Title
The impact of frailty on outcomes in dialysis

Journal
Current Opinion in Nephrology & Hypertension, 26(6)

ISSN
1062-4821

Authors
Sy, John
Johansen, Kirsten L

Publication Date
2017-11-01

DOI
10.1097/mnh.0000000000000364

Peer reviewed

HHS Public Access
Author manuscript
Curr Opin Nephrol Hypertens. Author manuscript; available in PMC 2019 July 03.

Published in final edited form as:
Curr Opin Nephrol Hypertens. 2017 November ; 26(6): 537–542. doi:10.1097/MNH.0000000000000364.

The impact of frailty on outcomes in dialysis

John Sy[a] and **Kirsten L. Johansen**[a,b]

[a]Division of Nephrology, University of California, San Francisco

[b]Division of Nephrology, San Francisco Veterans Affairs Medical Center, San Francisco, California, USA

Abstract

Purpose of review—Frailty is highly prevalent in the dialysis population and is associated with mortality. Recent studies have suggested that other dialysis outcomes are compromised in frail individuals. While we do not yet have a consensus as to the best measure of frailty, identification of these poor outcomes and their magnitude of association with frailty will help improve prognostication, allow for earlier interventions, and improve provider-to-patient communication.

Recent findings—The most widely used assessment of frailty is Fried's physical performance criteria. However, regardless of assessment method, frailty remains highly associated with mortality. More recently, frailty has been associated with falls, fractures, cognitive impairment, vascular access failure, and poor quality of life. Recent large cohort studies provide strong evidence that frailty assessment can provide important prognostic information for providers and patients both before and after initiation of dialysis. Trials aimed at improving frailty are limited and show the promise of augmenting quality of life, although more studies are needed to firmly establish mortality benefits.

Summary—We underscore the importance of frailty as a prognostic indicator and identify other recently established consequences of frailty. Widespread adoption of frailty assessment remains limited and researchers continue to find ways of simplifying the data collection process. Timely and regular assessment of frailty may allow for interventions that can mitigate the onset of poor outcomes and identify actionable targets for dialysis providers.

Keywords

dialysis; dialysis outcomes; frailty

INTRODUCTION

Frailty is a clinical state marked by a loss of resilience and diminished capacity to respond to health stressors [1]. It has been recognized that frail patients are at high risk for morbidity

Correspondence to Kirsten L. Johansen, Division of Nephrology, University of California, San Francisco, CA 94143, USA. kirsten.johansen@ucsf.edu.

Financial support and sponsorship
None.

Conflicts of interest
There are no conflicts of interest.

and mortality, with chronic kidney disease (CKD) further amplifying this risk. Since the 1990s, researchers have sought to operationally define this clinical state and determine its risk factors and sequelae. In 2007 and again in 2012, consensus conferences failed to agree on a single operational definition of frailty that would satisfy all experts [2], likely because of the multifaceted nature of frailty. However, experts agree that frailty is not encompassed fully by existing definitions of disability, sarcopenia, or multimorbidity despite significant overlap between these concepts and frailty [2,3].

FRAILTY: A PREDICTOR OF POOR OUTCOMES

Among community-dwelling, nondialysis-dependent older populations, frail individuals have higher mortality, more frequent hospitalizations, higher incidence of fractures, and loss of independence in activities of daily living (ADLs) compared with their nonfrail counterparts [4]. In a review published in 2010, Brown and Johansson [5] suggested that frailty may be a more meaningful predictor of important outcomes than age due to the stronger correlation with 1-year mortality and hospitalizations, consistent with the idea that frailty encompasses a more comprehensive portrait of an individual than age or comorbidity alone [6]. These associations with poor outcomes have also been observed among dialysis patients [6–8].

In fact, these adverse outcomes have led some to question whether clinicians are adequately preparing frail elderly patients for key medical transitions such as end-stage renal disease [9–11]. In one study, fewer than 10% of patients followed by a nephrologist for CKD care (stages 4 or 5 CKD, on dialysis, or having received a kidney transplant) reported having a discussion about end-of-life care issues, and 62% of dialysis patients later regretted their decision to start dialysis [12]. Furthermore, there has been a trend toward higher rates of withdrawal from dialysis in the last several years [13]. It is possible that a deeper understanding of the association between frailty and outcomes could lead to better prognostic information, which could improve the quality of discussions regarding end-of-life care issues [14].

