Published in final edited form as:
Clin J Am Soc Nephrol. 2016 March 7; 11(3): 423–430. doi:10.2215/CJN.01050115.

Quality of Life and Physical Function in Older Patients on Dialysis: A Comparison of Assisted Peritoneal Dialysis with Hemodialysis

Osasuyi U. Iyasere[*], **Edwina A. Brown**[*], **Lina Johansson**[*], **Les Huson**[†], **Joanna Smee**[‡], **Alexander P. Maxwell**[§], **Ken Farrington**[‖], and **Andrew Davenport**[¶]

[*]Imperial College Renal and Transplant Centre, Hammersmith Hospital, London, United Kingdom

[†]Centre for Pharmacology and Therapeutics, Division of Experimental Medicine, Imperial College London, London, United Kingdom

[‡]Cardiovascular and Renal Research Support Unit, Imperial College Healthcare National Health Service Trust, London, United Kingdom

[§]Centre for Public Health, School of Medicine, Dentistry and Biomedical Sciences, Queens University, Belfast, United Kingdom

[‖]Renal Department, Lister Hospital, Stevenage, United Kingdom

[¶]University College London Centre for Nephrology, Royal Free Hospital, London, United Kingdom

Abstract

Background and objectives—In-center hemodialysis (HD) is often the default dialysis modality for older patients. Few centers use assisted peritoneal dialysis (PD), which enables treatment at home. This observational study compared quality of life (QoL) and physical function between older patients on assisted PD and HD.

Design, setting, participants, & measurements—Patients on assisted PD who were >60 years old and on dialysis for >3 months were recruited and matched to patients on HD (needing hospital transport) by age, sex, diabetes, dialysis vintage, ethnicity, and index of deprivation. Frailty was assessed using the Clinical Frailty Scale. QoL assessments included Hospital Anxiety and Depression Scale (HADS), Short Form-12, Palliative Outcomes Symptom Scale (renal), Illness Intrusiveness Rating Scale, and Renal Treatment Satisfaction Questionnaire (RTSQ). Physical function was evaluated by Barthel Score and timed up and go test.

Results—In total, 251 patients (129 PD and 122 HD) were recruited. In unadjusted analysis, patients on assisted PD had a higher prevalence of possible depression (HADS>8; PD=38.8%; HD=23.8%; P=0.05) and higher HADS depression score (median: PD=6; HD=5; P=0.05) but higher RTSQ scores (median: PD=55; HD=51; P<0.01). In a generalized linear regression model

Correspondence: Dr. Osasuyi U. Iyasere, Hammersmith Hospital, Du Cane Road, London W12 0HS, United Kingdom. o.iyasere13@imperial.ac.uk.

Disclosures

E.A.B. has received speaker honoraria and research funding from Baxter Healthcare, Berkshire, United Kingdom. All other authors have declared no conflict of interest.

Europe PMC Funders Author Manuscripts

adjusting for age, sex, comorbidity, dialysis vintage, and frailty, assisted PD continued to be associated with higher RTSQ scores (P=0.04) but not with other QoL measures.

Conclusions—There are no differences in measures of QoL and physical function between older patients on assisted PD and comparable patients on HD, except for treatment satisfaction, which is higher in patients on PD. Assisted PD should be considered as an alternative to HD for older patients, allowing them to make their preferred choices.

Introduction

The management of older patients with advanced kidney disease remains a challenge. In 2012, the United Kingdom Renal Registry reported that the peak rates for starting RRT were in the 75- to 79-year-old age group for women and 80- to 84-year-old age group for men (1). In the United States, the highest growth rate for starting RRT is for those ≥85 years old (2). Older patients tend to present later for dialysis (3), with multiple comorbidities, a higher risk of cognitive dysfunction (4), frailty (5,6), and sensory impairments (7) as well as functional and psychologic dependence (8). These limitations have traditionally restricted the use of home-based therapies, including peritoneal dialysis (PD), in older people. However, with education and the availability of assistance, 60% of eligible older patients prefer PD, 40% of whom start dialysis on PD (9).

In the United Kingdom, older patients on dialysis typically receive in-center hemodialysis (HD), with only 10.5% of patients ≥75 years old on prevalent dialysis being on PD (10). This pattern is replicated in many European countries, with patients ≥70 years old being 56% less likely to receive PD than those between 20 and 44 years of age (11). In contrast, dialysis delivery in France has been by assisted PD provided by private community nurses (12,13). This has enabled older patients to dialyze at home, with PD being chosen more often than in-center HD by patients >85 years old (14). Assisted PD is becoming increasingly available as a model of care for older patients in other European countries (15).

In the United Kingdom, the use of assisted PD provided by the National Health Service has increased slowly since 2006. This involves the use of overnight cyclers (automated PD), which are set up by family members or health care assistants who visit once daily. The patients and their families remain responsible for connection to and disconnection from the cycling machine (16). Assisted PD is used to allow existing patients to continue PD as they become frailer or for patients who are considered too frail for HD. The restricted use of assisted PD is partly explained by limitations in current evidence.

