Advances in Practice

Improving health outcomes with exercise in patients with end-stage renal disease

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Cardiovascular disease (CVD) is a major contributor to morbidity and mortality in patients with chronic renal disease, and CVD mortality is approximately 15 times higher in patients undergoing dialysis than in the general population (1). However, early implementation of strategies used in the general population can reduce CVD risk factors in patients with end-stage renal disease (ESRD) (1,2).

Both the American Heart Association (AHA) and the National Kidney Foundation (NKF) Task Force on Cardiovascular Disease recommend moderate levels of physical activity for 30 minutes per day on most days of the week (3,4). A 12-month endurance exercise training program comprising cycling, walking and jogging improved lipid profiles and insulin sensitivity, and decreased dosages of antihypertensive medications required in hemodialysis patients (5). Despite the benefits of increased physical activity, exercise interventions are the least frequently implemented rehabilitation activities, according to a recent survey of Texas dialysis facilities (6).

Since the renal dietetics professional has early and ongoing contact with patients to evaluate lifestyle interventions for improving their health and well-being, this member of the multidisciplinary team can play an important part in promoting exercise in the ESRD population (7). Optimizing functional ability is an important goal of both nutrition and exercise therapy, and the registered dietitian has the expertise to ensure adequate calorie and protein intake to maintain or increase muscle mass, and improve physical performance (7,8).

Resistance training, characterized by resisting, lifting and lowering weights has been associated with increased energy intake and protein utilization in patients with chronic renal insufficiency (CRI) consuming a low-protein diet (9,10). As a result, muscle mass and nutritional status improved in these patients. Since nutritional status at initiation of maintenance dialysis therapy seems to determine subsequent improvement in nutritional parameters (11), the ability of resistance training to counteract the catabolic effects of low-protein diets during CRI may have important implications when the patient reaches ESRD.

This column will review the benefits of exercise for patients with ESRD undergoing maintenance dialysis therapy and explore strategies for increasing physical activity in this population.

Beneficial effects of exercise for patients with ESRD can be categorized as follows:
Increased quality of life: Exercise coaching and rehabilitation counseling provided to both pre-dialysis and dialysis patients increased their quality of life compared with non-exercising control patients (12). In this study, hematocrit and sickness impact profile scores served as indicators of quality of life. Greater benefits were realized in pre-dialysis than dialysis patients.

Increased appetite and improved nutritional status: Protein-energy malnutrition (PEM) affects up to 70% of adults with ESRD undergoing maintenance dialysis therapy and despite aggressive nutrition intervention, its prevalence has remained virtually unchanged over the past decade (13-15).

Patients undergoing HD who participate in intradialytic exercise programs report improved appetite and show small increases in mean energy and protein intake; estimated dry weight and serum albumin levels also increase when compared with non-exercising dialysis patients (16,17). In these programs, patients were given the option of cycling before or during HD, walking on a treadmill before HD, or stretching and exercising with light weights during HD (16) and cycling on a stationary bicycle (17).

Patients on continuous ambulatory peritoneal dialysis (CAPD) who underwent thrice weekly exercise training on a treadmill, bicycle or arm ergometer showed no significant changes in serum albumin (18).

Although the effects of exercise on nutritional status are subtle, research conducted to date has involved small numbers of patients participating in exercise programs of 3 to 12 months duration. Nutritional changes may be better assessed in studies that include larger numbers of patients participating in long-term exercise programs.

Improved lipid profile: Lipid abnormalities and defective cholesterol transport contribute to atherosclerosis in patients with ESRD (19). Fifty to 75% of patients undergoing maintenance dialysis therapy have hypertriglyceridemia and decreased high-density lipoprotein (HDL), and patients on CAPD have significantly higher serum triglycerides, total cholesterol and low-density lipoprotein (LDL), than those undergoing HD (20-22).

Endurance exercise training (cycling, walking and jogging) results in decreased serum triglycerides and increased HDL in HD patients (5,23). A similar exercise program elicited an increasing trend of HDL in patients on CAPD (18). However, a self-monitored program of aerobic activity for 15 minutes thrice weekly had no effect on lipid profile in patients with ESRD after 8 months (24). This suggests that supervised exercise programs of high intensity may be necessary to improve lipid profiles in this population.

