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The prevalence and impact of falls in elderly dialysis patients Frail elderly Patient Outcomes on Dialysis (FEPOD) study

Ismay N. van Loon[a,*], Hanneke Joosten[b], Osasuyi Iyasere[c], Lina Johansson[d], Marije E. Hamaker[e], Edwina A. Brown[d]

[a] Department of Nephrology and Hypertension, University Medical Center Utrecht, Heidelberglaan 100, the Netherlands
[b] Department of Internal Medicine, Division of Medicine for the Elderly, Maastricht University Medical Center, Maastricht, the Netherlands
[c] John Walls Renal unit, Leicester General Hospital, Leicester, United Kingdom
[d] Imperial College Renal and Transplant Centre, Hammersmith Hospital, London, United Kingdom
[e] Departments Geriatrics, Diakonessenhuis Utrecht, the Netherlands

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ABSTRACT

Background: As the numbers of older patients on dialysis rise, geriatric problems such as falling become more prevalent. We aimed to assess the prevalence of falls and the impact on mortality and quality of life in frail elderly patients on assisted PD (aPD) and hemodialysis (HD) from the FEPOD Study.

Methods: Data on falls and quality of life were collected with questionnaires at baseline and every six months during 2-year follow-up. Multiple regression analysis was used to evaluate factors associated with falls. Additionally, we performed a review of literature concerning the relation between falls and poor outcome.

Results: Baseline fall data were available for 203 patients and follow-up data for 114 patients. Dialysis modality was equally distributed (49% HD and 51% aPD). Mean (SD) age was 75 ± 7 years. Fall rate was 1.00 falls/patient year, comparable in HD and aPD. Falls led to fear of falling, resulting in less activities in 68% vs 42% ($p < 0.01$) and leaving the house less in 59% vs 31% ($p < 0.01$) of patients. Patients with diabetes mellitus were twice as likely to report falls at baseline (OR 1.91 [95%CI 1.00–3.63], $p = 0.05$) and falls at baseline were associated with falls during follow-up (OR 2.53 [95%CI 1.06–6.04] $p = 0.03$). Literature revealed frailty was a strong risk factor for falling and falling results in a higher mortality and hospitalization rate.

Conclusion: Falls were frequent in older dialysis patients and have a negative impact on quality of life. Fall incidence is comparable between aPD and HD.

1. Introduction

With the increase of the elderly dialysis population (Kurella, Covinsky, Collins, & Chertow, 2007), more patients will exhibit geriatric problems such as functional and cognitive impairment and a high comorbidity burden. Accumulation of multiple geriatric problems causes patients to become frail and more prone to adverse events, such as mortality, hospital admissions and dialysis related complications (Johansen, Chertow, Jin, & Kutner, 2007). Falls and associated fractures are increasingly recognized as risk factors for other poor outcomes such as hospitalisations and death (Polinder-Bos, Emmelot-Vonk, Gansevoort, Diepenbroek, & Gaillard, 2014). Elderly patients are more prone to falls, as the ageing process can lead to gait and balance deficits, decreased postural reflexes, neurosensory impairments, neurological and cardiovascular comorbidity, osteoarthritis, loss of muscle strength and polypharmacy. In addition, quality of life may be influenced by falls as they may lead to disability, loss of independence and fear of falling (Abdel-Rahman, Turgut, Turkmen, & Balogun, 2011).

Despite all available evidence on increased morbidity and mortality due to falls and their complications, and the growing population of older dialysis patients, relatively little attention has been directed towards this clinical problem in daily nephrological practice. Education on causes, consequences and prevention of falls are not part of the (continuing) education for nephrologists or dialysis nurses. Moreover, there is a paucity of epidemiological data on falls in older dialysis patients, particularly for those on peritoneal dialysis (PD) (Farragher et al., 2014). As PD patients have less marked volume and electrolyte shifts during dialysis their risk of falling might be lower compared to haemodialysis (HD) patients.

Data on falls have been collected at entry to the Frail Elderly Patient

* Corresponding author.
E-mail address: i.n.vanloon-3@umcutrecht.nl (I.N. van Loon).