ASSESSING AND OPERATIONALIZING FRAILTY

Despite three decades of investigation into how to quantify frailty, there remains little consensus as to its best measure. Initial studies in the early 1990s that attempted to assess prognosis in the elderly dialysis population (going beyond age alone) relied on simple measures such as ADLs, the Karnofsky Activity Score, and the Charlson comorbidity index [15,16]. Researchers suggested that timely identification and prevention of frailty could improve quality of life and reduce costs associated with loss of employment, but a translatable and easily replicated measure that encompassed the complexity of frailty was needed [17]. In the interim 20 years, researchers have published and adapted various operational definitions of frailty. These are largely divided into three constructs: a physical construct of frailty (i.e. the frailty phenotype), a subjective construct of frailty (i.e. the frailty score), and a deficit construct of frailty (i.e. the frailty index).

The physical construct of frailty was developed and validated by Fried *et al.* [1] in a cohort of community-dwelling elderly in 2001. Individuals were considered frail if three of five major physical components of frailty were identified: shrinking or weight loss, weakness, poor endurance and energy, slowness, and low physical activity level [1]. Fried's original frailty construct has been validated in other elderly populations [2] as well as the dialysis population [18]. In an extended physical construct used in the Netherlands, the Groningen Frailty Indicator (GFI), a 15-item questionnaire assessing four different domains (physical functioning, cognitive functioning, social functioning, and psychological functioning), has also been used in both nondialysis and dialysis populations [19]. The cognitive and psychosocial domains included in the GFI had not been assessed previously in frailty measures [20], but are also thought to be important contributors to frailty.

The subjective frailty construct, developed by Rockwood *et al.* [21], is the 7-point Canadian Study of Health and Aging Clinical Frailty Score based on clinical judgment and validated in an elderly Canadian population with individuals having a score of 5 or higher considered frail. Between 2001 and 2008, Mitnitski and Rockwood also developed and validated a deficit construct that consisted of 40 'deficits' (i.e. symptoms, signs, functional impairments, and laboratory abnormalities), with individuals being in the lowest quintile considered as frail [22,23].

These methods of assessing frailty in patients with kidney disease, including their strengths and limitations, have recently been reviewed in this journal [24]. Although the best measure of frailty has not yet been identified, researchers evaluating outcomes related to frailty have recently favored the physical construct of frailty (see Table 1) [25■], perhaps due to its use of objective measures that appear to facilitate comparisons across studies.

Studies have noted a wide variation in the prevalence of frailty in the dialysis population. For example, using variations of a physical frailty construct, prevalence ranged from 30 to 73% [26–28]. The large variability is likely explained by using substitutions for Fried's original criteria with more readily obtainable self-reported or alternative measures (e.g. substituting a sit-to-stand time for grip strength [28]). The impact of substituting self-reported physical functioning for physical performance measures has been investigated in two studies [20,29], and prevalence was higher using self-report measures (78 and 53%) than using performance measures (24 and 29%, respectively) in both. Researchers in Taiwan used six different frailty constructs within the same cohort and found that the prevalence of frailty ranged from 19.6 to 82.6% [30]. Thus, comparisons among populations and studies utilizing different frailty measures will remain challenging, and consensus is still needed on an easy-to-administer, consistent, and reliable operational definition of frailty [29].

In a more recent study, Salter *et al.* [31■■] compared perceived frailty with the measured physical frailty phenotype to ascertain differences in providers' and patients' perceptions in comparison to an actual measured construct. Perceptions were determined by asking providers if they felt that their patient was frail and asking patients if they themselves felt that they were frail [31■■]. They found that agreement between measured and perceived frailty was only 64% for nephrologists, 67% for nurse practitioners, and 55% for patients themselves (κ: 0.24, 0.27, and 0.07, respectively) [31■■]. It is worth mentioning that older, non-African American, and female patients were more likely to be incorrectly perceived as frail [31■■]. These interesting findings indicate that clinical gestalt may not be sufficiently accurate to identify frail dialysis patients, and a formal measured gold standard is warranted.