Several assisted PD programs have reported on patient survival (17,18) and technique survival (19), with outcomes comparable with those of self-care PD. Quality of life (QoL), an important outcome in older patients, has been shown to influence decisions regarding modality choice. Two studies have compared QoL on HD and self-care PD in older patients. The North Thames Dialysis Study found no difference in QoL between patients >70 years old on PD or HD (20). In the more recent Broadening Options for Long-Term Dialysis in the Elderly (BOLDE) Study, older patients on PD experienced less illness intrusion compared with those on HD after adjustment for comorbidities and other confounders (21). There are,

Europe PMC Funders Author Manuscripts

however, no studies comparing QoL between older patients on assisted PD and the more prevalent HD.

We hypothesize that QoL is better for older patients on assisted PD compared with similar patients receiving incenter HD. The Frail and Elderly Patient Outcomes on Dialysis (FEPOD) Study is an observational study that aims to compare QoL and physical function between older patients on assisted PD and HD.

Materials and Methods

Patients were recruited from 22 renal centers in England and Northern Ireland. The study sample consists of two subsets. The FEPOD 1 subset (funded by The Dunhill Medical Trust) included patients from centers in London and Northern Ireland. The study was expanded with additional funding (a Baxter Healthcare Clinical Evidence Grant) to include a second subset of patients from other centers in England (FEPOD 2). Ethical approval was obtained from the National Research Ethics Committee (London–Fulham; reference nos. 11/LO/1428 and 11/LO/1886).

Inclusion and Exclusion Criteria

Patients on assisted PD were defined as being unable to perform PD at home without assistance from paid health care workers or family members. Patients on HD were eligible if they required hospital transport to attend dialysis sessions. All were ≥60 years old, on dialysis for ≥3 months, and free from hospitalization for ≥30 days. Patients with known cognitive impairment, unable to understand English, or with a life expectancy of <6 months were excluded from the study.

Subjects and Recruitment

Because of fewer patients eligible for assisted PD, these were recruited first. Each was matched by the study team to an eligible HD patient from the same center by age (±2 years), sex, diabetes status, time on dialysis (±1 year), ethnicity (where possible), and socioeconomic status as determined by the Index of Deprivation 2007 (22). Matching was performed to ensure that both cohorts had similar baseline characteristics and reduce the influence of known confounders.

Study Visit

The study visit consisted of sequential QoL and physical function assessments performed in a standard order. Demographic and clinical characteristics were collected from medical records and during the assessment. Comorbidities were evaluated using the Stoke–Davies comorbidity score (23). Frailty was also assessed by the researcher during the study visit. For patients on HD, assessments were conducted on a nondialysis day or before dialysis. Cognitive function and timed up and go tests were conducted in the FEPOD 1 subset of 106 patients.

Europe PMC Funders Author Manuscripts

Outcome Measures

QoL Measures

Short Form-12, Version 2: The Short Form-12 (SF-12) is a self-assessment of physical and mental health and has two scores: the Physical Component Summary (PCS) scale and the Mental Component Summary (MCS) scale. As an abbreviated version of the SF-36, it minimizes the burden of completion in older people. With >90% agreement between the SF-12 and SF-36, population norms for the SF-36 can be used to interpret SF-12 results (24,25).

Hospital Anxiety and Depression Scale: The Hospital Anxiety and Depression Scale (HADS) is a screening tool with scores ranging from zero to 21 for either depression or anxiety. A depression score of eight and above indicates possible depression (26). Screening for depression in patients on dialysis using HADS correlates well with the gold standard diagnosis for mood disorders (depression) by the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders (27).

Illness Intrusiveness Ratings Scale: This self-reporting tool assesses the extent to which the illness and/or treatment interferes with 13 life domains. It has been validated in patients with ESRD (28). Scores range from 13 to 91, with a higher score indicating more illness intrusion.

Symptoms: Symptoms were measured using the Palliative Care Outcome Scale-S renal scale. This is an adaptation of the Palliative Care Outcome Scale, which was originally developed for oncology patients, allowing for renal-specific symptoms (29).

Satisfaction with Treatment: Satisfaction with treatment was assessed using the Renal Treatment Satisfaction Questionnaire (RTSQ) (30). This 11-item tool has been validated in patients on HD, patients on PD, and patients with transplants.

Physical Function

Barthel Index: This index evaluates performance in activities of daily living (31). Scores range from 0 to 100, with lower scores suggesting increased disability.

Timed Up and Go Test: This test times the patient standing up from a chair, walking a fixed distance, turning, walking back, and sitting down (32). Completion time ≥14 seconds is associated with an increased risk of falls.

Other Clinical Assessments

Frailty—The Canadian Study of Health and Aging Clinical Frailty Scale was used to measure frailty. Scores range from one to seven, with higher scores corresponding to increasing levels of frailty. It evaluates dependence for activities of daily living and has been shown to be predictive of death or the need to be institutionalized, similar to other established measures of frailty (33).

Europe PMC Funders Author Manuscripts

Cognitive Function

Miniature Mental State Examination: This test is routinely used in clinical practice (34), with available normative data stratified by age groups and education levels (35). Scores range from one to 30, with a score <24 suggesting cognitive impairment.

Trail-Making Test B: This test measures the time taken to follow a trail of alternating numbers and alphabets (36). Completion time ≥300 seconds suggests executive dysfunction.

Others—Questionnaires were designed to assess social networks, falls, and health care use.

