EXERCISE

FOR THE DIALYSIS PATIENT

A Guide for the Nephrologist

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Foreword

By Geoffrey E. Moore, MD

> *"How dull it is to pause,*
> *to make an end,*
> *To rust unburnished,*
> *not to shine in use!*
> *As though to breathe*
> *were life!"*
>
> From "Ulysses"
> Alfred, Lord Tennyson

Our culture's medical ethic has transformed from a belief that the doctor knows best to a belief that the patient's autonomy and right to self-determination prevail. In a nation founded on a "Divine and Inalienable Right to Life, Liberty and the Pursuit of Happiness," this transformation comes as no surprise.

Nevertheless, physicians disrupt Jefferson's divine triad with the tools of modern medical technology: we save life at the expense of liberty to pursue happiness. *Nowhere in medicine is this more evident than in the treatment of patients with end-stage renal disease (ESRD).* Tremendous technological advances in the management of ESRD do little by themselves to help patients regain predialysis lifestyles.

Barriers to rehabilitation remain. One of the most significant is the loss of physical strength and mobility. Many patients cannot climb stairs, walk down the street, or carry a bag of groceries; life is restricted, indeed.

Unfortunately, many physicians and, therefore, staff and patients make the assumption that dialysis patients should expect progressive physical degeneration. Not necessarily! There is a proven prescription for increasing both strength and endurance: exercise.

Exercise training can bring significant benefits to dialysis patients – the same benefits it brings to normal, healthy people, including increased physical work capacity, decreased risk factors for cardiovascular disease, improved blood pressure control, and improved psychological status. The well-documented benefits of exercise are often denied to dialysis patients, however, because of an over-cautious assessment of potential risks.

In many cases, the fear of exercise is simply not based on objective data. For example, exercise during dialysis is often considered "unsafe," yet it is physiologically equivalent to exercise off dialysis and is well tolerated during the first two hours of treatment. To our knowledge, there has never been a report that a patient exercising during dialysis suffered any adverse effects.

Other fears, including the risk of exercise-induced myocardial infarction, are often greatly overstated. The relative risk of exercise training, for example, is thought to be lower than the risk of cardiac arrest during dialysis.

Prescribing an exercise regimen for a particular patient will, of course, depend on many factors. This guide suggests some criteria and offers other considerations for the clinical nephrologist. Careful screening and evaluation of comorbidities are a must. A final decision about exercise should always be made on an individual basis, using the best knowledge of the physician, physical therapist, and the patient.

Every dialysis patient deserves the opportunity to live his or her life to the fullest. As physicians, we can take several important steps to make that goal a reality. First, we can ensure that our patients receive optimal medical management; second, we can make appropriate referrals to physical therapy or cardiac rehabilitation; third, we can communicate our expectation and encouragement for physical activity; and finally, we can work to include physical activity in every patient's medical care plan. In my view, merely providing dialysis services is just not enough.

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Introduction

Successful rehabilitation, defined as the restoration of meaningful participation in life, requires physical strength, endurance, and mobility. The lack of these capabilities results in a restricted lifestyle and presents a significant barrier to rehabilitation.

Experts in the renal community, through their work as members of the Life Options Rehabilitation Advisory Council, have identified one "bridge" that can help patients surmount this barrier: **Exercise.***

Exercise is important for patients with end-stage renal disease. Without it, deconditioning and extremely low levels of physical functioning can compromise patients' ability to perform even simple tasks. In addition, ESRD patients are often subject to coronary artery disease and other cardiac conditions. Exercise training can modify many of the risk factors for coronary artery disease.

Although the potential benefits of exercise for ESRD patients can be significant, programs to increase physical activity and improve physical functioning are rarely incorporated into treatment plans. This must change if ESRD patients are ever going to achieve their optimal rehabilitation potential.

Physicians have the opportunity to make a difference. They can — and do — have a meaningful and lasting impact on their patients' behaviors and well-being. Nephrologists, in particular, can help dialysis patients improve their quality of life by encouraging them to increase physical activity. Not all patients will benefit from exercise; some will not. But every patient deserves a chance.

Exercise can work wonders for the majority of dialysis patients, but few will succeed in adopting a program of regular exercise with the first, or even second, try. Embarking on a program of enhanced fitness may be difficult for dialysis patients; malaise, hospitalizations, medical setbacks, and major life adjustments to their disease and treatment must be accommodated.

This does not mean that improving physical functioning through exercise training is a lost cause. It does mean that dialysis patients need education, extra encouragement, and support from their healthcare team when they attempt to increase physical activity.

Exercise following kidney transplantation is equally important.

For all ESRD patients, the physician and the healthcare team must develop a capacity for the patience and indulgence needed when patients do not immediately succeed in adopting a recommended program. By drawing on the resources of professionals already assembled, nephrologists can assist their patients with both medical adjustments and behavior modification for better physical functioning.

** The work of the Council, which is supported by an educational grant from Amgen Inc., has also focused on other bridges to rehabilitation. These bridges, five in all, are known as the five E's. In addition to exercise, they include encouragement, education, employment, and evaluation. Each one is an important part of a complete rehabilitation program.*

Executive Summary

Dialysis patients typically have low exercise capacity, which limits their potential for rehabilitation. The causes are both physiological (*eg*, anemia) and behavioral (*eg*, physical inactivity).

Rationale. Exercise capacity can be improved an average of 25% by exercise training. This improvement is associated with physical, psychological, and social benefits. It is hypothesized that exercise training, in conjunction with epoetin alfa (EPO) therapy, will result in even greater improvements in exercise capacity.

