Kidney Medicine

Physical Function Assessment in Older Hemodialysis Patients

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Rationale & Objective: Physical function is not routinely measured in older adults receiving dialysis. We evaluated the appropriateness of repeated measurements of physical function, including Short Physical Performance Battery (SPPB), handgrip strength, and activities of daily living (ADLs), in older adults receiving dialysis.

Study Design: Prospective study.

Setting & Participants: 37 community-dwelling adults 65 years and older receiving in-center hemodialysis at 5 dialysis units located in North Carolina.

Exposures: SPPB (an assessment of standing balance, chair stands, and gait speed), handgrip strength, and Katz and Lawton ADLs at baseline and subsequent 3-month intervals up to 6 months.

Outcomes: Completion rate, presence of floor or ceiling effects, and presence of clinically meaningful change in physical function measurements.

Results: Of 55 potential participants, we enrolled 37 (67%) older adults receiving hemodialysis. Among 35 enrolled participants who completed baseline assessment in a dialysis unit, mean age was 70.1 (SD, 5) years, 46% (n = 16) were women, 77% (n = 27) were African American, and median time receiving dialysis was 2.7 (IQR, 0.6-5.0) years. There were 3 deaths within the observation period, and study retention at 3 and 6 months was 83% (n = 29) and 74% (n = 26), respectively. Participants tolerated measurements; only 2 participants did not attempt 1 of the performance-based tests at a study visit. Baseline median SPPB score, grip strength, and gait speed were 6 (IQR, 4-9), 55 (IQR, 42-70) kg, and 0.76 (IQR, 0.46-0.86) m/s, respectively. Baseline median for Katz and Lawton ADLs were 6 (IQR, 6-6) and 7 (IQR, 4-8), respectively; ceiling effects were observed for both measures. For some participants, clinically meaningful changes (improvement or decline) in SPPB score, grip strength, and gait speed occurred at each 3-month interval.

Limitations: Limited geographic and ethnic variation.

Conclusions: SPPB, handgrip strength, and gait speed alone are appropriate measures for interval physical function assessment in community-dwelling older adults receiving in-center hemodialysis.

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Older adults are the fastest growing population initiating dialysis, and >60% of community-dwelling older adults experience functional decline within 6 months of dialysis initiation.[1] Self-reported functional decline (or impairment) in older adults receiving dialysis has been associated with mortality.[2-5] Low physical function assessed using performance-based measures (eg, gait speed and balance) has been associated with both mortality and hospitalization.[6,7] Despite this compelling evidence, there is no routine approach for identifying functional decline in older adults receiving dialysis.

Periodic functional assessments in older adults help identify new functional decline, the trajectory of functional decline, and opportunities for interventions.[8,9] Because of time constraints and immobility associated with dialysis, some functional measures may be inappropriate for older dialysis patients. Some measures may also be insensitive to change and/or unacceptable to dialysis patients due to frailty, functional impairment, fatigue, and low physical activity.[10-12] Activities of daily living (ADLs), Short Physical Performance Battery (SPPB), grip strength, and gait speed have been used in longitudinal studies of aging.[13] However, there is insufficient evidence on the appropriateness (ie, usefulness) of these measures for short-interval physical function assessment in a population of older adults receiving hemodialysis.

Understanding the appropriateness of physical function measures in community-dwelling older adults receiving dialysis is a critical step toward both routine functional assessments in dialysis units and interventions to mitigate functional decline. Therefore, we conducted a prospective study of adults 65 years and older receiving hemodialysis to observe select performance-based and self-reported functional measures (SPPB, grip strength, and ADLs) and assess appropriateness, defined as completion rate, presence of floor or ceiling effects, practicality in relation to time and space constraints, and responsiveness.

METHODS

Study Population

We recruited a convenience sample of older (≥65 years) adults receiving hemodialysis for this prospective longitudinal study. Exclusion criteria included nonambulatory status, dependence in all basic ADLs, advanced dementia (operationalized as a patient with diminished capacity to

PLAIN-LANGUAGE SUMMARY

Older adults receiving hemodialysis commonly experience worsening physical function; however, there is no routine approach to measuring physical function in dialysis units. One barrier to routine measurements is understanding which physical function measures to use in this population. Our study was designed to determine whether specific physical function measures, the Short Physical Performance Battery (SPPB), handgrip strength, and activity of daily living (ADL) instruments are appropriate for routine use in dialysis units. We found that SPPB, handgrip strength, and the gait speed component of the SPPB provide meaningful information on changes in physical function over time. ADL scores did not identify physical function problems. These findings will help researchers and clinicians decide on which physical function measures to use.

consent), non–English speaking, and hospice patients. Participant screening, recruitment, and consent occurred in outpatient dialysis units within 15 miles of Duke University.