Statistical Analyses

All statistical analyses were performed using SAS software (version 9.3; SAS Institute Inc., Cary, NC). Categorical variables are presented as percentages, and continuous variables are presented as median values with interquartile ranges. Mann–Whitney, Pearson chi-squared, or Fisher exact tests were used to compare baseline clinical characteristics between PD and HD. Statistical significance tests were not used to compare baseline demographic characteristics, because both samples were matched on demographics and therefore, do not constitute random samples from the respective populations. Relationships between QoL measures and participant characteristics were analyzed using generalized linear models with a γ-error structure, because the assumption of normality was not justified for most of the outcome measures. This modeling methodology followed standard practice for multiple regression analysis. Both univariate analyses and multivariate analyses were performed, the latter indicating the effect of the covariate on the outcome measure after adjustment for all other covariates in the model. All models adjusted for age, sex, dialysis vintage, Stoke–Davies comorbidity score, and frailty score in addition to dialysis modality. These covariates were selected *a priori* as potential confounders. Effect estimates were derived from the γ-regression models. A *post hoc* analysis of frail patients (frailty score ≥5) was also performed using the same method.

The relationship between dialysis modality and possible depression (HADS depression score ≥8) was evaluated using logistic regression analysis adjusting for baseline participant characteristics as stated above.

Because the models studied associations between participant characteristics and several outcomes, all P values were adjusted for multiple significance testing using the false discovery rate adjustment by Benjamini and Hochberg (37). This adjustment provides strong protection against false-positive associations and has been recommended for use in health studies in a recent review (38).

Power Calculation

A retrospective power calculation suggests that the study sample size would have 80% power to detect associations, which gives a small increase in multiple correlation (0.028) in a model that has low overall multiple correlation (0.100). Multiple regression sample size calculations are on the basis of many assumptions, and this retrospective power calculation

should be regarded as approximate. However, it suggests that this sample size is capable of detecting relatively small associations.

Results

Patient Characteristics

In total, 251 patients (129 PD and 122 HD) were recruited. Seven patients on assisted PD included in the analysis remained unmatched. The assisted PD and HD groups were well matched by age, ethnicity, sex, dialysis vintage, diabetes status, and index of deprivation (Table 1); 53% of the patients on assisted PD connected and disconnected themselves to/from the cycling machine, whereas 40% and 7% were connected and disconnected by family and a paid caregiver, respectively. However, they all required assistance with the PD fluid bags and setting up the cycler.

Clinical Characteristics

Table 2 shows the clinical characteristics for the cohort; 48% met the criteria for frailty (frailty scores ≥5; 51.9% PD; 42.6% HD; P=0.32). The comorbidity burden was not different between the groups; 46% of the study group had been admitted in the previous 3 months, and 33% sustained one or more falls in the preceding 6 months. Cognitive function was assessed in the FEPOD 1 subset (n=106 patients). Only four patients (4.8%) had abnormal Mini Mental State Examination scores. In contrast, 41% had executive dysfunction (Trail-Making Test B time >300 seconds), with no significant difference in prevalence between patients on assisted PD and patients on HD; 38% of patients with executive dysfunction met the criteria for possible depression (HADS depression score ≥8).

Study Outcomes

Table 3 presents the unadjusted QoL measures for patients on assisted PD and patients on HD. The assisted PD group had higher HADS depression scores (median: PD=6; interquartile range [IQR], 3–7.75; HD=5; IQR, 3–8.75; P=0.05) and a higher prevalence of possible depression (38.8% versus 23.8%; P=0.05). Conversely, the RTSQ score was higher in patients on assisted PD (median: 55; IQR, 48–59.75 versus 51; IQR, 44–57; P<0.01). There were no significant differences in the other QoL measures.

In multivariate analysis using generalized linear models (each adjusted for age, sex, dialysis vintage, comorbidity score, and frailty), HD was associated with lower RTSQ scores (P=0.04) compared with assisted PD. There were no significant differences in other QoL measures between HD and assisted PD. Frailty was associated with worse SF-12 MCS, SF-12 PCS, Barthel Index, symptoms, illness intrusion, and HADS scores (P<0.01), whereas age was associated with lower illness intrusion (P<0.01). Table 4 shows the effect estimates of each covariate on each QoL measure.

In a *post hoc* analysis of 119 frail patients (frailty score ≥5), there was no significant difference in any QoL measure between assisted PD and HD after adjusting for the other covariates (Table 5).

In logistic regression analysis with possible depression (HADS depression score ≥8) as the outcome variable, there was no difference in the odds for depression between assisted PD and HD. However, the odds for depression were 53% higher for every unit increase in the frailty score (odds ratio, 1.53; 95% confidence interval, 1.12 to 2.07).

Discussion

The principal determinants of QoL as rated by the older person are being independent and being in control of one's own life (39). We, therefore, postulated *a priori* that QoL is better for patients on assisted PD compared with patients on in-center HD. However, the study showed no differences in measures of QoL apart from treatment satisfaction, which was higher in older patients on assisted PD compared with patients on HD.

Reports on the value of assisted PD in older patients have been published recently from developed and emerging economies (9,40,41). A registry study from France, which has the largest experience with assisted PD (12,13), reported a median survival of 27.1 months in 1613 patients >75 years old on PD (89% on assisted PD) (17). This compares with a median survival of 2.4 years for patients of the same age but mostly on HD in the United Kingdom (42).