Most dialysis patients can tolerate low to moderate levels of exercise. Although some patients will not experience any benefits, every patient should be encouraged to try. The goals of exercise rehabilitation for ESRD patients are similar to the goals of cardiac rehabilitation for cardiac patients.

Risk. At this time, lack of sufficient data from controlled studies of exercise in dialysis patients makes it impossible to quantify the risks of exercise-induced injury in this population. Anecdotal evidence suggests, however, that exercise for dialysis patients does not entail extraordinary risk and that a greater, long-term risk may come from not exercising.

When dialysis patients begin an exercise program, both patients and their physicians should be aware that some degree of risk exists. Patients should be willing to accept that risk in order to reap the benefits of participating in an exercise program.

Testing. For a variety of reasons, exercise testing may have limited diagnostic utility in dialysis patients. There is limited experience with exercise testing in dialysis patients; therefore, it is incumbent upon the nephrology community to use knowledge of individual patients rather than guidelines established for other groups to determine the need for exercise testing prior to the start of an exercise regimen.

There is general agreement that initiation of low and/or moderate intensity exercise does not require exercise testing.

Motivation. The physician plays a critical role in developing patient and staff expectations about exercise and encouraging participation. The most effective exercise programs are initiated and encouraged by the dialysis team.

An understanding of the principles of change may help physicians and staff provide the structure and motivation patients need to include regular physical activity in their lives.

Recommendations. Given the very low maximal exercise capacity of most dialysis patients, recommended exercise programs usually focus on low level activities. Vigorous activity is tolerated by only a very few dialysis patients. Specific suggestions about how to put together an exercise program for dialysis patients are outlined in the separate guide entitled *A Prescription Guide*.

The Rationale for Dialysis Patients

Numerous reasons exist to promote regular physical exercise for dialysis patients. Anecdotal evidence and documented case histories, as well as published studies, combine to support the value of physical activity in the dialysis population. Any evaluation of the merits of exercise for dialysis patients should take into consideration the following factors:

Exercise Capacity

Dialysis patients typically have only half the peak (maximal) exercise capacity of normal sedentary individuals (Figure 1).[1-18] They are similar in this regard to patients with congestive heart failure.

The energy demands of most vocational, recreational, and daily activities meet or exceed the average maximal capacity of dialysis patients. The activities that they can sustain over an eight-hour period (defined as 50% to 60% of maximal capacity in normal individuals)[19,20] are quite sedentary (Figure 2).

The reason for such a low exercise capacity in dialysis patients is not fully known. Insofar as deconditioning contributes to the problem, exercise can be part of the solution. Several studies have reported an average of 25% improvement in exercise capacity following exercise training (Figure 3).[1,4,5,11,12,14] Exercise capacity has also been shown to improve an average of 28% after correction of anemia with EPO therapy (Figure 4).[9,15-17]

The peak level of exercise capacity achievable by dialysis patients is not known. Anecdotal experience shows that some patients may achieve levels at least as high as the average transplant recipient — or higher.

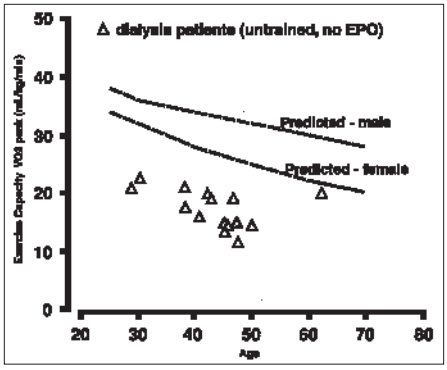

Fig 1.— *Peak exercise capacity of dialysis patients vs predicted exercise capacity of normal, sedentary individuals.*

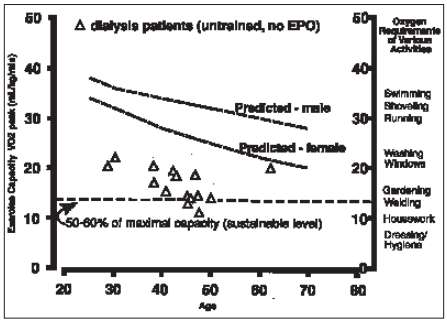

Fig 2.— *Oxygen requirements of various activities compared to sustainable exercise capacity of dialysis patients.*

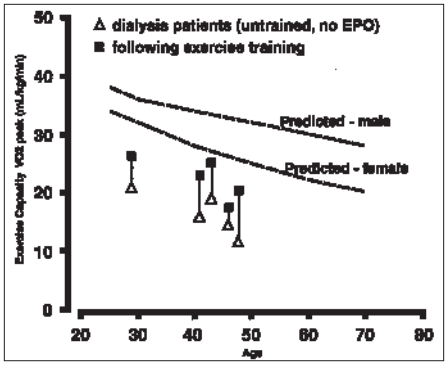

Fig 3.— *Peak exercise capacity of dialysis patients before and after exercise training.*

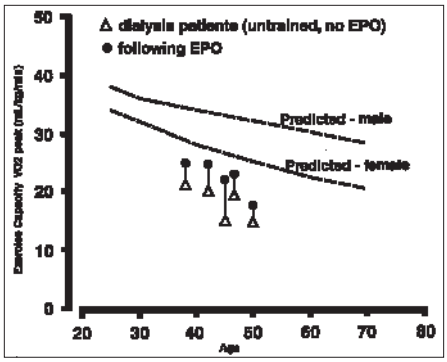

Fig 4.— *Peak exercise capacity of dialysis patients before and after EPO therapy.*