This study was approved by the Duke University Institutional Review Board (Pro00075802). All study participants provided informed consent before enrollment and received incentives for participation.

Physical Function Measures

We measured physical function at baseline and 2 additional visits (~3 months apart). We selected a 3-month interval because it was used to identify functional changes among nursing home residents receiving dialysis.[2] We used 2 physical performance measures with high test-retest reliability in the hemodialysis population,[14,15] the SPPB[16] and handgrip strength, and 2 ADL survey instruments, Katz ADLs[17] and Lawton ADLs.[18]

The SPPB includes 3 assessments (balance, gait speed, and chair stands), each with score range of 0 to 4 based on ability to attempt task and/or time to completion, with a maximum score of 12 indicating high physical performance. We wanted to explore the relationship of timing within the interdialytic period with the reliability of physical function measures; therefore, we initially conducted the SPPB and handgrip strength on nondialysis (weekday) days at the participant's residence and dialysis days at the hemodialysis unit. On dialysis days, we attempted to conduct all physical performance measures before a hemodialysis session to avoid limiting participation due to postdialysis complications (eg, cramps or hypotension). In both settings, a trained research coordinator led each participant through the SPPB and the handgrip strength protocols in a quiet space (ie, separate from the treatment floor in the dialysis unit). After 22 participants completed baseline assessments, we found good agreement between SPPB scores on dialysis days and nondialysis days through visual inspection of Bland-Altman plots. Given this minimal variability in SPPB scores in the interdialytic period and logistical challenges in arranging home visits, we discontinued nondialysis day assessments for the remaining participants. Although we attempted to maintain consistency in conducting physical performance measures before dialysis, we conducted physical performance measures after dialysis when patients were unable to participate before their session. Handgrip strength was performed 3 times with a Jamar dynamometer (Jamar), and the maximum force (kg) of the 3 trials was used in analyses.

Katz and Lawton ADLs were administered during dialysis and scored based on the participant's self-report of ability to complete a task. With higher score indicative of higher physical function, the maximum score of the Katz and Lawton ADLs were 6 and 8, respectively. We assessed completion of each of these physical function measures if a participant attempted the task. To assess practicality in relation to time and space constraints of a dialysis unit, we measured time to completion for each of the assessments, as well as a subjective assessment of available space to conduct physical function measures. We telephoned participants to schedule follow-up visits (visits 2 and 3) at 12-week intervals. If visits could not be completed after 3 attempts, we stopped pursuing data collection.

Additional Measures

At baseline, participants reported residence type (eg, private residence, residential living, and long-term care) and assistive device use (eg, cane, walker, and wheelchair), and we administered life-space mobility[16,19] and Mini-Cog assessments.[20] We reviewed dialysis unit medical records for baseline demographics, comorbid conditions for the Charlson index, hemodialysis access type, length of time since dialysis initiation (years), hemoglobin level, dialysis adequacy (Kt/V), and albumin level.

Statistical Analysis

We performed descriptive statistics of baseline demographic, social, and clinical characteristics, as well as each SPPB score (including its chair stand time and gait speed components), maximum handgrip strength, ADL scores, and time to complete each of these physical function measures. We examined for floor and ceiling effects, defined as >15% of responses at the lowest or highest score for an instrument.[21] We calculated average time between visits and the change from baseline to visit 1 and from visit 1 to visit 2 for measures without evidence of floor or ceiling effects.

For consistency across participants, we calculated change over time using data collected on a dialysis day. Because gait speed alone is practical and has high prognostic value,[22] we also calculated changes in gait

speed (available through the SPPB). We identified the proportion of within-person change that was clinically meaningful (improvement or decline) and not clinically meaningful. Derived from the existing literature, cut points for clinically meaningful SPPB score, handgrip strength, and gait speed were ± 1 point, ±5 kg, and ± 0.1 m/s, respectively.[23-25] To demonstrate the extent of clinically meaningful change at the individual level, we developed panel-data line plots with baseline set to zero to display change from baseline and used horizontal lines to demarcate clinically meaningful change cut points. We performed multilevel mixed-effects linear regressions to explore trends in physical function over time. Time was modeled as a categorical fixed effect and the models were fit through restricted maximum likelihood with the Kenward-Roger degrees of freedom approximation method. All analyses were performed using STATA (version 15; StataCorp) and SAS (version 9.4; SAS Institute, Inc).