Two prior studies compared QoL in older patients on self-care PD and HD. They also found no significant difference in outcomes, similar to the FEPOD Study. The BOLDE Study did, however, report less illness intrusion in the PD group (20,21). The SF-12 scores were lower in the FEPOD Study cohort compared with those in the BOLDE Study, with higher illness intrusion scores. Possible depression was also more prevalent in the FEPOD Study compared with the BOLDE Study (32% versus 18%). These differences may reflect the influence of frailty in our cohort, a common indication for assisted PD.

Although dialysis modality was not statistically significantly associated with measures of QoL in either unadjusted or adjusted analysis, higher frailty scores were associated with lower QoL, even after adjustment for dialysis modality and other patient characteristics. Frailty is characterized by a lack of physiologic reserve and an impaired response to acute stressors. It is predictive of increasing disability, hospitalization, and mortality (43); 48% of our study participants were characterized as frail (frailty score ≤5). Collectively, these findings may suggest that, among patients requiring assistance with dialysis treatments, choice of modality is a less important determinant of QoL than characteristics, such as frailty, that drive the need for assistance.

Because one half of the patients on PD were not frail, there would have been other indications for assistance (*e.g.*, visual impairment or stroke). There are no standardized criteria for assisted PD other than a requirement for assistance to enable PD at home. We did not assess the indications for assisted PD at individual centers.

Treatment satisfaction (RTSQ) scores were higher in patients on assisted PD compared with those receiving incenter HD, even when baseline characteristics were considered. This is consistent with the results from comparative studies involving patients on self-care PD

Europe PMC Funders Author Manuscripts

(44,45). One may speculate that assisted PD at home increases the likelihood of maintaining independence and control, leading to higher treatment satisfaction in older patients.

This study has some notable limitations. The cross-sectional design means that results are limited to associations and not causality. The timing of the two sources of funding also affected the study design. Cognitive function and timed up and go tests were, therefore, not assessed in all patients. To limit confounding, patients on assisted PD were recruited and matched to eligible patients on HD requiring hospital transport at individual centers. We have, therefore, been unable to collect information about the denominator PD and HD populations. Because dialysis transport in the United Kingdom is most often provided (and funded) for multimorbid, dependent patients, this criterion was included to help ensure that suitable HD matches were recruited. It is, however, recognized that this matching process may increase the risk of selection bias. In addition, the findings may not be generalizable, because the frailest patients with short life expectancy and significant cognitive impairment were excluded. Study outcomes may also differ in a population with a different model of assisted PD compared with that in the United Kingdom. The sample size was limited by the number of patients eligible for assisted PD, although a retrospective power calculation suggests that the study is suitably sized to detect associations. Despite these limitations, this is the largest study to compare QoL between patients on assisted PD and patients on HD.

In summary, our study has shown that QoL measures do not differ between older patients on assisted PD and comparable patients receiving in-center HD, with the exception of treatment satisfaction. This is higher for patients on assisted PD compared with patients on HD. QoL in these patients may be influenced by nondialysis factors, including frailty. The morbidity risk is also considerable, with a high prevalence of falls and hospitalization. These issues should be discussed with older patients with advanced kidney disease and their families to allow them choose the most appropriate therapy (46,47).

Longitudinal studies are needed to determine comparative outcomes, use of health care resources, and overall costs. This study suggests that assisted PD should be considered as an alternative to in-center HD for older patients, at least from the viewpoint of QoL.

Acknowledgments

This work was supported by The Dunhill Medical Trust Grant R202/0511, Baxter Clinical Evidence Council Grant 11CECPDEU1006, the Imperial National Institute for Health Research Biomedical Research Centre, and the National Institute for Health Research through the Comprehensive Clinical Research Network.

We thank the Frail and Elderly Patient Outcomes on Dialysis Study investigators and centers: Peter Maxwell, Belfast Health and Social Care Trust; John Stoves, Bradford Teaching Hospitals; Anand Vardhan, Central Manchester University Hospitals; Richard Fluck, Derby City General Hospital; E.A.B., Hammersmith Hospital; Helen Collinson, Hull Royal Infirmary; Sally Krause, Kent and Canterbury Hospital; Maxine Keddo, Kings College Hospital; Graham Warwick, Leicester General Hospital; K.F., Lister Hospital; Richard Fielding, Newcastle Hospitals; Sarah Jenkins, Northern General Hospital; Camille Harron, Northern HSC Trust; A.D., Royal Free Hospital; Stan Fan, Royal London Hospital; David Lewis, Salford Royal Hospital; Neal Morgan, Southern HSC Trust; Steve Nelson, St. George's Hospital; Hugh Gallagher, St. Helier Hospital; Graham Woodrow, St. James University Hospital; Michael Quinn, Western HSC Trust; and Simon Davies, University Hospitals of North Staffordshire.