Two dialysis patients who participated in the 1991 California Transplant Games finished in the top two places in the one-mile run; one of these patients also won the five-kilometer race. The one-mile winner, with a time of 6:42 minutes, was a 40-year-old man with end-stage renal disease secondary to insulin-dependent diabetes. He had been treated with continuous ambulatory peritoneal dialysis (CAPD) for four years and had a $VO_{2\ peak}$* of 40.2 mL/kg/min. The second place winner, with a time of 7:02 minutes, was a 26-year-old man with end-stage renal disease secondary to glomerulonephritis. He had been treated with hemodialysis for eight years and had a measured $VO_{2\ peak}$ of 36.1 mL/kg/min.[21] These patients are clearly exceptions, but they serve as dramatic reminders that our expectations of dialysis patients often may be inappropriately low.

In clinical practice, most dialysis patients will be able to tolerate and benefit from low to moderate levels of exercise. There are some patients who do not respond physiologically to exercise training, but available research makes it difficult to identify them, since we still lack a clear understanding of what specifically limits their exercise capacity.[21] Every patient, therefore, should be encouraged to attempt some physical activity.

Effects of Medical Interventions

The availability of epoetin alfa (EPO)for correction of anemia in ESRD patients offers the promise of improved physical functioning. Actual improvements observed in exercise capacity resulting from increased hemoglobin average 28%. These changes, in $VO_{2\ peak}$ per change in hemoglobin, are about one third the magnitude of changes in healthy subjects whose hemoglobin is manipulated (through phlebotomy and/or red cell infusion).[21]

There is currently no data on whether exercise *plus* EPO will normalize physical functioning in dialysis patients. However, the correction of anemia with EPO may make patients more interested and willing to participate in exercise training; it may also allow them to exercise at higher intensities, thus providing a greater training stimulus.

Regardless of physiological effects, EPO therapy does not change behavior. It should not be expected that patients will automatically increase their activity level or start an exercise program once their hematocrits are increased. Neither has it been shown that correction of anemia automatically changes the ability of the skeletal muscle to use oxygen. Deterioration of muscle function resulting from physical inactivity can only be reversed by increased muscle activity.

Cardiovascular Risk Profile

Nearly all risk factors for development of coronary artery disease (CAD) are present in most dialysis patients. A program of exercise training over a 12-month period resulted in significant reduction in cardiovascular risk in dialysis patients.[1,21,22] When compared to a control group of hemodialysis patients, patients who exercised showed significantly improved risk profiles, including:

- Reduced plasma VLDL (very low-density lipoprotein) cholesterol
- Reduced plasma triglyceride levels

** Volume of oxygen consumed when exercising at peak capacity*

- Increased HDL (high-density lipoprotein) cholesterol
- Improved glucose tolerance, with lower circulating fasting insulin levels
- Lower systolic and diastolic blood pressures, with fewer antihypertensive agents required (dosage either reduced or discontinued)

Improved blood pressure management was especially striking. Six patients who required antihypertensive agents at the beginning of the study were able to decrease dosage or discontinue medications entirely after six months of exercise training.[23] Similar findings were reported in another study; six of eight patients requiring antihypertensive medications were able to discontinue them after six months of exercise training.[11]

Need for Independence

Gutman *et al*[24] reported that only 60% of nondiabetic and 23% of diabetic patients on maintenance hemodialysis were capable of physical activity beyond caring for themselves. Such advanced impairment renders many ESRD patients dependent on healthcare assistance and/or institutions. Little information exists concerning the exact number of ESRD patients who live in nursing homes or require ambulatory assistance. However, based on a 1991 sample of 6536 patients, the United States Renal Data System (USRDS) estimates that approximately 5.5% of ESRD patients require nursing home care, and approximately 8% may be unable to walk unassisted.[25]

As the number of elderly patients in the dialysis population continues to increase, the need to maintain their physical functioning cannot be overemphasized. There are no published studies concerning the effects of exercise in older dialysis patients. However, recent studies of resistance exercise training in "normal" octogenarians and nonagenarians have shown dramatic improvements in muscle strength — of the magnitude of 113% or more.[26,27]

One high-intensity resistance exercise training program in the elderly resulted in a 12% increase in walking speed, 28% improvement in stair climbing, and significant increases in spontaneous physical activity. Four patients of 17 who used walkers were able to switch to canes by the end of the training.[26]

Among eleven 90-year-old patients participating in a similar program, exercise training resulted in reduced use of assistive devices in several patients.[27] These exercise training programs have been completed with excellent levels of adherence (97%) and no orthopedic or cardiovascular complications.

A Standard Therapy in Other Patient Populations

Exercise training is a well-established part of treatment for patients with cardiovascular disease. In most cases, participation in a program of cardiac rehabilitation represents standard therapy for individuals with known disease (*eg*, angina, postmyocardial infarction) and after coronary artery bypass surgery.

Typically, cardiac rehabilitation programs include structured exercise training and other interventions designed to reduce the risk factors associated with cardiac disease.

The American College of Cardiology Goals of Cardiac Rehabilitation[28]:

- Reverse the adverse effects of deconditioning that result from a sedentary lifestyle and bed rest
- Assist patients with heart disease to optimize functional capacity
- Assist patients to adapt to, and function within, the limitations imposed by the disease and/or treatment
- Prepare patients and families for a lifestyle that may reduce the risk of coronary artery disease and hypertensive cardiovascular disease
- Reduce the emotional problems that accompany serious health disorders
- Prevent premature disability and lessen the need for institutional care of elderly patients

The goals of exercise rehabilitation for patients with renal disease are similar to the stated goals for cardiac rehabilitation.