RESULTS

Cohort Characteristics

Of 55 hemodialysis patients approached to participate in the study, 37 enrolled. Two withdrew after experiencing hospitalizations within a week of study enrollment, leaving 35 who completed baseline measures (Fig S1). Among the 35 study participants, mean age was 70.1 (SD, 5.0) years, 46% (n = 16) were women, 77% (n = 27) were African American, and median time receiving dialysis was 2.7 (interquartile range [IQR], 0.6-5.0) years (Table 1). Most (97%; n = 34) lived at home and did not use an assistive device (51%; n = 18) but had restricted life-space mobility such that most needed help going outside their own home (Table 1).

Table 1. Baseline Cohort Characteristics

Characteristic	Value[a]
Demographics	
Age, y	70.1 (5.0)
Female sex	16 (46%)
Race	
African American	27 (77%)
White	8 (23%)
Hispanic ethnicity	0 (0%)
Clinical	
Charlson Comorbidity Index score	4.5 (1.6)
Time on dialysis, y	2.7 [0.6-5.0]
Access type (n = 34)	
Central venous catheter	4 (12%)
Arteriovenous graft	10 (29%)
Arteriovenous fistula	20 (59%)
Hemoglobin, g/dL	10.6 (1.0)
Kt/V[b] (n = 32)	1.5 (0.2)
Albumin, g/dL (n = 34)	3.8 [3.5-4.0]
Functional	
Type of residence	
Home	34 (97%)
Residential care	1 (3%)
Assistive device use	
None	18 (51%)
Cane	5 (14%)
Walker	12 (34%)
Mini-Cog score[c]	
0-2	2 (6%)
3-5	33 (94%)
Life-space mobility[d]	22.0 [14.0-26.0]
SPPB score	6.0 [4.0-9.0]
Handgrip strength kg (n = 34)	55.0 [42.0-70.0]
Gait speed, m/s (n = 34)	0.76 [0.46-0.86]

Note: Values for categorical variables are given as number (percent); values for continuous variables are given as mean (standard deviation) or median [interquartile range].
Abbreviation: SPPB, Short Physical Performance Battery.
[a]Values computed among N = 35 unless otherwise noted.
[b]Kt/V is measure of dialysis adequacy.
[c]Mini-Cog score of 2 or less is suggestive of higher likelihood of dementia.
[d]Life-space mobility; score <60 indicates restricted life-space. Lower scores suggest increasing limitations in moving beyond bedroom or home.

Completion Rate

Of the 35 participants, 97% (n = 34) were able to undergo baseline SPPB and hand grip measures. For longitudinal measures, 83% (n = 29) and 74% (n = 26) were able to be measured at visits 2 and 3, respectively. Study dropout was due to death (n = 3) and voluntary withdrawal (n = 8; Fig S1). Reasons for withdrawal were acute health concerns (n = 5), social concerns (n = 1), lost interest in participation (n = 1), and kidney transplantation (n = 1). Compared with those who completed 1 or 2 study visits, participants who completed all 3 study visits tended to have lower Charlson scores (Table S1).

Although most study visits were completed before dialysis, 3 participants completed 1 or more physical function measure after dialysis. An additional participant could not complete the measures after dialysis because of postdialysis muscle cramps. One participant was unable to complete a follow-up visit because of scheduling conflicts. When prompted by the coordinator, all participants attempted each measure at subsequent visits, except 1 participant who had general weakness did not attempt the visit 3 SPPB. Although participants were cooperative, 31% (n = 11) of those who attempted the SPPB at baseline could not complete the SPPB's repeated chair stand at least once because of knee pain and/or need to use arms to stand. Median completion times at baseline for SPPB, grip strength, and ADL instruments were 7 (IQR, 6-8), 3 (IQR, 3-4), and 3 (IQR, 2-4) minutes, respectively (Table S2). Each of the dialysis units had adequate space to conduct the SPPB and handgrip measures without interruption (eg, secluded hallway or examination room).

Physical Function Measures and Sensitivity to Change

At baseline, median SPPB score, grip strength, and gait speed were 6 (IQR, 4-9), 55 (IQR, 42-70) kg, and 0.76

Table 2. Proportion With Clinically Meaningful Change Between Visits

	Clinically Meaningful Improvement	No Clinically Meaningful Change	Clinically Meaningful Decline
SPPB total score			
Visit 2-visit1[a] (N = 28)	13 (46%)	5 (18%)	10 (36%)
Visit 3-visit 2[a] (N = 24)	9 (38%)	6 (25%)	9 (38%)
Visit 3-visit 1[b] (N = 25)	10 (40%)	8 (32%)	7 (28%)
Maximum grip strength			
Visit 2-visit 1[a] (N = 28)	15 (54%)	10 (36%)	3 (11%)
Visit 3-visit 2[a] (N = 24)	6 (25%)	12 (50%)	6 (25%)
Visit 3-visit 1[b] (N = 25)	10 (40%)	9 (36%)	6 (24%)
Gait speed			
Visit 2-visit1[a] (N = 28)	8 (29%)	14 (50%)	6 (21%)
Visit 3-visit 2[a] (N = 23)	3 (13%)	14 (61%)	6 (26%)
Visit 3-visit 1[b] (N = 24)	6 (25%)	13 (54%)	5 (21%)