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Outcomes on Dialysis (FEPOD) study (Iyasere, Brown, & Johansson, 2015). This has provided an opportunity to assess the prevalence of falling in a population of older, frail patients on assisted PD and HD.

The aim of this analysis is to assess the prevalence of falls and fractures in frail elderly dialysis patients in the FEPOD study, the relation with mortality and hospitalization and the influence of falls on functional performance and quality of life (QoL). Additionally, a review of the literature on risk factors for falls and the impact of falling was performed.

2. Methods

2.1. Setting and participants

FEPOD is an observational longitudinal study consisting of two parts. FEPOD part 1 is a cross-sectional study aiming to compare detailed patient reported outcomes of quality of life and physical function for older patients on renal replacement therapy (either PD or HD). FEPOD part 2 is a 2-year prospective study aiming to evaluate patient outcomes, including healthcare use, in frail older patients with assisted PD (aPD) or HD. Assisted PD patients were defined as requiring assistance to perform PD by United Kingdom National Health Service (NHS) provided carers or by family carers. HD patients were considered for the study if they required transport provided by the hospital or family/friends to and from dialysis centres. The design has been described in detail elsewhere and can be found at http://public.ukcrn.org.uk (StudyID 11870 and 12386) (Iyasere et al., 2016).

2.2. Recruitment

Patients were recruited from 22 renal centres in England and Northern Ireland.

Ethical approval was obtained from the National Research Ethics Committee (London–Fulham; reference nos. 11/LO/1428 and 11/LO/1886). Patients on assisted PD were defined as being unable to perform PD at home without assistance from paid health care workers or family members. 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. Purposeful recruitment was undertaken to achieve comparable aPD and HD groups. The aPD patient was recruited first (due to smaller numbers), and matched to an eligible HD patient from the same renal centre with similar demographic characteristics: age (±2 years), gender, diabetes status (as a measure of comorbidity), time on dialysis (±1 year), ethnicity (where possible) and socio-economic status as determined by the Index of Deprivation 2007 based on postcode (Iyasere et al., 2016).

2.3. Outcome measures

Assessments were performed every six months during a follow-up time of 2 years. Demographic and clinical characteristics were collected from medical records and during the assessment. For patients on HD, assessments were conducted on a non-dialysis day or before dialysis. Comorbidities were evaluated using the Stoke–Davies comorbidity score (Davies, Phillips, Naish, & Russell, 2002). Data on hospitalisations and mortality were collected per centre.

Falls data were assessed by a questionnaire reviewing any falls in the last 6 months at every 6-months visit. The first questionnaire was applied at baseline and comprised retrospective data of the 6 months preceding the study, referred to as *baseline falls*. The subsequent questionnaires collected prospective data during follow-up. The aims of the questionnaire were to explore the number and location of falls, predictive factors including dialysis, fear of falling and fractures as a result of falling (Supplemental material Table 1).

Frailty was measured with the CSHA (Canadian Study of Health and Aging) scale. This is an easy to use 7-point judgment-based clinical scale with increasing frailty resulting in higher scores (Rockwood, Song, & MacKnight, 2005).

Activities of daily living (ADL)was assessed with the Barthel Index. (score 0–100; lower scores suggesting increased disability (Mahoney & Barthel, 1965).

Mental function included Hospital Anxiety and Depression Scale (HADS). : Scores ranging from 0 (no symptoms) to 21 for either depression or anxiety; a score of ≥8 indicates possible depression (Zigmond & Snaith, 1983).

Quality of life (QoL) outcomes included the Physical Component Summary scale (PCS) and Mental Component Summary scale (MCS) of Short Form-12 (SF-12) version 2. (a higher score meaning a better QoL) (Ware, Kosinski, & Keller, 1996). In addition we used the Illness Intrusiveness Ratings Scale (scores 13–91; a higher score indicating more illness intrusion) (Devins, Edworthy, Guthrie, & Martin, 1992) and Satisfaction with Treatment (Barendse, Speight, & Bradley, 2005).