Improving exercise capacity is often part of treatment plans for other patient populations. Exercise training is important in glucose regulation in diabetic patients, both type I and type II.[29] In addition, exercise training as part of a comprehensive *pulmonary* rehabilitation program has been shown to be effective in reducing the ventilatory load on the lungs (through reduced lactate production in the muscles), thereby improving functional capacity, as well as desensitizing patients to dyspnea limitations to exercise.[30] It has also been suggested that patients participating in pulmonary rehabilitation experience fewer days of hospitalization.[31]

The Risks

There are limited data on the risks of exercise training in dialysis patients, but no adverse cardiac events have yet been reported in any of the published exercise testing or training studies. Since experience in a wide variety of dialysis patients is limited, information on the risks of exercise training must be gathered from data for the general population, for individuals with known cardiac disease, and for individuals at high risk for cardiac disease.

Various risks are associated with exercise, and these may occur with varying frequency. The most *common* risk is injury to the musculoskeletal system, ranging from minor muscle strain to tissue or bone trauma. The most *serious* risk of physical activity is inducement of a cardiac event.

Cardiac Risk

Cardiac events associated with exercise include cardiac dysrhythmia, myocardial infarction (MI), and sudden death. Recent studies performed on persons at high risk and/or persons suspected of having cardiac disease have reported the following risks per 10,000 *exercise tests**: fewer than one death; four or fewer nonfatal myocardial infarctions; and approximately five hospitalizations.[32]

The risk of *exercise training*** in cardiac patients participating in cardiac rehabilitation is most recently reported to be: one arrest per 112,000 patient hours of exercise; one death per 790,000 patient hours of exercise; and one myocardial infarction per 300,000 patient hours.[32]

At this risk level, the relative risk of exercise training (1 arrest per 112,000 exercise training sessions) is actually lower than the risk of cardiac arrest during hemodialysis, which has been reported to be 1 per 11,570 dialysis sessions.[33] To put these numbers in perspective, it should be noted that dialysis is rarely withheld for fear of a cardiac event, and no patient undergoes a complete cardiac work-up prior to initiating dialysis.

Two recent studies have reported that 4% to 7% of 1,000 nondialysis patients presenting with acute myocardial infarction acknowledged strenuous physical exertion preceding the event.[34,35] Thus, perhaps 1 in 20 myocardial infarctions appears to be triggered by vigorous physical exertion. [Vigorous exertion is defined as activity >6 metabolic equivalents (MET). One MET is equal to 3.5 mL of 0_2/kg per min.]. The relative risk of myocardial infarction during or soon after unaccustomed strenuous physical activities was found to be two to six times higher than at other times.

It seems clear, then, that the risk of cardiovascular complications is *transiently* increased during vigorous exercise. This is especially true in persons with latent or known heart disease and in those who are unaccustomed to exercise.[36]

Regular exercise participation, however, *attenuates* the risk of a cardiovascular event during strenuous exercise. When patients in the studies mentioned above were stratified according to frequency of regular exercise, the relative risk of a cardiac event was clearly higher in those who were sedentary (see Table 1).

* *Exercise testing refers to controlled periods of exertion in which subjects are pushed to exercise at maximum capacity.*

** *Exercise training refers to sustained activity at 40% to 85% of maximum capacity.*

TABLE 1. Frequency of Exercise and Relative Risk of Exercise-Induced MI

Study	Frequency of Regular Exercise Per Week	Relative Risk of MI
Willich[34]	<4 x/week	6.9
	>4 x/week	1.3
Mittleman[35]	<1 x/week	107.0
	1-2 x/week	19.4
	3-4 x/week	8.6
	>5 x/week	2.4

The relative risk of *cardiac arrest* during exercise compared to risk at other times was 56 times greater in men with low levels of habitual physical activity and only five times greater among men with high activity levels.[37] Several studies also show that regular exercise participation reduces the long-term risk of coronary events.[38,39]

It is possible, then, that dialysis patients are actually at greater risk by *not* becoming physically active, since the risk of a cardiac event is so much higher in less active individuals.

Conservative and rigid guidelines for exercise testing and participation can take risk factors into account, but there is no way to absolutely eliminate the risk of a serious event during exercise testing or exercise participation.[40] Superior athletic ability, high levels of habitual activity, and absence of cardiac risk factors do not provide protection against an exercise-precipitated death.

Orthopedic Risk

The potential for orthopedic injury is high in dialysis patients who have had secondary hyperparathyroidism, renal osteodystrophy, or other types of bone disease, over a long period of time. Reports of spontaneous quadriceps tendon rupture secondary to osteitis fibrosis exist in the literature.[41,42] This risk appears to be greatest in younger patients (<40 years old) who fail to take oral phosphate binders and have long-standing renal disease.[41]

The predisposing causes of such ruptures are unknown. In three patients, alkaline phosphatase levels had been increasing continuously for five years prior to the injuries. It is hypothesized that uncontrolled osteitis fibrosa due to prolonged secondary hyperparathyroidism preceded the tendon ruptures.[42] Interestingly, there is anecdotal evidence of normalization of bone density following strength training of 20 months duration in one patient with significant bone disease.[43]

In contrast, exercise may reduce the risk of orthopedic injury from falls. Patients who are allowed to become deconditioned through inactivity experience significant muscle weakness, making them more likely to fall.