FRAILTY OUTCOMES IN THE DIALYSIS POPULATION

Frailty and mortality

Several recent studies have confirmed the association between frailty and mortality in dialysis patients (Table 1) [18,19,26,32,33■,34–36]. Here, we highlight more recent work and some interesting findings related to mortality.

In 2012, a study by Bao *et al.* [26] not only looked at the association between frailty and mortality, but also noted that higher eGFR at dialysis initiation was associated with mortality (hazard ratio: 1.12 per 5 ml/min/1.73 m^2, 95% CI 1.02–1.23), an association that was no longer statistically significant once frailty was accounted for (hazard ratio: 1.08 per 5 ml/min/1.73 m^2, 95% CI 0.98–1.19). This suggested that frail patients may have overlapping signs and symptoms with uremia, perhaps prompting earlier dialysis initiation [26].

Looking at various stages of frailty, McAdams-DeMarco *et al.* [36] performed an analysis of 146 prevalent dialysis patients showing that even those classified as intermediate frail (meeting only two of five physical frailty criteria) had a 2.6-fold (95% CI 1.02–7.07) higher risk of death, independent of age, sex, comorbidity, and disability.

Lee *et al.* [33■] recently studied a large prospective cohort of 1658 prevalent dialysis patients in Korea and noted that the physical frailty phenotype was associated with mortality (hazard ratio: 3.05, 95% CI 1.55–6.00), which remained significant even after adjustment for other important risk factors (hazard ratio: 2.37, 95% CI 1.11–5.02). Interestingly, an investigation in India looking at outcomes among 205 impoverished prevalent dialysis patients (mean age 45 years, 82% considered frail by the physical construct of frailty) found no significant association between frailty and death (hazard ratio: 0.75, 95% CI 0.30–1.88) [32]. In this study, only 38 patients were not frail and only 26 patients died during follow-up [32]. Unsurprisingly, frail patients were at statistically significantly higher risk of falls and hospitalization in the same cohort [32], suggesting that low study power may have accounted for the mortality differences compared with other studies.

With respect to use of a subjective frailty construct, a study by Alfaadhel *et al.* [37] in 2015 showed higher mortality in 390 incident dialysis patients with higher frailty scores (hazard ratio:1.22 per 1-point higher frailty score, 95% CI 1.02–1.43). Thus, frailty appears to be associated with mortality regardless of the general frailty construct used.

Frailty and cognitive outcomes

Like frailty, cognitive impairment is a mechanistically complex phenomenon with multiple proposed links including hormonal and nutritional deficiencies, cardiovascular risks, chronic inflammation, and poor mental health [38]. Indeed, frailty and cognitive impairment share many of the same risk factors such as age and cardiovascular disease [38], leading some researchers to propose incorporating cognitive domains into the frailty construct instead of considering them as possible sequelae [19,24,39]. However, as there is some evidence that frailty is independently associated with cognitive impairment in nondialysis populations [40,41], it may be reasonable to consider cognitive impairment as a mediator between frailty and poor outcomes. Given our current understanding of the complex pathophysiology between frailty and cognitive impairment, considering cognitive impairment as a predictor or as an outcome of frailty are likely reasonable, so long as the analytical method is sound.

In a longitudinal study, McAdams-DeMarco *et al.* [42■] assessed the association between frailty and cognitive impairment at dialysis initiation and 1-year follow up in 324 incident dialysis patients. They observed that Fried's physical frailty construct was associated with lower cognitive function at cohort entry relative to nonfrail individuals, that there was a dose-dependent association of higher frailty with worse cognitive function at dialysis initiation, and that patients who were frail at dialysis initiation had lower mini-mental status test scores after 1 year of dialysis compared with those who were not frail at the time of dialysis initiation [42■]. However, there were no differences in measures of cognitive processing speed and executive function (Trail Making Tests A and B) among frail and nonfrail patients after 1 year [42■]. The authors concluded that the discordant results may be due to lack of statistical power, as only about half of the patients completed cognitive testing at 1 year [42■].

