

Review

Effects of physiotherapy in patients treated with chronic hemodialysis

**Radojica V. Stolić¹,
Branko Mihailović²,
Ivana R. Matijašević³,
Maša D. Jakšić³**

¹University of Kragujevac, Faculty of Medical Sciences, Department of Internal Medicine, Kragujevac, Serbia

²University of Priština/Kosovska Mitrovica, Faculty of Dentistry, Priština/K. Mitrovica, Serbia

³University of Priština/Kosovska Mitrovica, Faculty of Medicine, Priština/K. Mitrovica, Serbia

Corresponding author:
Prof. Radojica Stolić
Faculty of Medical Sciences
69 Svetozar Markovic,
34000 Kragujevac,
radojica.stolic@med.pr.ac.rs

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Summary

Although physical activity is an important factor in prevention of many chronic, non-infectious diseases, it is rarely used as a regular procedure in dialysis patients. Despite the guidelines on good clinical practice, recommended physical exercise as a part of routine activities is implemented in a very small number of centers. Factors that contribute to sustainable exercise programs are the professional commitment of a multidisciplinary team consisting of physiotherapist, nephrologist, geriatrist, social worker, nurse, the incentive and encouragement of the entire dialysis staff for carrying out active exercise, as well as adequate physical space and equipment, with individualization for each patient in turn. Patients with end-stage kidney disease who are in the physical treatment program show significant functional improvements, especially those associated with the cardiovascular, respiratory and muscular system, as well as with the quality of life. There are no reports on serious injuries as a result of participation in the exercise program. This indicates that it is time for physical therapy to be included in the regular routine care procedure in hemodialysis patients. However, it is necessary to identify an optimal training regimen in accordance with the individual characteristics of each patient, in order to make it easier to apply the exercise program.

Keywords: physical activity, hemodialysis, intensity of exercise

Introduction

According to the World Health Organization, rehabilitation has been defined as the use of all means in order to create conditions for reducing disability and enabling people with disabilities to achieve optimal social integration [1]. The progression of

chronic kidney disease leads to functional constraints and severe disabilities connected to poor quality of life requiring an appropriate rehabilitation strategy. This is especially due to the fact that this population of patients has a greater number of comorbidities, which leads to an extremely sedentary lifestyle [2].

Effect of physical (non) activity on the ability to live independently

Physical inactivity is the fourth leading risk factor for the high prevalence of chronic non-communicable diseases. In the world, 31.1% of the adult population is physically inactive, and the percentage of them grows with age. It is higher in women living in highly development countries. The average life expectancy of physically inactive people is 5 years shorter. Physical inactivity increases the risk of diabetes mellitus, cardiovascular disease, the colon and breast cancer, and some other chronic diseases [3, 4].

Patients with chronic kidney disease are characterized by low physical performance due to the effects of numerous factors. Uremic intoxication, acidosis, increased protein degradation, many other metabolic abnormalities, as well as anemia, peripheral neuropathy and cardiovascular disease contribute to muscle wasting and impaired physical condition. The sedentary lifestyle accompanied by insufficient informing of nephrological patients about the importance of the need for physical activity contribute to impaired physical performance [5, 6].

Hemodialysis patients, regardless of the etiology of kidney diseases, tolerate physical effort to a lesser degree. In hemodialysis patients, there is a large number of complications and comorbidities associated with the musculoskeletal system, which limits physical fitness and professional ability. The maximum physical load of hemodialysis patients is 51% of the healthy population load. The reason for the reduction in physical fitness in these patients is reduced metabolic activity, limited oxygen exchange, acidosis, intracellular disorders of the electrolytes, and the constant loss of muscle tissue caused by catabolic processes [7]. Passive or active physical activity can have a very positive psycho-social impact, increasing the level of self-confidence and the ability to cope with problems and their illness. The goal of physical rehabilitation, adapted to hemodialysis patients, is the optimization of physical fitness necessary for safe and long-lasting mobility, as well as their independence.

In 1981, Goutman et al. [8] assessed the in-

dependence of hemodialysis patients in everyday life, and found that 60% were completely or partially independent of the help of another person, 20% were independent only in home conditions, and 20% were completely dependent on other persons.

The parameters for improving physical activity are vitality, general health perception and health behavior change (three elements of quality of life), as well as a significant improvement in the strength of the muscles of the lower extremities. Moderate exercise improves the level of physical work, nutrition and quality of life of hemodialysis patients [9].

Inactivity is considered to be a major factor leading to impaired physical condition, reduced exercise capacity, and finally to muscle loss. In hemodialysis patients physical activity decreases by 3.4% every month. The mortality risk is significantly higher in those patients who have severe limitation and moderate physical activity, compared to those with minimal or no physical limitations, and it is even smaller in patients who regularly exercise [5].

Malnutrition, loss of muscle tissue and muscle fatigue are closely related to reduced physical activity, which has a negative impact on the physical condition of hemodialysis patients. One of the causes lies in the fact that these patients spend 600-1000 hours (4-6 weeks) a year sitting or lying down. Due to this, 30-year-old hemodialysis patients have reduced working capacity to 75%, those with between 30 and 60 years of age to 57%, and patients with over 60 have only 40% of the working capacity of the general population [7].