Minimizing the Risks of Exercise

Several steps can be taken to minimize the risks of exercise. Although many of these actions fall within the routine medical care of dialysis patients, their importance increases when exercise is added to the treatment plan. For exercising patients, nephrologists must be sure to:

Provide adequate dialysis

The effectiveness and safety of exercise may be affected detrimentally by inadequate dialysis.

Manage ongoing medical concerns

Concomitant problems such as infections, anemia, hypertension, and bone disease must be treated appropriately. Glucose,

potassium, serum albumin, calcium, phosphorus and parathyroid hormone (PTH) levels must be monitored and controlled.

Control hypertension

Exercise testing and/or training should be deferred if blood pressure is greater than 200/120.[40]

Respond to symptoms suggestive of cardiac disease

Exercise training should be deferred and the patient may be referred to a specialist if he or she experiences new symptoms such as
angina, palpitations, dizziness, weakness, extreme and/or unusual fatigue, or excessive shortness of breath.[40]

Musculoskeletal risk can be minimized by:

- Starting slowly and progressing gradually
- Assuring adequate calcium/phosphorous balance
- Avoiding high-impact activities (jumping, jogging, etc)
- Prescribing sessions of short duration for poorly conditioned individuals
- Assuring appropriate warm-up and cool-down times
- Assuring use of appropriate footwear
- Avoiding heavy weight training or testing
- Avoiding use of maximal leg press to test muscle strength
- Monitoring patient responses to increasing levels of activity

Managing Liability Concerns

At this time, lack of sufficient data from controlled studies of exercise in dialysis patients makes it impossible to quantify the risks of exercise-induced injury in this population. For the same reason, it is also impossible to quantify the benefits of exercise for dialysis patients. Anecdotal evidence suggests, however, that exercise does not entail extraordinary risk for dialysis patients. A greater, long-term risk may come from *not* exercising.

Nevertheless, when dialysis patients begin an exercise program, both patients and their physicians should be aware that some degree of risk does exist. Patients should be willing to accept that risk in order to reap the benefits of participating in an exercise program.

To ensure that patients do, in fact, understand and accept any risks, physicians and staff may want to suggest that patients sign a statement to that effect.

Screening for Participation

Guidelines for exercise screening have been presented by the American College of Sports Medicine[40] and the American Heart Association[44] for apparently healthy individuals, for individuals at high risk for cardiac disease, and for those with known cardiac disease. Currently, no guidelines exist for dialysis patients.

Existing guidelines suggest that persons with any known cardiac, pulmonary, or metabolic disease undergo exercise testing prior to participation in exercise training. These guidelines are developed based on the assumption that – in patients with coronary artery disease and congestive heart failure – exercise limitations and end points are cardiac-related and can be predicted from exercise testing information. Such an assumption may *not* be appropriate in patient groups limited by other systemic problems.

Because there is limited experience with exercise testing/training in dialysis patients, it is incumbent upon the nephrology community to use knowledge of individual patients to determine the need for testing rather than guidelines established for other patient groups.

Decisions about whether to require exercise testing and/or full cardiac work-up prior to initiation of exercise training in dialysis patients should be made with care by the physician. Factors to consider include the intensity of recommended activity; the diagnostic utility of exercise testing (*ie*, the likelihood of false negative or false positive results); the physiologic response of dialysis patients to testing; and, of course, the clinical status of the patient (see Recommended Interventions, page 24).

Intensity of Activity

The intensity of activity in a recommended exercise program helps to determine whether exercise testing is indicated. For example, moderate activity (intensity of 40% to 60% of $VO_{2\ peak}$), which is well within the individual's capacity and can be sustained comfortably for a prolonged period (*ie*, 60 minutes), places the individual at less risk than vigorous exercise.

Vigorous exercise (>60% $VO_{2\ peak}$), on the other hand, is intense enough to represent a substantial challenge and results in significant increases in heart rate and respiration. This level of exercise cannot be sustained by untrained individuals for more than 15 to 20 minutes.

There is general agreement that initiation of a program of low and/or moderate intensity exercise does not require exercise testing. Given the very low maximal exercise capacity of most dialysis patients, recommended exercise programs usually focus on activities that are low to moderate in intensity. Vigorous activity is tolerated by only a very few dialysis patients.

Most recommended activities do not demand exercise capacity greater than what is required to perform activities of daily living. Typically, the prescription simply aims toward sustaining "normal" activity for longer durations.

Diagnostic Utility of Exercise Testing

Nephrologists must also evaluate the diagnostic utility of exercise testing before making it a prerequisite for exercise training in dialysis patients.

The purpose of exercise testing is to determine the physiologic responses to controlled exercise stress.

Clinical applications include:

- Diagnostic and prognostic evaluation of suspected or established cardiovascular disease
- Assessment of exercise capacity
- Evaluation of medical therapy with certain classes of drugs such as antianginal agents, antihypertensive agents, antidysrhythmic agents, and other drugs prescribed for heart disease

Normal end points for termination of an exercise test include symptoms of:

- General fatigue
- Muscle fatigue
- Shortness of breath
- Achievement of maximal predicted heart rate
- High level of perceived exertion
- Inability to maintain increased level of work

Abnormal responses requiring discontinuation of the test include:

- Angina
- Dyspnea
- Dizziness
- Falling systolic blood pressure
- Indications of severe ischemia
- Dangerous or complex dysrhythmias

The diagnostic value of exercise testing (for coronary artery disease) is determined by a number of factors shown in Tables 2 and 3.[40]

Most data show that sensitivity of exercise ECG responses range from 50% to 90% and specificity from 60% to 98%. The wide variation in these reported values has been attributed to significant differences in patient selection, test protocols, ECG criteria for a positive test, and angiographic definition of coronary artery disease.