References

1. Gilg J, Rao A, Fogarty D. UK Renal Registry 16th annual report: Chapter 1 UK renal replacement therapy incidence in 2012: National and centre-specific analyses. Nephron Clin Pract. 2013; 125:1–27. [PubMed: 24662165]
2. U.S. Renal Data System. USRDS 2010 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: 2010.
3. Roderick P, Jones C, Drey N, Blakeley S, Webster P, Goddard J, Garland S, Bourton L, Mason J, Tomson C. Late referral for end-stage renal disease: A region-wide survey in the south west of England. Nephrol Dial Transplant. 2002; 17:1252–1259. [PubMed: 12105249]
4. Kurella M, Chertow GM, Fried LF, Cummings SR, Harris T, Simonsick E, Satterfield S, Ayonayon H, Yaffe K. Chronic kidney disease and cognitive impairment in the elderly: The health, aging, and body composition study. J Am Soc Nephrol. 2005; 16:2127–2133. [PubMed: 15888561]
5. Johansen KL, Chertow GM, Jin C, Kutner NG. Significance of frailty among dialysis patients. J Am Soc Nephrol. 2007; 18:2960–2967. [PubMed: 17942958]
6. Roshanravan B, Khatri M, Robinson-Cohen C, Levin G, Patel KV, de Boer IH, Seliger S, Ruzinski J, Himmelfarb J, Kestenbaum B. A prospective study of frailty in nephrology-referred patients with CKD. Am J Kidney Dis. 2012; 60:912–921. [PubMed: 22770927]
7. Chiu E, Markowitz SN, Cook WL, Jassal SV. Visual impairment in elderly patients receiving long-term hemodialysis. Am J Kidney Dis. 2008; 52:1131–1138. [PubMed: 18706752]
8. Cook WL, Jassal SV. Functional dependencies among the elderly on hemodialysis. Kidney Int. 2008; 73:1289–1295. [PubMed: 18354381]
9. Oliver MJ, Quinn RR, Richardson EP, Kiss AJ, Lamping DL, Manns BJ. Home care assistance and the utilization of peritoneal dialysis. Kidney Int. 2007; 71:673–678. [PubMed: 17264874]
10. Shaw C, Pitcher D, Pruthi R, Fogarty D. UK Renal Registry 16th annual report: Chapter 2 UK RRT prevalence in 2012: National and centre-specific analyses. Nephron Clin Pract. 2013; 125:29–53. [PubMed: 24662166]
11. van de Luijtgaarden MW, Noordzij M, Stel VS, Ravani P, Jarraya F, Collart F, Schön S, Leivestad T, Puttinger H, Wanner C, Jager KJ. Effects of comorbid and demographic factors on dialysis modality choice and related patient survival in Europe. Nephrol Dial Transplant. 2011; 26:2940–2947. [PubMed: 21325351]
12. Verger C, Ryckelynck JP, Duman M, Veniez G, Lobbedez T, Boulanger E, Moranne O. French peritoneal dialysis registry (RDPLF): Outline and main results. Kidney Int Suppl. 2006; 103:S12–S20. [PubMed: 17080102]
13. Lobbedez T, Moldovan R, Lecame M, Hurault de Ligny B, El Haggan W, Ryckelynck JP. Assisted peritoneal dialysis. Experience in a French renal department. Perit Dial Int. 2006; 26:671–676. [PubMed: 17047234]
14. Couchoud C, Moranne O, Frimat L, Labeeuw M, Allot V, Stengel B. Associations between comorbidities, treatment choice and outcome in the elderly with end-stage renal disease. Nephrol Dial Transplant. 2007; 22:3246–3254. [PubMed: 17616533]
15. Brown EA, Dratwa M, Povlsen JV. Assisted peritoneal dialysis–an evolving dialysis modality. Nephrol Dial Transplant. 2007; 22:3091–3092. [PubMed: 17595188]
16. Brown EA, Pryde K, Schlamlzhaf C. Assisted automated peritoneal dialysis (aAPD)—Results of a feasibility study. Brit J Renal Med. 2006; 11:23.
17. Castrale C, Evans D, Verger C, Fabre E, Aguilera D, Ryckelynck JP, Lobbedez T. Peritoneal dialysis in elderly patients: Report from the French Peritoneal Dialysis Registry (RDPLF). Nephrol Dial Transplant. 2010; 25:255–262. [PubMed: 19666656]
18. Povlsen JV, Ivarsen P. Assisted peritoneal dialysis: Also for the late referred elderly patient. Perit Dial Int. 2008; 28:461–467. [PubMed: 18708537]
19. Lobbedez T, Verger C, Ryckelynck JP, Fabre E, Evans D. Is assisted peritoneal dialysis associated with technique survival when competing events are considered? Clin J Am Soc Nephrol. 2012; 7:612–618. [PubMed: 22344506]

