Kidney Medicine

Exercise Training in Peritoneal Dialysis: Delivering Exercise and Rehabilitation in the Home

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When the Medicare End-Stage Renal Disease (ESRD) Beneficiary program was created in 1972 to provide federally funded payment for kidney replacement therapy for patients with ESRD, it was expected by congressional leaders that maintenance dialysis would provide sufficient rehabilitation to enable nearly all patients to permit a return to employment, with 40% of patients not even requiring vocational retraining.[1] However, studies conducted in the years soon after the creation of this program demonstrated that only 25% of hemodialysis patients were employed outside the home, and a substantial proportion (including 75% of diabetic patients) had a functional status unlikely to permit such employment.[2] Although many factors, including socioeconomic and psychosocial conditions, may contribute to poor functional status in patients with ESRD, a major contributing factor is likely to be impaired physical performance. There is substantial evidence collected over many decades that maintenance dialysis patients have markedly impaired physical function, including decreased aerobic capacity,[3,4] slow gait speed,[5] and decreased lower-extremity strength/power. Compounding these deficits, habitual physical activity in maintenance hemodialysis patients is at least one-third lower than in healthy patients,[6] with substantially lower activity during hemodialysis treatment days.[7] Decreased physical activity in patients with ESRD is a strong predictor of mortality.[7]

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Multiple interventional studies over more than 4 decades have examined the effects of exercise training in patients with ESRD receiving maintenance dialysis. These studies have used a broad range of exercise interventions, including walking/running, cycle ergometry, yoga, and resistance training, across a wide range of durations. Many of these studies have involved small samples of participants and short durations of follow-up and lacked blinded outcome assessments. Although enormous heterogeneity across studies in terms of exercise modality, duration, and outcome measures challenges the rigorous meta-analysis of exercise effects in ESRD, summary studies have suggested small to moderate effects on lower-extremity performance and moderate-sized effects on aerobic capacity.[8,9]

These studies have overwhelmingly focused on hemodialysis patients, with many featuring intradialytic exercise regimens. Comparatively, there have been very few exercise trials in peritoneal dialysis (PD) patients. With the recent Advancing American Kidney Health Initiative intended to markedly increase use of home dialysis modalities in the United States, there is a need for greater evidence on the feasibility and effectiveness of exercise in PD patients. Bennett et al[10] have attempted to address this evidence gap by reporting results from a pilot and feasibility randomized controlled trial of home-based exercise training in PD patients.

The authors recruited participants among PD patients in a single home dialysis facility. Eligibility criteria were defined very broadly; permitting all PD patients able to ambulate independently and without amputation to participate. Specifically, there were no exclusion criteria based on cardiovascular or pulmonary comorbid conditions or on current levels of habitual or leisure-time physical activity. Patients were randomly assigned 1:1 to either 12 weeks of home-based exercise or standard of care.

An important design component of this trial is that all participants were first trained in the exercise routines by an exercise physiologist during their monthly dialysis center visit. Exercise consisted of cardiovascular training, walking or cycle ergometry, depending on available resources, 10 to 30 minutes thrice weekly along with twice-weekly resistance training. The former exercises were performed at "moderate" intensity, although it was not specified how this intensity was ascertained; standard methods used in exercise science include achieved heart rate[11] and/or validated rating of perceived exertion scales.[12] Resistance training included upper- and lower-extremity exercises but also core strengthening, although it is unclear what modifications if any were made to minimize abdominal discomfort in these PD patients. Participants met monthly with an exercise physiologist in person and with additional telephone conversations, and the duration and frequency were gradually increased to a goal of 300 minutes weekly of cardiovascular exercise, with increased intensity. This is an ambitious goal for exercise in patients with ESRD, substantially greater than the weekly duration of aerobic exercise prescribed in many prior trials in patients with chronic kidney disease or ESRD[9] and double the minimum weekly duration of moderate to vigorous physical activity recommended for the general population.[13]

With regard to the feasibility of the study, the authors reported that 76% of PD patients at the home dialysis facility were eligible, likely reflecting the very broad eligibility criteria of this trial. Among those eligible, a remarkable 63% consented to enrollment, representing a much higher participation rate than in many prior physical activity trials in the general population.[14] Participant characteristics were broadly representative of PD patients nationally, with 58% having diabetes, mean age of 57 years, and 65% nonwhite. All participants used automated

Table 1. Potential Challenges and Uncertainties in the Design of Clinical Trials of Exercise Training in PD Patients