Note: Cut points for clinically meaningful SPPB score, handgrip strength, and gait speed were ± 1 point, ±5 kg, and ± 0.1 m/s, respectively.[23-25]
Abbreviation: SPPB, Short Physical Performance Battery.
[a]Approximately 3-month interval.
[b]Approximately 6-month interval.

(IQR, 0.46-0.86) m/s, respectively (Table 1). Among the 33 participants who completed the Katz and Lawton ADLs at baseline, ceiling effects were present among 46% (n = 15) for the Katz and 82% (n = 27) for the Lawton ADLs. High ADL scores persisted at visits 2 and 3 (Table S3). Mean times between visits 1 and 2 and between visits 2 and 3 were 93.3 (SD, 11.1) and 89.7 (SD, 12.2) days, respectively.

For those with data at visits 1 and 3, a total of 40% (n = 10) had a clinically meaningful improvement in SPPB score and/or grip strength, and 25% (n = 6) had a clinically meaningful improvement in gait speed (Table 2). Some participants experienced both clinically meaningful decline and improvement on a measure during the follow-up period (Fig 1). Our statistical model demonstrated more between-participant than within-participant variation in SPPB score, grip strength, and gait speed over time (Table S4).

DISCUSSION

We explored the appropriateness of interval assessment of physical function in a cohort of ambulatory older adults receiving in-center hemodialysis. More than half the participants completed the SPPB, grip strength, and ADL assessments in the dialysis unit. Although ADLs demonstrated ceiling effects, average SPPB, grip strength, and gait speed measures revealed a low-functioning cohort with clinically meaningful changes at 3-month intervals. Overall, these findings provide guidance for future clinical and research efforts targeting identification of functional impairment in older adults receiving hemodialysis.

Although functional assessment is not part of routine care for older adults receiving dialysis, some studies in this population have used related measures. The predominance of those measures has involved self-report or provider evaluation (eg, 12-Item Short Form Health Survey or Karnofsky performance score).[26-28] One study engaged older adults receiving dialysis in the timed-up-and-go test[29]; however, most studies involving physical performance measures included younger adults and evaluated changes in measures over longer intervals (12 months).[7,30] Our findings extend those of the other studies demonstrating that older adults receiving hemodialysis, a highly vulnerable subgroup, can engage in 3-month interval physical performance measures and clinically meaningful changes can be found in those intervals.

The main goal of this study was to investigate the appropriateness of the SBBP, handgrip strength, and ADL assessments in older adults in the dialysis unit setting. Findings from this prospective study inform future implementation of physical function measures, specifically the SPPB, handgrip strength, and ADL assessments, for both clinical and research purposes. In terms of practicality of time and space constraints in the dialysis unit, we were able to reliably identify adequate space at each dialysis unit to complete the assessments without interference with hemodialysis sessions.

Considering that prior clinical trials with tailored recruitment plans for enrolling older adults achieved 72% to 73% enrollment,[31,32] we enrolled 67% of eligible patients, suggesting older adults' willingness to undergo physical function measures for research purposes. However, absent longitudinal data was primarily driven by study attrition from new medical issues and/or death. Future studies should enroll more participants at baseline in anticipation of attrition, as well as acknowledge that survival bias will affect interpretation of longitudinal data. The responsiveness of the SPPB, the gait speed obtained from the SPPB, and grip strength over time support their utility in detecting functional decline in community-dwelling older adults receiving dialysis. However, the SPPB chair stand component was commonly difficult to attempt due to physical limitations. Taken together, these findings suggest that gait speed alone, instead of the SPPB, may be a more appropriate measure of lower-extremity function in this population. There is also limited utility of ADL assessments because of the Katz and Lawton ceiling effects.