2.4. Data analysis

The falls data were assessed in two separate ways: retrospectively, including falls data at baseline (i.e. within 6 months preceding the study), and prospectively, including falls during follow-up. Data were summarized using means with standard deviation (SD), medians with interquartile ranges, or proportions when appropriate. To assess baseline factors associated with falling (both retrospectively and prospectively), we used chi-squared tests for dichotomous variables, t-tests for normally distributed continuous variables and non-parametric tests for non-normally distributed continuous variables. Subsequently, clinically relevant factors (age, gender, dialysis modality, frailty) and baseline characteristics that differ significantly between the groups in the univariate analysis (or with a p-value < 0.10), were entered into a multivariate logistic regression model (a retrospective and a prospective model).

With regards to the outcome survival, baseline characteristics were assessed using a log rank test. To facilitate this, continuous baseline characteristics were categorized into clinical relevant categories; for age: < 70, 70–79 and ≥80 years, for time on dialysis: < 12, 12–36 and > 36 months. For the geriatric domains the following categories of interest were used: “mild or severe frailty” (a Frailty score ≥ 5), “severe comorbidity” (Stoke Comorbidity score ≥ 3) and “possible depression” (HADS score ≥ 8). Baseline falls data were used to assess the relation with mortality. A Cox proportional hazards model was used to calculate hazard ratios for two-year mortality. Potential confounders were selected as described for the logistic regression analyses. Proportional hazards assumptions were assessed using a log-minus-log plot.

Finally, two analyses were performed regarding quality of life. First, we focused on the two questions of the falls questionnaire that concerned potential impact on quality of life (i.e. “Have you limited any of your activities due to fear of falling?” and “Do you leave your home less often now due to fear of falling?”, Supplemental material Table 1). The answers to these questions (yes/no) were compared between patients with falls and those without falls at baseline (i.e. in the six months preceding the study) using a chi-squared test. In addition, mean differences in baseline and 1-year score of the QoL domains between patients with falls and those without falls during the first year and during the whole follow-up period were compared with an independent-samples *t*-test. A two-tailed $p < 0.05$ was considered statistically significant.

2.5. Literature study

In order to place our results in a broader perspective, a literature search was performed to identify risk factors for falling and associations of falling with quality of life, mortality and hospitalisations. We conducted the search in both Medline and Embase on March 1, 2018 using

a combination of falls and dialysis (Supplemental material Table 3). No limits in publication date were applied. One investigator (IvL) assessed the titles and abstracts of all studies retrieved by the search to determine which studies would be eligible for additional investigation. All potentially relevant articles were subsequently screened as full text. Studies were excluded if the primary focus was not dialysis, or if the study had a diagnostic or therapeutic design. Cross-referencing of the remaining articles was done to retrieve any additional relevant citations. Results of factors assessed ≥3 studies were summarized in a forest plot, using OpenMetaAnalyst (Wallace et al., 2012).

3. Results

3.1. Baseline characteristics

All 206 patients of FEPOD 2 were reviewed. Subjects lacking data on falls (n = 3) were excluded. Mean age was 75 (± 7 SD) years and 60% of patients were male. Dialysis modality was equally distributed with 49% (n = 100) on HD and 51% (n = 103) on aPD. As expected the study population was vulnerable, as can be observed from the mean score of the Clinical Frailty Scale of 4.3 (± 1.2). The frailty score in the aPD group was slightly higher compared to the HD group (mean score 4.5 ± 1.1 in the aPD group vs 4.1 ± 1.3 in the HD group, p = 0.03). Of the patients, 31% had a high comorbidity burden (Stoke Comorbidity score ≥ 3). The majority of patients (95%) were at least somewhat impaired in their activities of daily life (Barthel score < 100) with a median score of 90 (80–100). Eleven percent of patients were living in a nursing home facility. The baseline characteristics of the study population are summarized in Table 1.