Criteria	Examples of Uncertainties and Challenges
Selection Criteria and Screening	
CAPD vs automated PD	Patients with daytime dialysate dwells may have discomfort with certain core exercises and/or aerobic exercises
CV disease	Exclusion of patients with symptomatic heart failure? Screening for silent/asymptomatic severe CAD? Physician evaluation before initiation of exercise (nephrologist only? Cardiology evaluation appropriate?)
Current habitual physical activity	A minority of patients may already be physically active but uncertain how to best quantify habitual or leisure time activity in PD patients
Exercise Modality	
Resistance training	Potential safety concerns or intolerance for core training, especially with daytime full abdomen
Aerobic exercise	Access to aerobic exercise equipment (eg, cycle ergometer, treadmill)
Duration and Frequency	
Goal of at least 150 min of aerobic exercise weekly	Most protocols include a stepped approach to reach goal duration & frequency
Intensity	
At least moderate aerobic training likely of greatest benefit	Need for reliable quantification of exercise intensity
Safety	
Hypoglycemia ascertainment and prevention	High proportion of diabetic patients receiving PD; protocols required to minimize risk for exercise-induced hypoglycemia, especially for those receiving insulin or sulfonylureas
CV events	Concern for exercise-induced CV events during home-based exercise, especially for those with prior CV disease

Abbreviations: CAD, coronary artery disease; CAPD, continuous ambulatory peritoneal dialysis; CV, cardiovascular; PD, peritoneal dialysis.

PD, with 62% having daytime dialysate dwells. Among the 18 participants randomly assigned to exercise, 2 withdrew before the intervention beginning and 3 more withdrew in the first few weeks of the intervention; 1 for medical reasons and 2 due to loss of interest. However, total withdrawal was similar in the exercise and control groups. This 38% total attrition rate was substantially higher than that reported in a 12-week exercise study of PD patients in Japan[15] and in a large general population study of physical activity in older adults.[14]

Of the remaining 13 patients, 10 achieved at least 50% adherence to the prescribed exercise sessions during the 3-month period. Importantly, no serious exercise-related safety events were reported, the total adverse event rate was similar between exercise and control groups, and only 2 minor exercise-related events (abdominal discomfort and slight dizziness) were noted. Although 58% of participants had diabetes, the authors did not describe a process of screening for and protecting against exercise-induced hypoglycemia, which would be expected to be more common in diabetic patients with ESRD than among diabetic patients with normal kidney function. The authors acknowledge that the trial was not designed with sufficient sample size to detect plausible effects in physical performance or health-related quality of life; however, they identified significantly greater improvements on the Timed-Up-and-Go test (a composite test of lower-extremity strength and balance) and in self-reported appetite, but not in other domains of health-related quality of life or on tests of lower-extremity strength and power.

With the number of patients treated with PD expected to grow considerably, it will be necessary to expand the evidence base on the safety, feasibility, and efficacy of different exercise methods in PD patients. Conceptually, there are unique challenges and opportunities to delivering and implementing exercise training in PD patients (Table 1). For patients treated with continuous ambulatory PD and/or with daytime dialysate dwells, there are potentially concerns about safety and discomfort, especially for exercises involving core and abdominal musculature. Further, in-center supervised exercise training (eg, as with intradialytic exercise in hemodialysis patients) is unlikely to be feasible. However, home-based exercise may be more acceptable for patients receiving home dialysis modalities than for in-center hemodialysis patients. Furthermore, the lower risk for hemodynamic stability and absence of vascular cannulation potentially permits greater safety compared with intradialytic exercise in hemodialysis patients.

Results of this pilot study provide important information in several areas and raise important questions for future design and implementation of exercise studies in PD patients (Table 1). First, the results suggest, at least within a dedicated home dialysis facility, that there is considerable interest and willingness to participate in structured exercise training among PD patients. Retention during 3 months was only moderate despite monthly telephone and in-person contacts with an exercise physiologist. One withdrawal was due to unavoidable medical issues, but others were due to lack of continued interest. Efforts to enhance retention and engagement in exercise training over a span of months, perhaps through increased communication with exercise and/or dialysis staff, are crucial to the long-term success of any intervention. Despite an aggressive goal for exercise frequency, adherence was acceptable, at least among those who did not withdraw from the study. Although the sample size of the study was small, there were no exercise-related serious adverse events noted, with only 2 mild total exercise-related adverse events.

Although more than half the participants had diabetes, the authors did not describe a protocol for screening or mitigating against exercise-induced hypoglycemia. There was also no protocol for excluding or screening for patients with active ischemic heart disease, as has been implemented in some past exercise trials in patients with kidney disease. Nevertheless, the results suggest that even in an unselected sample of PD patients, including a majority with daytime dialysate fills, home-based aerobic and resistance exercise exchanges are safe and overall well-tolerated. Although significant effects were noted on lower-extremity function and self-reported appetite, these results should be interpreted with caution given the relatively high rate of withdrawal and the multiple functional outcomes assessed. Whether similar safety and adherence would be possible without a dedicated exercise physiologist, a resource that is unlikely to be available to most dialysis centers, is uncertain. However, it is hoped that the results of this pilot study will spur additional investigation into the safety and benefits of exercise training among PD patients.

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