Last, our study shows good agreement between a nondialysis day and dialysis day (before the session), but it remains unknown whether there is similar agreement between measures performed before and after a dialysis

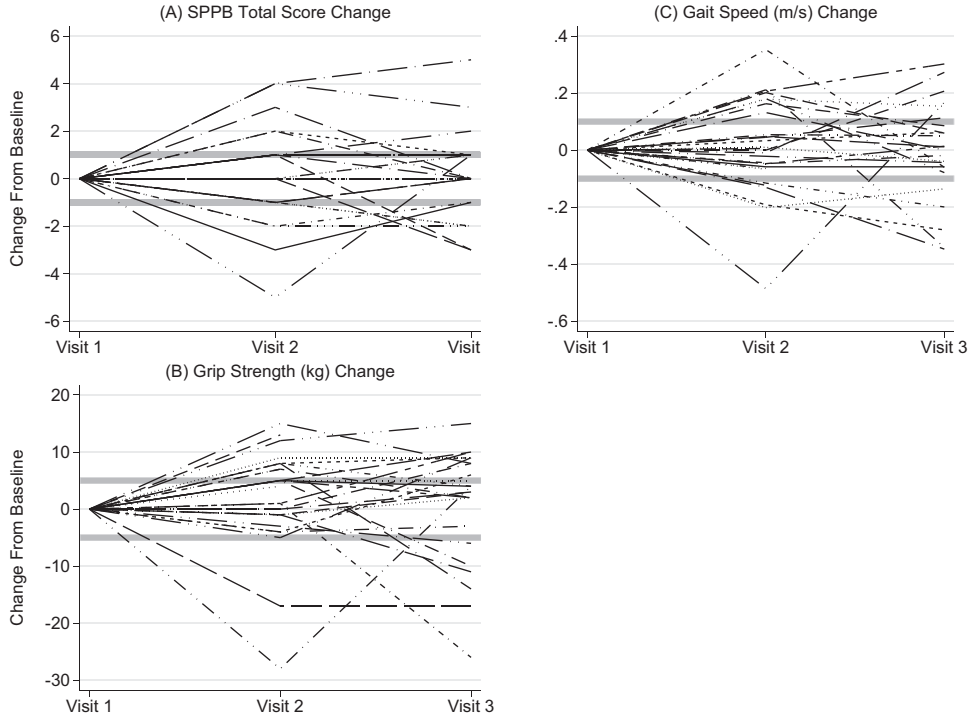

Figure 1. Panel-data line plots of change in (A) Short Physical Performance Battery (SPPB) score, (B) grip strength, and (C) gait speed from baseline. Baseline was set to zero such that clinically meaningful changes in each measure can be identified when lines are outside the boundary for clinically meaningful change (denoted by gray horizontal bars): 1 point for SPPB score, 5 kg for grip strength, and 0.1 m/s for gait speed.

session. Future studies that aim to measure this agreement are needed to provide evidence on the extent of flexibility in timing of functional assessments. Additional studies should also explore longitudinal physical function changes over longer observation periods.

This study revealed heterogeneity in the degree of vulnerability among community-dwelling older adults receiving dialysis. Some participants were highly vulnerable because nearly 25% of participants either died or withdrew for health issues. At baseline, the cohort's median SPPB score and gait speed were lower than average for community-dwelling older adults,[23,33] suggesting that nearly half the participants had increased risk for future disability and mortality.[7,22,34] Still, some participants met the average physical performance for their age. This heterogeneity suggests that additional research could potentially reveal factors that influence maintenance of physical function among older adults receiving dialysis.

Our ability to collect robust functional measurements over time in a cohort seldom included in research, older hemodialysis patients, is a strength of this study. However, there are some limitations. First, our study does not confirm the feasibility of physical function assessment. To confirm feasibility, future studies would need to assess the practicality of adding functional measures to dialysis unit staff workload and measure acceptability (ie, participant or staff satisfaction or opinions on clinical relevance). Second, inconsistency in the timing of functional assessments (before vs after hemodialysis) may introduce measurement bias. However, additional studies are needed to evaluate whether post- and predialysis physical function are incongruent. Last, our study's generalizability is limited given the small geographic distribution, absent Hispanic representation, and exclusion of patients receiving home dialysis. Future studies are needed to see whether our findings are consistent in a larger more representative cohort of older dialysis patients.

In summary, this prospective study in a vulnerable population of older hemodialysis patients demonstrates that interval assessment of physical function is feasible in the busy dialysis unit setting, and it provides clinically meaningful information on functional change over time. Using interval assessment of physical function to inform the management of functional decline is the next critical step toward improving function in older adults receiving dialysis.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Figure S1: Participant flow diagram.

Table S1: Baseline Cohort Characteristics Stratified by Number of Assessments

Table S2: Duration of Physical Function Measures, in Minutes

Table S3: Physical Function Measures at Each Study Visit

Table S4: Mixed Model of Change in Physical Function Measures Over Time

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