3.2. Retrospective analysis

3.2.1. Falls at baseline

Thirty-six percent of patients (n = 72) had experienced at least one fall in the six months preceding the study. The median number of falls during this period was 2 [IQR 1–3] and the majority of fallers experienced multiple falls (56%). The number of fallers in the HD and the PD group was comparable (Table 1). HD patients, however, had a higher median number of falls compared to aPD patients (3 [IQR 1–4] versus 2[IQR 1–3]; p = 0.04). Most falls occurred at home (66%); falls in the hospital occurred in 23% of the HD patients and 5% of the aPD patients.

Patients with diabetes were more likely to fall (44% vs. 30%, p = 0.03). In addition, patients who fell were more likely to be physically impaired, as reflected by a higher mean frailty score (4.6 ± 1.2 versus 4.1 ± 1.2 p = 0.02), lower median Barthel score (90[71,100] versus 95[85,100], p = 0.03) and lower SF12 PCS (30 ± 11 versus 34 ± 10 p = 0.04) in the falls group. After adjustment for relevant confounders, diabetes was significantly associated with the odds of falling (OR 1.91 [95%CI 1.00–3.63], p = 0.05) and frailty (OR 1.29 [0.99–1.67] p = 0.06) was borderline significantly associated with falls (Table 2a).

Table 2a
Retrospective analysis: outcome baseline falls.

Baseline characteristics[a] (n = 203)	*OR*	*95% CI*	*P value*
Age (years)	1.02	0.98-1.07	*0.38*
Gender (male)	1.06	0.56-1.99	*0.86*
Dialysis modality (PD vs. HD)	0.95	0.52-1.75	*0.87*
Frailty (per point)	1.29	0.99-1.67	*0.06*
Diabetes mellitus (yes)	1.91	1.00-3.63	*0.05*
Use of sedative drugs (yes)	1.66	0.91-3.07	*0.10*

[a] Barthel score and SF12 PCS were not included in the multivariate analysis besides frailty, as they reflect physical functioning as well.

3.3. Prospective analysis

3.3.1. Falls during follow-up

Follow-up data on falls were available for 114 patients (56%). Twenty-six patients (13%) dropped out < 6 months and 31% had missing falls data (of whom 8% died before the first follow-up visit). There were no significant differences in baseline characteristics between the patients with and those without missing falls data. During follow-up 47% experienced one or more falls, resulting in an incidence of 1.00 falls/patient year. The median number of falls was 2 [IQR 1–5] and this was comparable between HD and PD. Falling was directly reported to a health care professional by half of the fallers (53%).

Table 1
Baseline characteristics of patients with and without falls at baseline.

	No falls	Falls	*p-value*
N (%)	131 (65)	72 (36)	
Demographics			
Age, years, mean (± SD)	75 ± 7	75 ± 7	*0.97*
Male, n (%)	79 (60)	43 (60)	*0.94*
Dialysis modality aPD, n (%)	65 (50)	38 (53)	*0.67*
Time on dialysis, months, median [IQR]	24 [16,37]	29 [15,41]	*0.47*
Cardiovascular risk factors, n (%)			
Ischemic heart disease, n (%)	43 (33)	25 (35)	*0.76*
Diabetes mellitus, n (%)	44 (34)	35 (49)	*0.03*
Peripheral vascular disease, n (%)	30 (23)	20 (30)	*0.29*
Drugs, n (%)			
Use of sedative drugs, n (%)	44 (34)	34 (47)	*0.06*
Social setting, n (%)			
Independently at home, n (%)	114 (88)	65 (90)	*0.58*
Test scores			
Stoke Comorbidity score, mean (± SD)	2.0 ± 1.2	2.2 ± 1.2	*0.18*
Frailty score[^], mean (± SD)	4.1 ± 1.2	4.6 ± 1.2	*0.02*
Mild or severe frailty[&], n (%)	52 (40)	38 (54)	*0.07*
HADS[*], median [IQR]	10 (Delgado et al., 2015; Farragher et al., 2014)	10 (Desmet et al., 2005; Farragher et al., 2014)	*0.89*
Possible depression[$], n (%)	79 (61)	59 (41)	*0.80*
Barthel score, median [IQR]	95 [85,100]	90 [71,100]	*0.03*
SF12 PCS, mean (± SD)	34 ± 10	30 ± 11	*0.04*
SF12 MCS, mean (± SD)	49 ± 10	47 ± 11	*0.25*