20. 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; 22:463–470. [PubMed: 12322817]
21. Brown EA, Johansson L, Farrington K, Gallagher H, Sensky T, Gordon F, Da Silva-Gane M, Beckett N, Hickson M. Broadening Options for Long-term Dialysis in the Elderly (BOLDE): Differences in quality of life on peritoneal dialysis compared to haemodialysis for older patients. Nephrol Dial Transplant. 2010; 25:3755–3763. [PubMed: 20400451]
22. Office of National Statistics. [Accessed December 31, 2013] Neighbourhood Statistics. 2007. Available at: http://www.neighbourhood.statistics.gov.uk/dissemination
23. Davies SJ, Phillips L, Naish PF, Russell GI. Quantifying comorbidity in peritoneal dialysis patients and its relationship to other predictors of survival. Nephrol Dial Transplant. 2002; 17:1085–1092. [PubMed: 12032201]
24. Nortvedt MW, Riise T, Myhr KM, Nyland HI. Performance of the SF-36, SF-12, and RAND-36 summary scales in a multiple sclerosis population. Med Care. 2000; 38:1022–1028. [PubMed: 11021675]
25. Ware J Jr. Kosinski M, Keller SD, A 12-Item Short-Form Health Survey. Construction of scales and preliminary tests of reliability and validity. Med Care. 1996; 34:220–233. [PubMed: 8628042]
26. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983; 67:361–370. [PubMed: 6880820]
27. Cukor D, Coplan J, Brown C, Friedman S, Newville H, Safier M, Spielman LA, Peterson RA, Kimmel PL. Anxiety disorders in adults treated by hemodialysis: A single-center study. Am J Kidney Dis. 2008; 52:128–136. [PubMed: 18440682]
28. Devins GM, Edworthy SM, Guthrie NG, Martin L. Illness intrusiveness in rheumatoid arthritis: Differential impact on depressive symptoms over the adult lifespan. J Rheumatol. 1992; 19:709–715. [PubMed: 1613699]
29. Murphy EL, Murtagh FE, Carey I, Sheerin NS. Understanding symptoms in patients with advanced chronic kidney disease managed without dialysis: Use of a short patient-completed assessment tool. Nephron Clin Pract. 2009; 111:c74–c80. [PubMed: 19088482]
30. Barendse SM, Speight J, Bradley C, The Renal Treatment Satisfaction Questionnaire (RTSQ). A measure of satisfaction with treatment for chronic kidney failure. Am J Kidney Dis. 2005; 45:572–579. [PubMed: 15754280]
31. Mahoney FI, Barthel DW. Functional evaluation: The Barthel index. Md State Med J. 1965; 14:61–65. [PubMed: 14258950]
32. Podsiadlo D, Richardson S. The timed “Up & Go”: A test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991; 39:142–148. [PubMed: 1991946]
33. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, Mitnitski A. A global clinical measure of fitness and frailty in elderly people. CMAJ. 2005; 173:489–495. [PubMed: 16129869]
34. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975; 12:189–198. [PubMed: 1202204]
35. Crum RM, Anthony JC, Bassett SS, Folstein MF. Population-based norms for the Mini-Mental State Examination by age and educational level. JAMA. 1993; 269:2386–2391. [PubMed: 8479064]
36. Tombaugh TN. Trail Making Test A and B: Normative data stratified by age and education. Arch Clin Neuropsychol. 2004; 19:203–214. [PubMed: 15010086]
37. Benjamini Y, Hochberg Y. Controlling the false discovery rate: A practical and powerful approach to multiple testing. Series B (methodological) ed. J R Stat Soc. 1995; 57:289–300.
38. Glickman ME, Rao SR, Schultz MR. False discovery rate control is a recommended alternative to Bonferroni-type adjustments in health studies. J Clin Epidemiol. 2014; 67:850–857. [PubMed: 24831050]
39. Ahmed S, Addicott C, Qureshi M, Pendleton N, Clague JE, Horan MA. Opinions of elderly people on treatment for end-stage renal disease. Gerontology. 1999; 45:156–159. [PubMed: 10202260]

40. Povlsen JV, Ivarsen P. Assisted automated peritoneal dialysis (AAPD) for the functionally dependent and elderly patient. Perit Dial Int. 2005; 25(Suppl 3):S60–S63. [PubMed: 16048259]

41. Franco MR, Fernandes N, Ribeiro CA, Qureshi AR, Divino-Filho JC, da Glória Lima M. A Brazilian experience in assisted automated peritoneal dialysis: A reliable and effective home care approach. Perit Dial Int. 2013; 33:252–258. [PubMed: 23660606]

42. Pruthi R, Steenkamp R, Feest T. UK Renal Registry 16th annual report: Chapter 8 survival and cause of death of UK adult patients on renal replacement therapy in 2012: National and centre-specific analyses. Nephron Clin Pract. 2013; 125:139–169. [PubMed: 24662172]

43. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop WJ, Burke G, McBurnie MA, Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: Evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001; 56:M146–M156. [PubMed: 11253156]

44. Fadem SZ, Walker DR, Abbott G, Friedman AL, Goldman R, Sexton S, Buettner K, Robinson K, Peters TG. Satisfaction with renal replacement therapy and education: The American Association of Kidney Patients survey. Clin J Am Soc Nephrol. 2011; 6:605–612. [PubMed: 21330485]

45. Juergensen E, Wuerth D, Finkelstein SH, Juergensen PH, Bekui A, Finkelstein FO. Hemodialysis and peritoneal dialysis: Patients' assessment of their satisfaction with therapy and the impact of the therapy on their lives. Clin J Am Soc Nephrol. 2006; 1:1191–1196. [PubMed: 17699347]

46. Muthalagappan S, Johansson L, Kong WM, Brown EA. Dialysis or conservative care for frail older patients: Ethics of shared decision-making. Nephrol Dial Transplant. 2013; 28:2717–2722. [PubMed: 23787549]

47. Swidler M. Considerations in starting a patient with advanced frailty on dialysis: Complex biology meets challenging ethics. Clin J Am Soc Nephrol. 2013; 8:1421–1428. [PubMed: 23788617]