Frailty and falls/fractures

Several recent studies have addressed the association between frailty and risk of falls and fractures. In 2013, McAdams-DeMarco *et al.* [43] utilized Fried's physical frailty construct in a prospective cohort and noted that frailty predicted a 3.89-fold greater number of falls over a median of 6.7 months of follow-up in an adjusted model (95% CI 1.78–8.49) compared with nonfrail dialysis patients. In 2015, Delgado *et al.* [44] also used a physical frailty construct and confirmed that frailty was associated with a higher risk of fall or fracture (hazard ratio: 1.60, 95% CI 1.16–1.20). These studies raise the possibility that if we could improve physical aspects of frailty, we might lower the risk of falls and potentially reduce patient morbidity and healthcare costs.

Frailty, vascular access failure, and quality of life

Researchers have also recently looked into less traditional outcomes. For example, Chao *et al.* [45■■] investigated a potential link between a physical frailty construct and vascular access failure in a cohort of 51 prevalent dialysis patients in rural Taiwan with a mean age of 68 years. They found that frailty was associated with higher risk of vascular access failure (hazard ratio: 2.63, 95% CI 1.03–6.71) and hypothesized that endothelial dysfunction in end-stage renal disease (ESRD) accompanied by oxidative stress and low-grade inflammation may lead to frailty and also predispose patients to have complications related to their vascular access [45■■].

In 2016, Iyasere *et al.* [46■■] used a subjective frailty scale and noted that frailty was associated with worse quality of life based upon several measures including the Short Form-12 questionnaire, hospital anxiety and depression scale (HADS), and the illness intrusiveness rating scale. They also noted a graded association between frailty and depression (as assessed using the HADS), such that the odds of depression were 53% higher for each point higher in frailty score (OR 1.53, 95% CI 1.12–2.07) [46■■].

TIMING OF FRAILTY ASSESSMENT

Although frailty is associated with poor outcomes, there has not been widespread adoption of assessing frailty in the dialysis setting. This is likely due to the time-intensive task of gathering data, even for self-reported measures. More readily obtainable measurements in the dialysis unit have been suggested, such as the ‘Sit-to-Scale’ score, a measure of gait speed that can be instituted on dialysis rounds or even on a daily basis [47].

As more elderly patients are being started on dialysis, it will be important to assess frailty. An assessment at dialysis initiation and 1–2 years after initiation can provide rich prognostic information that will inform dialysis practitioners and patients of potential risks and benefits of dialysis continuation [48■]. Better prognostication would undoubtedly help to improve the decision-making process whenever considering dialysis in the elderly frail.

Early identification of frailty may also assist with improving overall outcomes, but timing of initial assessment has been a crucial question. Identification of frailty may need to begin at earlier stages of CKD. Two recent studies looking at frailty in the predialysis population have confirmed that frailty is still a predictor of mortality in CKD patients, and assessment of frailty may lead to patients selecting a more conservative treatment approach or having more realistic expectations if they choose dialysis [19,49].

Trials have also suggested that exercise may improve physical functioning among dialysis patients, but more studies are needed to assess whether increased muscle mass translates to decreased mortality risk in these patients [50–52]. There is speculation that the uremic milieu present in dialysis patients may contribute to poor muscle function [53], suggesting that we may be able to further improve physical performance by coupling better dialysis performance with an aggressive exercise regimen. Unfortunately, published studies of vigorous exercise interventions have been limited by waning patient enthusiasm and high dropout rates [52]. Perhaps gradual rehabilitation with the assistance of physical therapists may be beneficial to those unable or unwilling to perform more vigorous or more independent interventions.

CONCLUSION

Despite significant advances in the assessment of frailty among dialysis patients and our understanding that frailty makes patients vulnerable to poor outcomes, we still lack consensus on a single, easily adapted operational definition of frailty that would allow improved quantification and adequate comparison between studies. Perhaps widespread adoption of frailty assessment may not occur until a simpler construct is achieved. Alternatively, expansion of electronic health records and development of advanced data mining strategies might facilitate collection of frailty markers from various sources, including within or outside the dialysis unit. Identification of these high-risk patients may allow tailored interventions, provide more accurate prognostic information, and improve provider-to-patient discussions on the risks and benefits of the dialysis procedure.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