Abbreviations IQR Inter Quartile Range, SD Standard Deviation, HADS Hospital Anxiety and Depression Scale, MCS Mental Component Scale, PCS Physical Component Scale.
[^]Frailty Score was measured by the Canadian Study of Health and Aging (CSHA) scale (Cook et al., 2006), [&]Frailty Score ≥5, [$]HADS Score > 7.

Table 2b
Prospective analysis: outcome falls during follow-up.

Baseline characteristics[a] (n = 114)	*OR*	*95% CI*	*P value*
Age (years)	0.97	0.91-1.02	*0.10*
Gender (male)	0.88	0.39-1.99	*0.94*
Dialysis modality (PD vs. HD)	2.09	0.92-4.71	*0.06*
Frailty (per point)	0.83	0.59-1.18	*0.53*
Falls at baseline (yes)	2.53	1.06-6.04	*0.03*

[a] Barthel score and SF12 PCS were not included in the multivariate analysis besides frailty, as they reflect physical functioning as well.

Eighteen percent of patients experienced at least one falls-related fracture. Risk of falling within the 2-year follow-up period was only associated with previous falls (38% vs 20% p = 0.03), adjusted OR 2.53 [95%CI 1.06–6.04] p = 0.03 (Table 2b).

3.3.2. Mortality, hospitalization & quality of life

Two-year mortality rate was 29% and transplantation rate 3%. Mortality was higher in the group of patients with falls at baseline compared to the patients without (43% vs. 31%), although this did not reached significance (p = 0.12). In the multivariate Cox analysis, only possible depression (HR 2.43 [95%CI 1.27–4.65] p < 0.01) was independently associated with mortality (Table 3). Falls at baseline was not significantly associated with hospitalization (24% vs. 17% in the group without falls, p = 0.23). Falls reported at baseline were associated with impaired quality of life: 68% of the fallers reported that they limited activities because of fear of falling, as compared to 42% of the non-fallers (p < 0.01). In addition, fallers also significantly more often reported leaving home less due to fear of falling as compared to non-fallers (59% vs. 31%, p < 0.01).

Falls in the first year of follow-up did not influence the decline of the geriatric and/or quality of life domains during that year, as reflected by the relative small and non-significant changes in mean scores between baseline and 1-year follow-up of the different components (Table 4).

3.4. Literature search

The search resulted in 4077 articles of which 4024 were excluded for reasons listed in Supplement Table 3. The remaining 53 articles were subsequently screened as full text and 17 full-text publications were considered relevant to our search. Cross-referencing did not yield any additional relevant studies.

Fifteen studies assessed risk factors of falling in dialysis, of which half of the studies (n = 8) performed a multivariate analysis (Supplemental Table 2a and 2b) (Cook, Tomlinson, & Donaldson, 2006; Delgado, Shieh, & Grimes, 2015; Desmet, Beguin, Swine, & Jadoul, 2005; Farragher et al., 2014; Polinder-Bos et al., 2014; Kutner, Zhang, Huang, & Wasse, 2014; McAdams-DeMarco, Suresh, & Law, 2013; Wang, Sherrington, & Toyama, 2017). Only two studies included PD patients (Farragher et al., 2014; Polinder-Bos et al., 2014). Previous falls (OR 2.33 [1.22–4.45] (Cook et al., 2006) - 2.37 [0.98–5.70] (Farragher et al., 2014) was found to be related with new falls. Frailty was associated with reporting falls in the preceding year (OR 2.39 [1.22–4.71] (Kutner et al., 2014), with a higher number of falls (OR 3.09[1.38–6.90]) (McAdams-DeMarco et al., 2013) and with time to first medically urgent fall/fracture (OR 1.60 (1.16–2.20)). Older age (Delgado et al., 2015; Desmet et al., 2005; Kutner et al., 2014) was associated with falls as well (OR 1.02 [1.01–1.04] (Kutner et al., 2014)-1.06 [1.01–1.10] (Desmet et al., 2005) per year). In line with our results, diabetes mellitus was associated with a 2.8 higher risk of falls in a cohort with HD patients (Desmet et al., 2005). In addition, mobility impairment (Desmet et al., 2005; Wang et al., 2017), use of antidepressants/depression (Desmet et al., 2005; Kutner et al., 2014) and decrease of systolic blood pressure (Cook et al., 2006; Polinder-Bos et al., 2014) were associated with falls.