TABLE 2. ***Common Factors Contributing to False-Negative Results in Exercise Testing***

- Failure to reach an adequate exercise workload (>85% of age-predicted maximal heart rate)
- Insufficient number of leads to detect electrocardiogram (ECG) changes
- Failure to use other information such as systolic blood pressure drop, symptoms, dysrhythmias, or heart rate response in test interpretation
- Single vessel disease
- Good collateral circulation
- Musculoskeletal limitations before cardiac abnormalities occur
- Technical or observer error

TABLE 3. ***Common Factors Contributing to False-Positive Results in Exercise Testing***

- Left ventricular hypertrophy
- Anemia
- Coronary spasm
- Digoxin therapy
- Pre-excitation conduction patterns
- Type I antiarrhythmic drugs
- Phenothiazines
- Lithium

Exercise Testing Considerations in Dialysis Patients

In dialysis patients, several factors are present that may reduce the diagnostic utility of the exercise ECG.

- High prevalence of left ventricular hypertrophy (LVH), often with strain patterns
- Digitalis administration
- Electrolyte abnormalities
- A blunted heart-rate response to exercise (Most dialysis patients do not achieve 85% of their age-predicted maximal heart rates.)
- Low exercise capacity
- Musculoskeletal limitations to exercise

To Test or Not To Test?

When deciding whether an exercise test will be required for dialysis patients prior to beginning an exercise training program, nephrologists must evaluate the impact of the following factors:

- The prevalence of coronary artery disease in dialysis patients is high. Nevertheless, no routine screening is currently recommended to establish the absence or presence of cardiac disease or to establish a prognosis as a basis for making decisions about the need for further evaluation or intervention.

  Dialysis may represent as much cardiac stress as low-intensity exercise, yet it is routinely initiated without screening. The nephrology community must determine whether it makes sense to screen patients with full cardiovascular work-up (and therefore pursue further evaluation and/or intervention, when indicated) before beginning a low-intensity exercise program.
- Dialysis patients frequently fail to achieve myocardial stress levels adequate for diagnostic sensitivity in exercise testing. Limited by musculoskeletal fatigue, and subject to a blunted heart-rate response to exercise, many dialysis patients do not achieve 85% of the age-predicted maximal heart rate during exercise testing.

  Given this situation, a more appropriate diagnostic test for coronary disease would be the more expensive thallium scan or Persantine®[45] stress test. The expense of these diagnostic tests, at a time of acute awareness of costs in the ESRD program, may be a concern.
- Recommended exercise intensity for dialysis patients is usually very low, typically less than the intensity required for most activities of daily living. Prescribed exercise merely increases the duration of activity in a sustained fashion. Therefore, exercise at the prescribed intensity (40% to 60% of maximal capacity) does not put patients at a substantially higher risk than their daily living activities.

  If dialysis patients do not experience symptoms with routine activities of daily living (or with dialysis), they are not likely to experience problems with prescribed levels of low-intensity activity.

  In contrast, the prescribed exercise intensity for healthy individuals and cardiac patients often significantly exceeds the intensity of their daily activities (since they have a higher maximal capacity), and thus places them at higher risk.

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Principles of Change

For most people, habits are difficult to change. For dialysis patients, increasing physical activity may be especially difficult due to significant deterioration in physical functioning and fear that increased physical activity could cause fatigue and/or further deterioration of their health.

Understanding how and why people make changes in their behavior may help physicians and staff provide the structure and motivation patients need.

Five Principles of Change

There are five basic principles of change.[46] First, **people change in stages**, rarely in a sequential, linear manner. There is typically a considerable amount of backsliding, starting over, and retracing steps.

Second, **people change slowly**. Significant change, such as adopting a regular exercise program, tends to take a long time.

Third, **change requires multiple attempts**. According to successful organizations devoted to helping people make changes, a genuinely new habit requires successful use of the habit at least 37 *consecutive times*, without backsliding, before it can be considered truly adopted. Almost everyone backslides at first, so patients should not be reprimanded or demeaned for doing so.

Fourth, **change often involves relinquishing what is familiar** and may involve acknowledging mistakes. People tend to resist giving up familiar ways, even when they recognize that what they have been doing – or not doing – is not especially helpful. In addition, they will often defend their current practices.

Fifth, **helping patients change is often a thankless task**, a fact which prevents many healthcare workers from trying. On the other hand, the long-term payoff can be very satisfying, since patients who are successful in making positive changes in their health behaviors gain a sense of control that may result in improved compliance with medical treatment.

Steps to Successful Change

There are several steps to making lasting behavior changes. The first step is **acknowledging that something is not right**. Very few dialysis patients are satisfied with their level of physical functioning, and most will acknowledge they probably could benefit from more exercise.

The second step is **deciding to make a change**. This decision is important, but insufficient.

The third step, actually **making a commitment to change**, is typically more difficult. Commitment is demonstrated by actions, not by words.

Once a commitment has been made, subsequent steps include **setting a desirable and achievable goal** (*eg*, building up to 30 minutes of exercise four days per week over the next six weeks); **exploring options for achieving the goal** (*eg*, beginning independent home exercise, joining a community-based program, obtaining a referral to a cardiac rehabilitation program); and **deciding to try a particular plan** (*eg*, starting with five minutes of walking or stationary

bicycling and adding two minutes every day toward a goal of 30 minutes).