■ of special interest

■■ of outstanding interest

1. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001; 56:M146–M156. [PubMed: 11253156]
2. Morley JE, Vellas B, Abellan van Kan G, et al. Frailty consensus: a call to action. J Am Med Dir Assoc 2013; 14:392–397. [PubMed: 23764209]
3. Rodriguez-Manas L, Feart C, Mann G, et al. Searching for an Operational Definition of Frailty: A Delphi Method based consensus statement. The Frailty Operative Definition-Consensus Conference Project. J Gerontol Ser A 2013; 68:62–67.
4. Sood MM, Rigatto C, Bueti J, et al. The role of functional status in discharge to assisted care facilities and in-hospital death among dialysis patients. Am J Kidney Dis 2011; 58:804–812. [PubMed: 21820221]
5. Brown EA, Johansson L. Old age and frailty in the dialysis population. J Nephrol 2010; 23:502–507. [PubMed: 20383872]
6. Kurella Tamura M, Covinsky KE, Chertow GM, et al. Functional status of elderly adults before and after initiation of dialysis. N Engl J Med 2009; 361:1539–1547. [PubMed: 19828531]
7. Li M, Tomlinson G, Naglie G, et al. Geriatric comorbidities, such as falls, confer an independent mortality risk to elderly dialysis patients. Nephrol Dial Transplant 2008; 23:1396–1400. [PubMed: 18057068]
8. Thorsteinsdottir B, Swetz KM, Tilburt JC. Dialysis in the frail elderly - a current ethical problem, an impending ethical crisis. J Gen Intern Med 2013; 28:1511–1516. [PubMed: 23686511]
9. 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]
10. Johansen KL, Delgado C, Bao Y, Tamura MK. Frailty and dialysis initiation. Semin Dial 2013; 26:690–696. [PubMed: 24004376]
11. Davison SN. End-of-life care preferences and needs: perceptions of patients with chronic kidney disease. Clin J Am Soc Nephrol 2010; 5:195–204. [PubMed: 20089488]
12. 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]
13. Schell JO, Cohen RA. A communication framework for dialysis decision-making for frail elderly patients. Clin J Am Soc Nephrol 2014; 9:2014–2021. [PubMed: 24970868]
14. Byrne C. Effect of age and diagnosis on survival of older patients beginning chronic dialysis. JAMA 1994; 271:34–36. [PubMed: 8258884]
15. Ifudu O. Dismal rehabilitation in geriatric inner-city hemodialysis patients. JAMA 1994; 271:29–33. [PubMed: 8258883]
16. Blagg CR. Dialysis, old age, and rehabilitation. JAMA 1994; 271:67–68. [PubMed: 8258892]
17. Woods NF, LaCroix AZ, Gray SL, et al. Frailty: emergence and consequences in women aged 65 and older in the Women's Health Initiative observational study. J Am Geriatr Soc 2005; 53:1321–1330. [PubMed: 16078957]
18. Johansen KL, Chertow GM, Jin C, Kutner NG. Significance of frailty among dialysis patients. J Am Soc Nephrol 2007; 18:2960–2967. [PubMed: 17942958]
19. Meulendijks FG, Hamaker ME, Boereboom FTJ, et al. Groningen frailty indicator in older patients with end-stage renal disease. Ren Fail 2015; 37:1419–1424. [PubMed: 26337636]
20. Painter P, Kuskowski M. A closer look at frailty in ESRD: Getting the measure right. Hemodial Int 2013; 17:41–49. [PubMed: 22716227]

21. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. Can Med Assoc J 2005; 173:489–495. [PubMed: 16129869]

22. Searle SD, Mitnitski A, Gahbauer Ea, et al. A standard procedure for creating a frailty index. BMC Geriatr 2008; 8:24. [PubMed: 18826625]

23. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. Sci World J 2001; 1:323–336.

24. Bohm C, Storsley L, Tangri N. The assessment of frailty in older people with chronic kidney disease. Curr Opin Nephrol Hypertens 2015; 24:498–504. [PubMed: 26447796]

25 ■. Chowdhury R, Peel NM, Krosch M, Hubbard RE. Frailty and chronic kidney disease: a systematic review. Arch Gerontol Geriatr 2017; 68:135–142. [PubMed: 27810661] Good systematic review of frailty and outcomes among chronic kidney disease and ESRD patients with a section on frailty and transplant patients.