Five studies assessed the relation of falls with mortality and hospitalisations (Supplemental Table 2c). Falls were associated with a 2–2.5 (Abdel-Rahman et al., 2011; Bowling, Hall, Khakharia, Franch, & Plantinga, 2018; Kutner et al., 2014) times higher hospitalization rate. When combining the FEPOD results with data from the literature (Abdel-Rahman et al., 2011; Bowling et al., 2018; Farragher et al., 2014; Li, Tomlinson, Naglie, Cook, & Jassal, 2008), falling was associated in a 1.5 times higher mortality risk (weighted average OR 1.51 [95%CI 1.13–2.03]) (Fig. 1). Quality of life was not measured in any study.

Table 3
Mortality.[$]

	HR	*95% CI*	*P value*
Age (years)			
< 70	1.00		
70-79	0.95	0.50-1.82	*0.89*
> 80	1.12	0.52-2.38	*0.78*
Gender (male)	0.80	0.45-1.41	*0.44*
Dialysis modality (PD)	1.43	0.82-2.51	*0.21*
Frailty (mild-severe)[#]	1.60	0.99-2.84	*0.11*
Possible depression[%]	2.43	1.27-4.65	*< 0.01*
Use of sedative drugs (yes)	1.70	0.96-3.02	*0.07*
Falls at baseline	1.74	0.98-3.09	*0.06*

[$]SF12 PCS score was not included in the multivariate analysis besides frailty, as it reflects physical functioning as well.
Accordingly, the SF12 MCS was not included because possible depression was already included in the model.
[#]Frailty score ≥ 5, [%] HADS score ≥ 8.

4. Discussion

This analysis of the FEPOD study focused on the prevalence and risk factors of falls in a frail older dialysis population and looked more closely at the impact of falls on quality of life and physical performance. Within this vulnerable population, almost half of the patients (47%) experienced at least one fall during two year follow-up. The incidence of falls (1.0 falls/patient year) was in line with previous reports on elderly dialysis patients (0.85 (Li et al., 2008) to 1.7 (Farragher et al., 2014) falls/person year) and was comparable between aPD and HD. This is higher than in frail community dwelling populations were an incidence of 0.60-0.85 falls/patient years was reported (Campbell et al., 1990; Speechley & Tinetti, 1991). Our study showed that diabetes mellitus was associated with an almost 2 times higher risk of falling and having one or more previous falls was associated with a 2.5 times higher risk of new falls. Frailty was an additional risk factor for falling, when reviewing available literature.

To our best knowledge, this is the first longitudinal study in dialysis patients focusing on the influence of falls on quality of life. Falling may impair quality of life by initiating a downward cycle (Friedman, Munoz, West, Rubin, & Fried, 2002). We showed that fear caused by falling led to limitation of activities and leaving the home less frequently in a relevant and significant percentage of patients. This inactivity due to fear of falling may lead to decreased strength, agility, and balance, which in turn may form a predisposition for loss of independence, further functional decline and subsequent falling (Friedman et al., 2002; Murphy, Williams, & Gill, 2002). Others found that in a community-dwelling elderly population both falls and fear of falling were associated with lower long-term health-related quality of life (Cumming, Salkeld, Thomas, & Szonyi, 2000; Stenhagen, Ekstrom, Nordell, & Elmstahl, 2014). In addition, interventions to reduce fear of falling led to a better quality of life with an improvement in mobility range, higher level of intended activity and improved social function (Tennstedt et al., 1998). Although geriatric domains such as frailty, activities of daily living, physical functioning and depression were all

Table 4
Quality of life in the first year of follow-up.