Better glycemic control: Glucose uptake by skeletal muscle and adipose tissue decreases in patients with CRF, resulting in glucose intolerance and hyperglycemia (25). In patients with diabetic nephropathy, poor glycemic control prior to dialysis initiation is a risk factor for increased mor-

Continued on page 9

continued from page 7

When there is an urgent need to control glucose levels such as during pregnancy or when trying to determine if hypoglycemia is a factor in seizures.

CGMS has shown that hypoglycemia is more prevalent than was previously thought, and patients are often able to decrease insulin use. It is also useful in monitoring after-meal blood glucose levels allowing patients to adjust insulin or oral medications to keep these levels in acceptable ranges. (4) For the dialysis patient, CGMS could be used to determine if a patient is experiencing low blood-glucose during treatment. This information could then be used to counsel the patient about how to adjust medications and/or meals on dialysis days.

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continued from page 8

tality, and improving glycemic control can decrease cardiovascular damage (26,27).

Diabetic and non-diabetic HD patients participating in exercise programs experience a decrease in serum glucose (16,23). This is attributed to increased insulin sensitivity and responsiveness of skeletal muscle during exercise (23,26). The intradialytic period may be the safest time for diabetic HD patients to exercise because their blood glucose is maintained within normal limits by dialysate (19).

Improved serum phosphorus control: It is estimated that 60% of HD patients have serum phosphorus levels above 5.5 mg/dL, the upper limit of normal (28). Phosphorus elevates the cacium-phosphorus product (Ca x P) and stimulates secretion of parathyroid hormone (PTH), promoting vascular calcification and increasing the risk of CVD (29-31). Another consequence of altered phosphorus and PTH levels in patients beginning dialysis is increased risk for bone fracture due to lower bone mineral density compared with healthy people of the same age and gender (32,33).

A significant decrease in serum phosphorus from 6.02±1.4 mg/dL to 4.48±0.9 mg/dL has been reported in HD patients participating in a 12-month exercise program (16). Furthermore, in women undergoing HD, energy expenditure during daily physical activity showed a strong relationship to bone mineral density (34). Thus, exercise may decrease CVD risk and bone fractures in HD patients through its effects on serum phosphorus and bone mineral density.

Improved fluid removal and blood pressure control: The majority of patients with ESRD are hypertensive, and fluid status is significantly related to blood pressure (35,36). Since blood circulates through the body up to 4 times faster during exercise than at rest, fluid removal may be easier in patients who exercise during HD (19). Cardiac output in HD patients can also be improved by thrice weekly aerobic training sessions (37). HD patients participating in a 12-month in-center, intradialytic exercise program experienced a decrease in mean pre-dialysis systolic and diastolic blood pressure, mean post-dialysis systolic and diastolic blood pressure, and mean average interdialytic fluid gain (16). In a more recent study, patients performing stationary cycling during HD were able to reduce antihypertensive medications by 36%, resulting in an average annual cost savings of $885 per patient year (38).

Increased strength and functional capacity: Inactivity during HD treatments or illness, and after surgery, contributes to weakness, fatigue and decreased exercise capacity in HD patients (19).

Oxygen consumption during maximal exercise (VO_2 peak) is considered the best indicator of exercise capacity (19,39) and exercise training has a significant effect on this parameter in HD patients (40). However, overall changes in VO_2 peak are small in HD patients undergoing exercise training, and remain lower than in age-matched healthy individuals.

Patients receiving HD therapy who participate in aerobic exercise and resistance training show improvements in muscle strength and physical function (41-43). In these studies, patients trained on cycle ergometers and participated in progressive resisted quadriceps and hamstrings exercises. Outcome measures included walking speed and distance covered, handgrip strength and peak muscle torque, and scores on Medical Outcomes Study Short Form-36 (SF-36).

Thus, exercise training in HD patients improves the muscles' ability to use oxygen, leading to improved capacity for exercise. Improvements in self-reported physical functioning during exercise training may be significant because these scores are also predictive of hospitalization rates and mortality (40).