26. Bao Y, Dalrymple L, Chertow GM, et al. Frailty, dialysis initiation, and mortality in end-stage renal disease. Arch Intern Med 2012; 172:1071–1077. [PubMed: 22733312]

27. Johansen KL, Dalrymple LS, Delgado C, et al. Association between body composition and frailty among prevalent hemodialysis patients: a US Renal Data System Special Study. J Am Soc Nephrol 2013; 25:381–389. [PubMed: 24158987]

28. Delgado C, Doyle JW, Johansen KL. Association of frailty with body composition among patients on hemodialysis. J Ren Nutr 2013; 23:356–362. [PubMed: 23648049]

29. Johansen KL, Dalrymple LS, Delgado C, et al. Comparison of self-report-based and physical performance-based frailty definitions among patients receiving maintenance hemodialysis. Am J Kidney Dis 2014; 64:600–607. [PubMed: 24793033]

30. Chao CT, Hsu YH, Chang PY, et al. Simple self-report FRAIL scale might be more closely associated with dialysis complications than other frailty screening instruments in rural chronic dialysis patients. Nephrology 2015; 20:321–328. [PubMed: 25597434]

31 ■■. Salter ML, Gupta N, Massie AB, et al. Perceived frailty and measured frailty among adults undergoing hemodialysis: a cross-sectional analysis. BMC Geriatr 2015; 15:52. [PubMed: 25903561] Study showing that perceptions of frailty may not be sufficiently accurate to identify frail dialysis patients compared with a measured construct.

32. Yadla M, John J, Mummadi M. A study of clinical assessment of frailty in patients on maintenance hemodialysis supported by cashless government scheme. Saudi J Kidney Dis Transplant 2017; 28:15–22.

33 ■. Lee S-Y, Yang DH, Hwang E, et al. The prevalence, association, and clinical outcomes of frailty in maintenance dialysis patients. J Ren Nutr 2017;27:106–112. [PubMed: 28065454] Recent, large multicentered cohort study assessing mortality outcomes in prevalent hemodialysis patients in Korea.

34. Johansen KL, Dalrymple LS, Glidden D, et al. Association of performance-based and self-reported function-based definitions of frailty with mortality among patients receiving hemodialysis. Clin J Am Soc Nephrol 2016; 11:626–632. [PubMed: 26792529]

35. Ng JK-C, Kwan BC-H, Chow K-M, et al. Frailty in Chinese peritoneal dialysis patients: prevalence and prognostic significance. Kidney Blood Press Res 2016; 41:736–745. [PubMed: 27771713]

36. McAdams-DeMarco MA, Law A, Salter ML, et al. Frailty as a novel predictor of mortality and hospitalization in individuals of all ages undergoing hemodialysis. J Am Geriatr Soc 2013; 61:896–901. [PubMed: 23711111]

37. Alfaadhel TA, Soroka SD, Kiberd BA, et al. Frailty and mortality in dialysis: evaluation of a clinical frailty scale. Clin J Am Soc Nephrol 2015; 10:832–840. [PubMed: 25739851]

38. Robertson DA, Savva GM, Kenny RA. Frailty and cognitive impairment - a review of the evidence and causal mechanisms. Ageing Res Rev 2013; 12:840–851. [PubMed: 23831959]

39. Kallenberg MH, Kleinveld HA, Dekker FW, et al. Functional and cognitive impairment, frailty, and adverse health outcomes in older patients reaching ESRD - a systematic review. Clin J Am Soc Nephrol 2016;11:1624–1639. [PubMed: 27342598]

40. Kim JC, Kalantar-Zadeh K, Kopple JD. Frailty and protein-energy wasting in elderly patients with end stage kidney disease. J Am Soc Nephrol 2013; 24:337–351. [PubMed: 23264684]

41. Mitnitski A, Fallah N, Rockwood MR, Rockwood K. Transitions in cognitive status in relation to frailty in older adults: a comparison of three frailty measures. J Nutr Health Aging 2011; 15:863–867. [PubMed: 22159774]

42 ■. McAdams-DeMarco MA, Tan J, Salter ML, et al. Frailty and cognitive function in incident hemodialysis patients. Clin J Am Soc Nephrol 2015; 10:2181–2189. [PubMed: 26573615] This study was one of the first to show that frailty was associated with cognitive impairment both at dialysis initiation as well as at 1 year after diaysis initiation.