	No falls in 1 st year of follow-up			Falls in 1 st year of follow-up			
Domain	N	Baseline	Δ 1 year	N	Baseline	Δ 1 year	*p
Barthel	30	89.2 (± 12.4)	−1,8 (± 9.0)	15	95.0 (± 8.2)	−1.3 (± 8.5)	*0.86*
Frailty	30	3.97 (± 1.19)	0.17 (± 1.20)	16	3.63 (± 1.15)	0.13 (± 0.89)	*0.90*
IIRS	32	28.9 (± 13.2)	11.19 (± 17.91)	24	35.8 (± 15.4)	5.75 (± 13.05)	*0.21*
HADS	39	4.62 (± 3.70)	2.85 (± 6.41)	29	5.93 (± 3.35)	3.03 (± 6.64)	*0.91*
SF12 PCS	34	37.1 (± 10.7)	−6.51 (± 9.00)	28	32.2 (± 10.7)	−7.06 (± 1.33)	*0.19*
SF12 MCS	34	51.1 (± 12.4)	−2.38 (± 9.74)	28	48.9 (± 12.1)	−4.53 (± 13.77)	*0.48*

IIRS Illness Intrusiveness Ratings Scale HADS Hospital Anxiety and Depression Scale PCS Physical Component Score SF12 MCS Mental Component Score SF12.
* Result of independent *t*-test Δ 1 year falls vs no falls.

associated with falls in our univariate analysis, these associations disappeared in the multivariate analysis. We were not able to show any relation between falls and decline of geriatric domains in the FEPOD study, probably because of the lack of power (Table 4).

Impairment in quality of life was also reflected by the fact that almost 1 out of 5 patients suffered a fracture due to falling. This is consistent with the results of a Dutch study, which also showed a relative high fracture rate of 15% per fall in elderly HD patients (Mahoney & Barthel, 1965). Others showed that falling in the dialysis population was associated with a 2–2.5 times higher hospitalization rate and almost 6 times higher rate of nursing home admissions (Supplemental Table 2a) (Abdel-Rahman et al., 2011; Bowling et al., 2018; Kutner et al., 2014). In addition, falls were independently associated with a 1.5 times higher mortality rate (weighted average of available literature including our cohort). In FEPOD, we did not find significant relations with hospitalization and mortality, maybe due to the fact that our population was overall frail and the non-fallers were also at high risk of hospitalization and death (Johansen et al., 2007).

Among all factors associated with falls in dialysis patients, some may form a starting point for prevention of falls and others may be modifiable. Nephrology health care providers should regularly ask their dialysis patients about falls, as there is a high underreporting rate of falls and fall-related injury by patients themselves. Prior studies found an accuracy of reported falls of 32%–72% among older community dwelling patients (Cummings, Nevitt, & Kidd, 1988; Mackenzie, Byles, & D'Este, 2006). Awareness of fall risk should be higher in frail patients, those with known previous falls and patients with mobility impairment, diabetes patients and those in the post-dialysis initiation period (Plantinga, Patzer, Franch, & Bowling, 2017). Evaluation of the use of psychoactive drugs and sedatives on a regular basis may contribute here. There is paucity of evidence to determine optimal blood pressure targets in the frail elderly (Anand, Kurella Tamura, & Chertow, 2010). A more liberal and individual approach to prevent hypotensive episodes may also help in fall prevention. High-risk patients should be referred to outpatient falls clinics, which offer multidisciplinary evaluation of underlying causes, potential risk factors and preventive measures.

