adjusted for case-mix differences in all comparisons, there may be other unmeasured factors that may explain observed differences, so replication of

findings is important. Cross-sectional data also fail to capture trajectories of changes. Longitudinal studies are needed to examine course of outcomes over time across treatment modalities with regular assessments early upon dialysis initiation.

Responder bias may be a significant consideration in interpretation of data in any study. To this end, it is also important to note that HD patients were recruited as part of a RCT of an intervention program, which included serial questionnaire assessments [62]. Patient self-selection bias is, therefore, more likely as the higher-protocol demands in terms of assessments and likely randomization into an intervention may have discouraged participation among the more frail or needy patients. This may also explain the lower response rates for the HD patients. The lower comorbidity scores for HD participants indicate a possible selection bias for the healthier HD patients. Interestingly, our PD sample comprised a greater percentage of non-employed patients and those requiring assisted care (i.e., PD with assistance from carer) compared to PD registry data. This is likely to reflect the differential approach in recommending and supporting PD in different patient segments over time. Registry data refer to figures a few years back when centers may have taken a more conservative approach, and access to PD may have been more restrictive/selective than today. With the development and implementation of assisted PD programs, a greater number of functionally dependent patients are able to have PD treatment with good clinical outcomes [63]. It is of note though that the sociodemographic and clinical profile (i.e., comorbidities) was comparable to the PD registry data allowing some confidence concerning the generalizability of our findings. Moreover, all case-mix differences were carefully controlled for in all comparisons, and our overall dialysis study cohort (i.e., combined HD and PD) represents the national dialysis population [29]. It is also important to note that despite inclusion of covariates when comparing modalities, the risk for 'residual/unmeasured confounding related to modality selection may explain the observed pattern of results. There are systematic differences in patients on HD or PD that limit widespread generalizability of our findings. PD patients in Australia, New Zealand, France and Singapore are generally older, more dependent and sicker than those treated with HD, whereas the opposite trends are noted in US and UK cohorts [64–66]. The patient composition in our setting may explain the low albumin levels. Albumin is thought to reflect comorbid burden as well as inflammation and malnutrition. Unfortunately, no other nutritional/inflammatory biomarkers were collected to allow us to ascertain the role of nutrition and inflammation. Further research is, therefore, warranted to replicate findings and ascertain whether

advantages related to community HD may still hold true against younger and healthier PD cohorts.

Since our study cohort comprised prevalent patients with mean dialysis vintage over 3 years, study participants may have been self-selected for better clinical outcomes such as technique survival [i.e., lack of complications that could lead to death or permanent cessation of the therapy and switch from one dialysis modality to another] [67]. Future work should benefit from inclusion of both incident and prevalent patients and repeated assessments across time. Furthermore, our HD participants were recruited by community dialysis centers. Although community dialysis is the norm in Singapore, results may not be generalizable to the patients who are in private healthcare dialysis settings or patients who, due to high risks, are not admitted to community dialysis but need to undergo HD in tertiary centers.

Finally, depressive symptoms were assessed by self-reported scales, which do not allow a firm clinical diagnosis. Questionnaires, however, remain valuable tools for large-scale studies. The HADS depression questionnaire has been shown to be a reliable measure of depressive symptoms in renal patients [39, 68]. Recent studies questioned the utility of the HADS anxiety scale in serving as an effective screen for anxiety disorders [69], which may explain our finding of low anxiety symptoms and the lack of a significant difference between dialysis groups. More work is warranted to identify appropriate screening measures for anxiety in ESRD populations and explore the impact of dialysis modality on anxiety.

In conclusion, study findings indicate that certain patient-reported outcomes vary across renal replacement therapies and different models of delivery. Although QOL levels were in the main equivalent in PD and community-based HD, we noted disparate effects in depression and satisfaction with physical health and care. PD patients reported higher symptoms of depression and lower physical health yet higher satisfaction with care. In the context of increasing advocacy for expanding PD utilization, more work is, therefore, necessary to monitor the needs and concerns in PD patients so as to guide interventions and expand the highly rated PD care to programs to promote psychosocial well-being. HD programs in patients' communities outside tertiary health care settings show promise as an alternative mode of renal services that is well received and is associated with good patient-reported outcomes.

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