During implementation of a plan, **progress must be assessed** (*eg*, by timing how fast the patient can walk around a track or climb a flight of stairs). Often, the goals and plans may need to be modified; for example, if there is a hospitalization, the time frame for achieving a goal may be extended. Even after a patient has achieved a goal, the medical staff must help patients guard against backsliding.

Physician Responsibility

The safety and effectiveness of any exercise training program depend on the current clinical status of the patient. The level of medical management significantly affects how well patients tolerate an exercise training program, how well they adapt to it, and whether and to what degree they realize benefits. Thus, the primary responsibility of the physician for improving physical functioning is medical management of the patient.

Additionally, the physician plays a critical role in developing the expectations of patients and their families. By educating patients and families about physical activity and fostering the expectation of increased physical activity in medically stable patients, the physician can help temper the otherwise negative expectations of disability. The chances of achieving higher physical functioning increase if the outcome of "improved physical functioning" is included in the patient care plan and considered by the entire healthcare team as a part of the comprehensive medical therapy.

In summary, the responsibilities of the physician are as follows:

Assure appropriate medical management, including:

- Adequate dialysis
- Dietary and fluid compliance
- Control of hypertension
- Management of calcium/phosphorous and parathyroid hormone (PTH)
- Management of diabetes and its complications
- Control of infections
- Anemia control

Stratify patients based on clinical status and make appropriate referrals (see page 26)

Encourage patients to increase their levels of physical activity

Incorporate physical activity into the routine medical care plan, including:

- Assess current levels of activity
- Educate patients about the benefits of exercise and consequences of inactivity
- Suggest a program and/or refer to a physical therapy or cardiac rehabilitation program as indicated
- Follow up on patient progress/ participation as part of routine medical care
- Involve all clinic staff and include reference to physical activity in all documentation

Recommended Interventions

EXERCISE

Most dialysis patients are sedentary and have been for an extended period of time. Thus, most have experienced some degree of physical deconditioning. Given that advanced renal disease may also be associated with catabolic breakdown of skeletal muscle (and resulting weakness), it is clear that most patients can benefit from some intervention to improve muscular and/or cardiovascular function.

There is no single exercise activity that is best for dialysis patients; an optimal program of exercise has not been defined. Most existing programs use cardiovascular (aerobic) activity. Strength training may be particularly important since muscle weakness is a common complaint in dialysis patients. Although no studies have reported the effects of strength training in dialysis patients, nursing home residents clearly benefit.[27] It is reasonable to predict that improvements for dialysis patients will result from applying established principles of exercise training used with other populations.

Types of Exercise

Most exercise training programs incorporate three types of exercise: cardiovascular (aerobic or endurance) exercise, strength (or resistance) exercise, and flexibility exercise. Additional details about all three types can be found in *A Prescription Guide*.

Cardiovascular exercise is performed by moving large muscle groups in a rhythmic, sustained manner. Walking, swimming, and bicycling are examples. A typical training recommendation will target building up to 30 minutes (or more) of sustained activity three or four times per week for optimal cardiovascular conditioning. However, benefits can result from exercise of shorter duration (*eg*, 10 minutes) several times a day.

Strengthening exercise of specific muscle groups typically will result in increased muscle strength and increased muscle mass. It is believed that muscle strength can be maintained by two or three weekly sessions using free weights (dumbbells), weight machines, or calisthenics. A program using light weights and numerous repetitions is most appropriate for dialysis patients, to avoid excessive increases in blood pressure and to prevent excessive stress on tendons, bones, and joints.

Flexibility exercise involves muscle stretching to improve the range of motion (flexibility) around a variety of joints. Increased flexibility should improve functioning in daily activities and may help prevent musculoskeletal injury.

The combination of flexibility and strengthening exercises may help improve a patient's ability to perform activities of daily living, such as stooping, bending, reaching, lifting, and carrying.

Levels of Intervention

A number of approaches may be taken to incorporate an appropriate exercise program into a patient's medical care plan. The optimal intervention must be individualized and will depend on the patient's current level of functioning, goals, and clinical status. (see recommendations for stratification, page 26).

Independent Exercise

Most patients can exercise on their own if given appropriate information and

encouragement. The patient guide included in this kit offers suggestions that can be used by most patients. Flexibility and strengthening exercises, plus information about how to start a cardiovascular training program, are included.

The physician or clinic staff can assist patients in developing exercise plans using information in *A Guide for the Dialysis Team*, included in this kit.

Physical Therapy Referral

Physical therapists are trained to deal with a wide variety of patients, including those with poor physical functioning and neuromuscular problems. They can perform treatments that will:

- Increase range of motion/joint mobility
- Improve muscle strength
- Assist with gait training/balance/walking
- Provide some cardiovascular training
- Develop a customized program of therapeutic exercise

A referral to physical therapy can be made for many reasons, including "general muscle strengthening," "increasing range of motion," "ambulation assistance," or "general conditioning." Diagnosis may be "muscle weakness," "gait difficulties," etc. Any patient can be referred for a physical therapy evaluation visit, which is covered by Medicare, Part B.