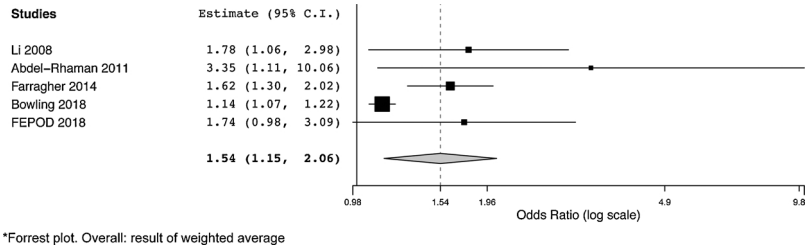
In addition, implementation of several fall interventions has been proven to reduce the incidence of falls in dialysis, with the number of falls decreasing from 32/100.000 dialysis sessions to 9/100.000 dialysis sessions (p = 0.06) (Heung, Adamowski, Segal, & Malani, 2010). These interventions included patient and staff education, implementation of a risk assessment tool, and environmental modifications such as an in-ground scale and good lightning. In the general elderly population exercise interventions had a small to moderate effect on fear of falling (Kendrick, Kumar, & Carpenter, 2014), while combined exercise training and cognitive training improved gait speed, cognitive function and balance among community-dwelling elderly with mild cognitive impairment (Lipardo, Aseron, Kwan, & Tsang, 2017). Whether interventions focused on increasing strength with exercise therapy in the dialysis population may contribute to reduction of fall rate, has not yet been assessed.

The strengths of the FEPOD study are the fact that it a large cohort of frail elderly patients, a population usually excluded from research. FEPOD included a relatively large PD population, which made it possible to compare fall outcomes with patients on HD. However, there are some limitations. First, the falls analysis was a secondary objective of the FEPOD Study and it was not powered for the falls analyses. Attrition due to mortality was very high in this cohort, as would have been expected in this frail population, leaving less patients for the falls follow-up. In addition to the small number of patients, missing QoL data limited the conclusions of the influence of falls on quality of life. The lack of difference between patients with and without falls could be explained by a higher mortality rate in the group with falls, excluding patients with a lower QoL.

Second, we can not rule out residual confounding, as we were not able to correct for potential risk factors for falls such as mobility impairment, cognitive impairment and occurrence of (inter or intra dialytic) hypotension.

Third, although the FEPOD had a prospective study design, falls were recorded in a retrospective way, by regularly (every six-month visit) asking the patient to recall falls in the previous six months. This may have contributed to an underestimation of the number of falls because of recall bias. Others found a 56% sensitivity of retrospective self-reported falls as compared to prospectively calandar report of falls within 6 months (Mackenzie et al., 2006). In addition, as the FEPOD Study included prevalent dialysis patients only, the incidence of falls may be even higher among elderly patients starting dialysis

Finally, the literature search yielded only a small amount of studies, which were very heterogeneous concerning population (i.e. not only elderly patients) and risk factors included, which impedes performing a



*Forrest plot. Overall: result of weighted average

Fig. 1. Falls and mortality.

proper meta-analysis. Other literature on the relation between falls and quality of life in dialysis patients is currently lacking. As quality of life may be more important than survival for elderly patients on life-sustaining dialysis therapy, we think this should be further explored in future research.

5. Conclusion

In the frail elderly population falls are frequently encountered and fall incidence is comparable between HD and aPD patients. Diabetes and previous falls were associated with new falls in our cohort of frail elderly patients. In addition, a review of literature showed frailty was related to falling and falling increases the risk of mortality and hospitalization. The negative impact of falls on quality of life was reflected in a high prevalence of fear of falling and consequently limiting activities in both HD and aPD. As falls reflect frailty and fear of falling limits functional dependency, evaluation of falls and related risk factors should be part of assessment of the geriatric dialysis population.

Statement of prior publication

Neither this manuscript nor substantial parts of it are under consideration for publication elsewhere, have been published nor made available elsewhere in a manner that could be construed as a prior or duplicate publication of the same content.

Statement of related content

There is not a manuscript of related content (e.g. from the same study with the same or very similar primary exposure and outcome) under consideration for publication elsewhere, nor has one been published nor made available elsewhere.

Statement of disclosures of conflict of interest

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Appendix A. Supplementary data

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