Clearly, exercise programs provide multiple benefits for patients with ESRD and these are summarized in Table 1. However, there is little evidence to suggest that exercise counseling provided to patients in a primary care setting promotes increased physical activity, and dialysis patients may be even less likely than the general population to receive advice about exercise from healthcare providers (44,45). Results from a survey conducted in 2001 indicate that rates of exercise counseling among nephrologists are low, with only 38% of respondents frequently assessing patients' physical activity levels and counseling inactive patients to increase activity (45).

A summary of these findings can be seen in Table 1.

Since rehabilitation activities provide more benefits in pre-dialysis than dialysis patients, exercise interventions should begin prior to the onset of maintenance dialysis therapy (12,19). Both the Life Options Rehabilitation Advisory Council (LORAC) and the National Kidney Foundation (NKF) have developed exercise programs and resources for patients with CRI and ESRD (7,46).

Research indicates that patients with ESRD benefit most from supervised exercise programs (24,47). Problems with adherence led to higher dropout rates among patients participating in thrice weekly aerobic and strength-training sessions on non-dialysis days (24%) than in patients who completed an exercise program during HD (17%). However, intense training on non-dialysis days resulted in a 43% increase in VO_2 peak, compared with a 24% increase in the intradialytic exercise group (47).

For the ESRD facility wishing to promote exercise, LORAC suggests 5 levels ranging from the least to the most involved commitment (7). At Level 1, incorporating an exercise prescription into the patient's care plan promotes the perception that exercise is an essential component of the treatment program. Levels 2 and 3 involve making routine referrals for physical therapy and providing information on community resources, respectively. At Level 4, motivational programs are provided to encourage exercise. Beginning an in-center exercise program is a Level 5 activity.

The success of any exercise program depends on educating patients and

Continued on page 12

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continued from page 12

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Table 1 *Summary of beneficial effects of exercise for patients with end-stage renal disease*

Benefit	Observed effect
1. Increased quality of life	Increased hematocrit and sickness impact profile score (12)
2. Increased appetite and improved nutritional status	Small increases in mean energy and protein intake, estimated dry weight and serum albumin in patients undergoing hemodialysis (HD) (16,17)
3. Improved lipid profile	Decreased plasma triglycerides and increased high-density lipoprotein (HDL) (5,18,23)
4. Better glycemic control	Improved insulin sensitivity, resulting in decreased serum glucose in diabetic and non-diabetic HD patients (5,16,23)
5. Improved serum phosphorus control	Decreased average serum phosphorus over 12 months in HD patients (16)
6. Improved fluid removal and blood pressure control	Decreased average interdialytic fluid gain and mean pre- and post-dialysis systolic and diastolic blood pressure (16). Reduction in antihypertensive medications in HD patients (5,38)
7. Increased strength and functional capacity	Increased oxygen consumption during maximal exercise, indicating improved exercise capacity (40) Improved muscle strength, walking speed and scores on Medical Outcomes Study Short Form-36 (41-43)

Table 2 *Exercise program resources for end-stage renal disease (ESRD)*

Organization/Contact information	Exercise program resources
Life Options Rehabilitation Advisory Council (LORAC) http://www.lifeoptions.org (800) 468-7777	1. Just the Facts: Exercise for Life 2-page fact sheet for patients emphasizing benefits of exercise and providing tips for overcoming obstacles to physical activity. 2. Exercise: A Guide for People on Dialysis 44-page booklet with instructions for starting an exercise program focused on strength, endurance and flexibility. 3. Feeling Better with Exercise: A Video Guide for People on Dialysis. 4. Exercise for the Dialysis Patient comprehensive program comprising resources for the dialysis patient and healthcare professionals. 5. Exercise Speaker's Kit resources to help the healthcare professional promote increased physical activity in patients with ESRD.
National Kidney Foundation (NKF) http://www.kidney.org (800) 622-9010	Staying Fit with Kidney Disease brochure for patients, addressing benefits of exercise and providing tips on type, frequency and length of exercise sessions appropriate for people with kidney disease.