Europe PMC Funders Author Manuscripts

Table 1
Demographic characteristics of the studied cohort

Characteristic	Participants	
	aPD, *n*=129	HD, *n*=122
Median age, yr (IQR)	76 (70–81)	75 (69–80)
Age range, yr, % of *n*		
60–69	24.0	24.8
70–79	45.0	47.1
80–89	30.2	27.3
≥90	0.8	0.8
Men, % of *n*	58.9	59.8
Ethnicity, % of *n*		
White European	86.0	86.8
Afro-Caribbean	4.7	7.4
Asian	8.5	5.0
Other	0.8	0.8
Diabetes, % of *n*	49.5	50.5
Median index of deprivation[a] (IQR)	16.3 (10.1–33.1)	20.4 (12.8–32.3)
Months on dialysis, median (IQR)	22 (11–35)	27.5 (15.5–39.5)
Cause of kidney disease, % of *n*		
Diabetes	26.6	21.0
GN	11.3	10.1
Pyelo/tubulointerstitial nephritis	16.1	6.8
Hypertension	8.9	5.9
Renovascular disease	11.3	21.0
Unknown	16.9	16.8
Other	8.9	18.5
Social support, % of *n*		
Residence		
Own home	92.9	84.4
Warden controlled (retirement housing)	6.3	13.9
Nursing home	0.8	1.6
Living alone	23.3	27.9
Help from friends/family for daily activities	54.3	63.9
Paid help for daily activities (one or more times in 1 wk)	49.6	36.1

aPD, assisted peritoneal dialysis; HD, hemodialysis; IQR, interquartile range.

[a]Does not include patients in northern Ireland.

Europe PMC Funders Author Manuscripts

Table 2
Clinical characteristics by dialysis modality

Characteristic	aPD, *n*=129	HD, *n*=122	Multiplicity–Adjusted *P* Value
Median frailty score (IQR)	5 (4–5)	4 (3–5)	0.17
Score ≥5 (mild to severe frailty)	51.9	42.6	0.32
Comorbidities, % of *n*			
Malignancy	10.9	21.3	>0.99
Ischemic heart disease	26.6	38.5	0.15
Peripheral vascular disease	54.2	45.8	0.79
Left ventricular dysfunction	23.4	18.0	0.54
Systemic collagenous vascular disorders	5.5	6.6	>0.99
Previous stroke	14.0	8.2	0.15
Visual impairment	5.7	3.1	0.31
Arthritis	17.1	17.2	>0.99
Median Stoke–Davies comorbidity score (IQR)	2 (1–3)	2 (1–3)	0.66
Cognitive function, % of *n*[a]			
TMT-B time >300 s (HD=47; PD=48)[a]	54.2	27.7	0.37
MMSE<24 (HD=43; PD=40)[a]	2.3	7.5	0.62
Hospital admissions in last 3 mo			
Patients admitted, % of *n*	49.2	42.9	0.31
Dialysis related, % of all admissions	55.5	23.1	0.14
Falls in preceding 6 mo			
Patients affected, % of *n*	34.1	32.0	0.72
Fracture, % of patients who fell	18.4	9.5	0.25

aPD, assisted peritoneal dialysis; HD, hemodialysis; IQR, interquartile range; TMT-B, Trail-Making Test B; PD, peritoneal dialysis; MMSE, Mini Mental State Examination.

[a]The Frail and Elderly Patient Outcomes on Dialysis Study subset with complete data.

Europe PMC Funders Author Manuscripts

Table 3
Univariate comparison: Measures of quality of life and physical function

Variables	aPD, *n*=129	HD, *n*=122	Multiplicity–Adjusted *P* Value
SF-12 PCS,[a] median (IQR)	33 (26.6–40.3)	31.7 (25.2–38.2)	0.57
SF-12 MCS,[a] median (IQR)	49.3 (38.4–54.2)	50.8 (40.3–59.6)	0.35
Illness Intrusiveness Rating Scale, median (IQR)	33 (21–43.75)	33 (23–43)	0.86
HADS depression, median (IQR)	6 (3–8.75)	5 (3–7.75)	0.05
Possible depression (HADS>8), % of *n*	38.8	23.8	0.05
Renal Treatment Satisfaction Questionnaire score, median (IQR)	55 (48–59.75)	51 (44–57)	0.01
Symptom count, median (IQR)	8 (6–10)	9 (7–11)	0.14
Symptom score, median (IQR)	14 (9–20)	16 (11–22)	0.39
Barthel Score, median (IQR)	90 (75–100)	90 (78.3–100)	0.82
Timed up and go test ≥14 s (HD=46; PD=49), % of *n*	80.4	79.6	0.99

aPD, assisted peritoneal dialysis; HD, hemodialysis; SF-12, Short Form-12; PCS, Physical Component Summary; IQR, interquartile range; MCS, Mental Component Summary; HADS, Hospital Anxiety and Depression Scale; PD, peritoneal dialysis.

[a]A higher score indicates better quality of life.