Ongoing physical therapy services may be covered by Medicare if a number of conditions are met, including:

- Physical therapy services are furnished to a patient while under the care of a physician
- A written plan of therapy is established by the physician or therapist, detailing the diagnosis; type, frequency, and duration of services; and anticipated goals
- The physician sees the patient, reviews and initials the plan every 30 days
- There is an expectation that the condition will improve "significantly" in a "reasonable period of time," or that the services are needed for the patient to maintain his or her current status
- The services are provided by a licensed physical therapist

Physical therapy services provided in an outpatient facility, rehabilitation hospital, hospital clinic, etc, are reimbursed on a cost basis and are *not* subject to a dollar limit, therefore no number of visits is specified. Independently practicing physical therapists, however, are reimbursed on a fee-for-service basis, with reimbursement limited to $900 per year, or about eight visits (Medicare pays 80% of the $900; the patient is responsible for the remainder).

Physical therapy visits need not be sequential but may serve (in apparently healthy patients) to assess progress periodically and update the program. For patients with more severe limitations, physical therapy may be extended, as long as the care plan is provided to Medicare by the physical therapist and documentation can show that the services are reasonable and necessary.

It may be best to identify physical therapy clinics that are interested and willing to work with patients who have chronic conditions and low fitness levels, since many clinics specialize in "athletic-type" interventions.

Cardiac Rehabilitation Referral

Cardiac rehabilitation usually emphasizes aerobic exercise training with some electrocardiographic and blood pressure monitoring. In addition, most programs include some resistance exercise to improve muscle strength. These programs will also address risk factors by providing assistance with smoking cessation, stress management, and counseling to reduce dietary fat/cholesterol. Since dietary considerations for dialysis patients are specialized and addressed in the dialysis unit, the dietary counseling components of cardiac programs may not be necessary. The other risk management interventions may be very helpful, however.

In most cases, up to three months of cardiac rehabilitation may be covered by Medicare for patients with diagnoses of angina, coronary artery bypass grafting, or myocardial infarction within the past 12 months. Many cardiac rehabilitation programs have now developed mechanisms for including other patient populations in their programs for minimal cost or when insurance coverage is available.

After the initial rehabilitation program, patients are typically given instructions on how to continue their exercise independently – at home or in a community-based program. Some programs allow patients to continue with low-cost maintenance plans; others check patients periodically to assess their progress.

Rehabilitation Hospital Referral

Rehabilitation hospitals offer a comprehensive approach to rehabilitation, including emphasis on increased physical functioning, rehabilitation counseling, and occupational therapy. These specialized hospitals employ physical therapists, occupational therapists, therapeutic recreation therapists, and rehabilitation counselors who are prepared to work with patients who have chronic disease conditions.

Most rehabilitation hospitals can work on an inpatient or outpatient basis. Some rehabilitation hospitals may be able to provide services at the dialysis unit, facilitating participation and involvement of the dialysis center staff.

In addition, special programs may be available. There are several examples of rehabilitation hospitals developing special classes and programs for dialysis patients at the request of local nephrologists or dialysis staff. These programs can address a variety of needs, individualize activities, and assist patients in increasing independence and functional levels.[47]

Patient Stratification Based on Clinical Status

The following is a system for stratification of dialysis patients, with recommendations for the type of intervention that may be most effective in increasing physical function.

Otherwise healthy patients

These patients are well-maintained on dialysis with few, if any, medical concerns other than end-stage renal disease. Independent exercise either at home or in a community program (YMCA, health club) is appropriate for these patients, with regular follow-up of any medical concerns that may arise. A referral to physical therapy, with a diagnosis of muscle weakness and a

request for "treatment as needed," may help these patients get started.

Recommendations:

- Encourage patient to increase physical activity levels
- Provide educational materials on how to get started/progress
- Refer to a community-based program (eg, YMCA, community recreation program, athletic club, personal trainer) for exercise at tolerated level
- Provide regular follow-up on adherence, progress, response

Patients with known or suspected cardiac disease

These patients can be referred to a cardiac rehabilitation program for supervised, monitored exercise. Prospective candidates must undergo cardiac evaluation. Testing can be requested as part of the referral.

Recommendations:

- Encourage patient to increase physical activity levels
- Educate patient on the benefits and importance of regular physical activity
- Refer to cardiac rehabilitation program
- Provide ongoing follow-up on adherence, progress, medical concerns

Patients with mobility problems

Referral to physical therapy is indicated for these patients. Common diagnoses for these referrals include muscle weakness, gait difficulties, and exercise intolerance. The referral may request specific treatment (*eg*, "muscle strengthening" or "gait training") or be more general (*eg*,"evaluation and treatment as per physical therapy recommendations").

Recommendations:

- Encourage patient to attend physical therapy sessions
- Educate patient about the benefits and importance of increasing physical functioning
- Refer to convenient physical therapy or rehabilitation hospital
- Provide ongoing follow-up on adherence, progress, medical concerns

Within each of these very broad stratification groups there are patients with other conditions (comorbid conditions and/or special psychosocial concerns) that must be considered when recommending exercise. These conditions need not rule out exercise, but the exercise prescription may require modification.

Exercise Prescription:

The importance of physician involvement in encouraging increased physical activity cannot be overemphasized. If you, as a physician, are interested in prescribing exercise for your patients, please refer to the separate guide entitled *A Prescription Guide*. It provides suggestions for developing an appropriate exercise prescription. Notes concerning how exercise programs can be adapted for various conditions are also included.

Whether you prescribe independent exercise for your patients, or refer them to physical therapy or a community program, follow-up on participation and progress is critical. A meeting with clinic and dialysis staff to determine the best way to incorporate exercise into the regular patient care plan will prove invaluable.

The entire healthcare team can be involved in motivating patients to increase physical activity without actually having supervised exercise on-site. The accompanying publication, *A Guide for the Dialysis Team*, describes various ways dialysis staff can assist in motivating patients to maintain their programs.

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