43. McAdams-DeMarco MA, Suresh S, Law A, et al. Frailty and falls among adult patients undergoing chronic hemodialysis: a prospective cohort study. BMC Nephrol 2013; 14:224. [PubMed: 24131569]

44. Delgado C, Shieh S, Grimes B, et al. Association of self-reported frailty with falls and fractures among patients new to dialysis. Am J Nephrol 2015; 42:134–140. [PubMed: 26381744]

45 ■■. Chao C-T, Chiang C-K, Huang J-W, Hung K-Y. Self-reported frailty among end-stage renal disease patients: a potential predictor of dialysis access outcomes. Nephrology 2017; 22:333–334. [PubMed: 28247523] This study found an association between frailty and vasclar access issues with the hypothesis that chronic inflammation that causes frailty may also predispose patients to having vascular damage and future complications with dialysis access.

46 ■■. Iyasere OU, Brown EA, Johansson L, et al. Quality of life and physical function in older patients on dialysis: a comparison of assisted peritoneal dialysis with hemodialysis. Clin J Am Soc Nephrol 2016; 11:423–430. [PubMed: 26712808] This study found an associtaion between frailty and lower quality of life by several standards suggesting that perhaps improving some aspects of frailty may also improve quality of life in frail dialysis patients.

47. Saito GK, Jassal SV. The ‘Sit-to-Scale’ score - a pilot study to develop an easily applied score to follow functional status in elderly dialysis patients. Nephrol Dial Transplant 2007; 22:3318–3321. [PubMed: 17611246]

48 ■. Johansen KL, Dalrymple LS, Delgado C, et al. Factors associated with frailty and its trajectory among patients on hemodialysis. Clin J Am Soc Nephrol 2017; 12:1100–1108. [PubMed: 28576906] This study showed that frailty status can change over time and suggests that prognoses may also change.

49. Pugh J, Aggett J, Goodland A, et al. Frailty and comorbidity are independent predictors of outcome in patients referred for predialysis education. Clin Kidney J 2016; 9:324–329. [PubMed: 26985387]

50. Chan D, Cheema BS. Progressive resistance training in end-stage renal disease: systematic review. Am J Nephrol 2016; 44:32–45. [PubMed: 27355619]

51. Headley S, Germain M, Mailloux P, et al. Resistance training improves strength and functional measures in patients with end-stage renal disease. Am J Kidney Dis 2002; 40:355–364. [PubMed: 12148109]

52. Johansen KL. Resistance exercise in the hemodialysis population - who should do the heavy lifting? Am J Nephrol 2016; 44:29–31. [PubMed: 27351524]

53. Marcus RL, LaStayo PC, Ikizler TA, et al. Low physical function in maintenance hemodialysis patients is independent of muscle mass and comorbidity. J Ren Nutr 2015; 25:371–375. [PubMed: 25836339]

KEY POINTS

- Despite no clear gold standard for assessing frailty, researchers have recently favored a physical definition of frailty, defined as having at least three of five criteria: shrinking or weight loss, weakness, poor endurance and energy, slowness, and low physical activity level.
- Frailty is associated with poor outcomes such as higher mortality, falls, hospitalizations, cognitive impairment, vascular access failure, and poorer quality of life among dialysis patients, regardless of how it is measured or defined.
- Understanding the association between frailty and poor outcomes may improve discussions between providers and patients on the risks and benefits of the dialysis procedure.

Table 1.

Utilization of various frailty constructs in studies assessing outcomes in dialysis patients

	Study	Outcomes
Physical construct of frailty (i.e. frailty phenotype)	Chao *et al.* [45■■]	Vascular access failure
	Yadla *et al.* [32]	Death, falls, hospitalization
	Lee *et al.* [33■]	Death, hospitalization
	Johansen *et al.* [34]	Death
	Ng *et al.* [35]	Death, hospitalization
	McAdams-DeMarco *et al.* [42■]	Cognitive function
	Delgado *et al.* [44]	Falls, fractures
	Meulendijks *et al.* [19]	Death, hospitalization
	McAdams-DeMarco *et al.* [36]	Death, hospitalization
	McAdams-DeMarco *et al.* [43]	Falls
	Bao *et al.* [26]	Death
	Johansen *et al.* [18]	Death
Subjective construct of frailty (i.e. frailty score)	Iyasere *et al.* [46■■]	Quality of life
	Alfaadhel *et al.* [37]	Death