Benefit from physical rehabilitation in patients on hemodialysis

Exercise has significant positive effects on dialysis patients and, rightly, there is the question why organized physical exercise is not widely accepted and does not apply properly in this population? The lack of a clearly defined program is probably an obstacle to the implementation of the exercise program. Fear of increased physical activity is a potent barrier when it comes to adopting or stimulating

exercises. Moderate exercise is recommended for 30 minutes or more, several days a week, which increases fitness, especially for individuals whose basic level of physical activity is extremely low [10].

The DOPPS study provided a first description of the international patterns of exercise, as well as the connection between exercise programs and the clinical outcomes of hemodialysis patients. The study described considerable variations in regular exercise frequency across countries and across dialysis facilities and found that 47.4% of hemodialysis patients regularly exercised [11]. There is a positive correlation between regular training and the ability to walk independently, lower body mass index, better sleep quality, reduced pain sensation and better appetite, while there is a negative correlation with age and a greater number of comorbidities. The results of the DOPPS study have confirmed that the mortality rate is lower in patients who have physical activity only once a week and that mortality risk decreases with the increase in exercise frequency, that is, the survival of hemodialysis patients may be dose-dependent in relation to physical exercise. The mortality risk of physically inactive patients is 62% higher. Only 45 minutes of weekly aerobic exercise during a year significantly reduces cardiovascular mortality and improves the quality of life [4, 11].

Many of the benefits of regular exercise in hemodialysis patients include: improving the functional capacity of the lungs, regulation of blood pressure, endothelial functions, lipid profile and reduction in inflammation markers, psychological status (fatigue, general health, anxiety, depression, vitality and overall quality of life), as well as improving muscle strength and walking speed.

According to K/DOQI Guidelines [12], all dialysis patients should be encouraged and advised to increase the level of physical activity by nephrologists and dialysis staff (Guideline 14.2). Assessment of physical fitness and re-evaluation of physical activity programs in relation to cardiovascular diseases should be performed at least once in six months (Guideline 14.3b) [12]. Unfortunately, in spite of the existing recommendations, it is obvious that

nephrologists do not deal with these issues in everyday practice [10].

Methods of exercise that are applied in patients with progressive chronic kidney failure include the supervised outpatient program in the rehabilitation center, the program of physical rehabilitation at home and the program of exercise during hemodialysis (intradially) [4].

Physical exercise reduces the potential risk of cardiovascular mortality. In a prospective study, 6215 American hemodialysis patients, who underwent aortic-coronary by-pass between 1998 and 2002, were the subject of physical therapy program. Patients receiving the physical therapy had a 35% lower risk of all mortality causes and 36% lower risk of cardiovascular mortality in comparison to hemodialysis patients who did not receive physical therapy. The general principles for starting any kind of physical rehabilitation treatment are similar and imply a good initial assessment, starting with a light exercise, with a gradual physical burden [13].

Physical activity has been identified as an important factor for improving the quality of life of patients on hemodialysis, contributing to the reduction in renal insufficiency, reducing pain sensation, improving walking ability and muscular strength of the extensor muscles of the knees and lower extremities. Some studies reported that muscle strength, after three months of exercise, increased by 82% [14].

(Un)attractiveness of the exercise program

In spite of the numerous confirmed benefits of exercise, dialysis patients are extremely inactive. The most common reasons are the lack of recommendations regarding the type and level of physical activity, as well as the fear of side effects of the physical treatment. Several studies examined the effect of aerobic exercise on maximum oxygen consumption. On average, aerobic exercise increased oxygen consumption by 17% for a period of eight weeks to six months. It was found that the effect of aerobic training is similar to erythropoietin effect [15].

Several studies pointed to the benefits of

the exercise during hemodialysis. First, there is the possibility of better adherence to exercise because it does not require extra time to do it. Second, exercise during dialysis reduces negative impact of the disease and, finally, it is possible that exercise improves the removal of uremic toxins due to an increase in blood flow in the muscles of the extremities. However, these potential benefits can be annihilated by reduced tolerance to effort during exercise and dialysis-associated hypotension. Nevertheless, it was found that the exercise is well tolerated in the first hours of dialysis sessions [15].

Despite many evidence that led to recommendations for increasing physical activity in hemodialysis patients, the application of physical rehabilitation programs is still unusual in most dialysis units. One of the main reasons for this situation is the heterogeneity of dialysis patients, from the clinical and physical point of view. There are three key elements for success of the program in hemodialysis patients. First, involvement of experts in a program of exercise, second, complete commitment of the nephrological team and medical personnel to the dialysis, and finally, individual adaptation of exercise programs for each patient in turn. It must be emphasized that motivation of patients for participation in the exercise program is of paramount importance [16].