Table 4
Effect estimates from multivariate analysis using generalized linear models

QoL Measures and Predictors	Effect Estimate	95% Confidence Interval	Adjusted *P* Value
SF-12 MCS			
Age	1.00	1.00 to 1.01	0.91
Sex	1.03	0.96 to 1.11	0.63
Time on dialysis	1.00	1.00 to 1.00	0.83
Stoke–Davies comorbidity score	0.98	0.95 to 1.02	0.63
Frailty score[a]	0.94	0.91 to 0.97	<0.01
HD versus PD	0.98	0.92 to 1.06	0.87
SF-12 PCS			
Age	1.00	0.99 to 1.00	0.85
Sex	1.10	1.00 to 1.22	0.23
Time on dialysis	1.00	1.00 to 1.00	0.70
Stoke–Davies comorbidity score	0.99	0.95 to 1.04	0.91
Frailty score[a]	0.88	0.84 to 0.91	<0.01
HD versus PD	1.03	0.93 to 1.13	0.85
Illness Intrusiveness Rating Scale			
Age[a]	0.98	0.98 to 0.99	<0.01
Sex	1.08	0.98 to 1.21	0.40
Time on dialysis	1.00	1.00 to 1.00	0.85
Stoke–Davies comorbidity score	0.99	0.94 to 1.03	0.85
Frailty score[a]	1.14	1.09 to 1. 20	<0.01
HD versus PD	1.07	0.96 to 1.19	0.51
Barthel Index			
Age	1.00	0.99 to 1.01	0.91
Sex	1.02	0.93 to 1.12	0.89
Time on dialysis	1.00	1.00 to 1.00	0.96
Stoke–Davies comorbidity score	0.98	0.94 to 1.02	0.57
Frailty score[a]	0.89	0.86 to 0.93	<0.01
HD versus PD	0.98	0.89 to 1.08	0.87
Symptom score			
Age	0.99	0.98 to 1.00	0.43
Sex	1.07	0.89 to 1.30	0.74
Time on dialysis	1.00	1.00 to 1.00	0.98
Stoke–Davies comorbidity score	0.99	0.91 to 1.07	0.91
Frailty score[a]	1.23	1.13 to 1.34	<0.01
HD versus PD	1.00	0.83 to 1.20	0.98
Renal Treatment Satisfaction Questionnaire			
Age	1.00	1.00 to 1.00	0.93
Sex	1.00	0.95 to 1.05	0.96

Europe PMC Funders Author Manuscripts

QoL Measures and Predictors	Effect Estimate	95% Confidence Interval	Adjusted *P* Value
Time on dialysis	1.00	1.00 to 1.00	0.29
Stoke–Davies comorbidity score	1.00	0.98 to 1.02	0.93
Frailty score	0.98	0.96 to 1.00	0.14
HD versus PD[a]	0.94	0.89 to 0.98	0.04
Hospital Anxiety and Depression Scale			
Age	0.99	0.97 to 1.00	0.19
Sex	0.97	0.80 to 1.17	0.89
Time on dialysis	1.00	1.00 to 1.00	0.86
Stoke–Davies comorbidity score	1.02	0.94 to 1.10	0.87
Frailty score[a]	1.21	1.11 to 1.31	<0.01
HD versus PD	0.97	0.81 to 1.17	0.91

Effects are multiplicative for the γ-regression model (*e.g.,* an increase of 1 U frailty score reduces the SF-12 PCS score by a factor of 0.88 [95% confidence interval, 0.84 to 0.91]; an increase of 1 U frailty score increases the symptom burden by a factor of 1.23 [95% confidence interval, 1.13 to 1.34]). QoL, quality of life; SF-12, Short Form-12; MCS, Mental Component Summary; HD, hemodialysis; PD, peritoneal dialysis; PCS, Physical Component Summary.

[a]Significant predictors ($P<0.05$).

Europe PMC Funders Author Manuscripts

Table 5

Multivariate analysis using generalized linear models in patients with frailty score ≥5 (*n*=119)

QoL Measures and Predictors	Adjusted *P* Value
SF-12 PCS	
Age	0.63
Sex	0.56
Time on dialysis	0.92
Stoke–Davies comorbidity score	0.96
Frailty score	0.68
HD versus PD	0.54
SF-12 MCS	
Age	0.89
Sex	0.68
Time on dialysis	0.89
Stoke–Davies comorbidity score	0.86
Frailty score	0.31
HD versus PD	0.67
IIRS	
Age	0.43
Sex	0.63
Time on dialysis	0.54
Stoke–Davies comorbidity score	0.86
Frailty score	0.43
HD versus PD	0.56
HADS Score	
Age	0.92
Sex	0.63
Time on dialysis	0.96
Stoke–Davies comorbidity score	0.98
Frailty score	0.19
HD versus PD	0.92
Barthel Score	
Age	0.96
Sex	0.97
Time on dialysis	>0.99
Stoke–Davies comorbidity score	0.45
Frailty score[a]	0.03
HD versus PD	0.96
RTSQ	
Age	0.86
Sex	0.85

Europe PMC Funders Author Manuscripts

QoL Measures and Predictors	Adjusted *P* Value
Time on dialysis	0.32
Stoke–Davies comorbidity score	0.89
Frailty score	0.96
HD versus PD	0.10
Symptoms	
Age	0.60
Sex	0.92
Time on dialysis	0.85
Stoke–Davies comorbidity score	0.89
Frailty score	0.10
HD versus PD	0.56

QoL, quality of life; SF-12, Short Form-12; PCS, Physical Component Summary; HD, hemodialysis; PD, peritoneal dialysis; MCS, Mental Component Summary; IIRS, Illness Intrusiveness Rating Scale; HADS, Hospital Anxiety and Depression Scale; RTSQ, Renal Treatment Satisfaction Questionnaire.

[a]Significant predictor ($P<0.05$).