Exercise programs should be adapted to physical abilities of each patient who needs to enter the decision-making process. Medical staff working on dialysis plays a key role in the exercise process, most often twice a week. The duration of each session was 90 minutes, including a stretching program of 15-20 minutes, then 20-50 minutes of driving with an ergobic wheel. The intensity of exercise is submaximal, i.e. that the anaerobic threshold does not exceed the consumption of 60% of oxygen [6].

Are there any risks of participation in the physical rehabilitation program?

Patients with chronic renal failure have complex functional disorders and multiple clinical disorders which require an interdisciplinary

approach and engagement of physiologists, geriatrician, nephrologists, other specialists, as well as nurses, social workers and professional physiotherapists [2]. In hemodialysis patients, in addition to muscle weakness, a serious problem is the low tolerance to exercise, which may result in increased cardiovascular risk, or even sudden death. Fatigue is also most commonly reported in hemodialysis patients and it affects negatively their clinical state. Fatigue can be the result of physiological fatigue (decreased aerobic capacity and strength of muscles), psychological fatigue (anxiety, stress, depression, a sleep disorder), the fatigue associated with dialysis (dialysis frequency, lifestyle change, causing physical limitations) and socio-demographic fatigue (professional status, social support). In addition to muscle weakness, fatigue can be due to inflammation, obesity, various modalities of dialysis, sleep disorders, depression and elevated cytokines [9].

The most common risk of physical rehabilitation in the general population is the musculo-skeletal injury, while the most serious consequences are the cardiovascular complications – rhythm disorders, ischaemia, sudden death, especially in exercise of high and sub-maximal intensity. In the general population, there is a higher risk of cardiovascular disorders in the individuals who still continue with a sedentary lifestyle, compared to those who are gradually increasing their regular physical activity. In patients with chronic renal failure, risk assessment must be made before the beginning of the physical rehabilitation on an individual basis and the exercise should be carried out in the first two hours of dialysis [4].

Conditions requiring application of the physical load program

Since patients with end-stage kidney disease have an increased risk of cardiovascular morbidity, existing guidelines provide little help as to whether the load test should be performed before the beginning of the exercise program and which patients should be tested in this way. However, patients with suspected or known heart disease must undergo

a load test, especially if the physical activity of a higher intensity is planned. Anamnesis, physical examination and ECG are used to determine whether or not the exercises of moderate intensity are suitable for the patient. Almost any increase in the physical activity of dialysis patients is likely to be beneficial even with an initial low level of exercise, gradually progressing towards higher levels of physical activity, up to 30 minutes of physical activity three days a week [13].

Contraindications for realization of exercise programs

The recent cardiac infarction, uncontrolled arrhythmia and hypertension, unstable angina pectoris, unregulated diabetes, left ventricular dysfunction, the presence of neurological and muscular dysfunctions, tumors and pregnancies represent absolute contraindications for physical load. The reason for the cancellation of the initiated treatment of physical rehabilitation can be fatigue, chest pain, dizziness, fainting, syncope, dyspnoea, arrhythmia, hypotension, or reactive hypertension [14].

Physical load is mostly followed by tachycardia, which is positively correlated with oxygen consumption. The individualization of pharmacotherapy is crucial in relation to the intensity of physical activity. Static and dynamic exercise of high intensity, sudden change of position or exercise with hands above the head are strictly forbidden. Every physical activity is strictly contraindicated in patients with arrhythmia, tachycardia or bradycardia, without obvious reasons [17].

Effects of a controlled program of physical load in patients on hemodialysis

An increase in hemoglobin concentration after erythropoietin therapy correlates with aerobic performance improvements, although high tolerance to physical load is not recovered after normalizing hemoglobin levels [5]. The working capacity of dialysis patients decreased by 50% due to anemia, especially after a dialysis

procedure. High-intensity activity, high-intensity sports and exercises are unsuitable for dialysis patients with anemia, but aerobic effects can be enhanced by gradual training endurance [18].

The results of various studies that assess the impact of physical activity on lowering blood pressure do not give consistent conclusions. Hagberg et al. [19] found a decrease in blood pressure from 155 mmHg to 135 mmHg. Deligiannis et al. [20] suggested a moderate decrease in pressure from 145/87 mmHg to 136/79 mmHg after three months of exercise. Some authors found a significant reduction in the consumption of antihypertensive drugs after three months of exercise. They showed that 36% of patients reduced the use of antihypertensive drugs, which led to economical savings of \$ 885 for each patient per year [21, 22]. On the contrary, the others denied such positive findings indicating that a three-month study is too short period for any relevant conclusion concerning the impact of physical activity on blood pressure [17, 23, 24].

Atherosclerosis is one of the main factors of morbidity and mortality in population of hemodialysis patients. Painter et al. [25] showed that 6-9 months of exercise activity reduced the triglyceride concentration by 25-39% and increased HDL-cholesterol levels to 22-23%. It is assumed that increased blood flow during physical activity exerts considerable pressure on the walls of the blood vessels, especially in the area of atherosclerosis, so it is necessary to adjust the level of physical activity. However, it has been found that physical activity effectively prevents atherosclerosis [25].

It is absolutely necessary to check the level of glycemia before any physical activity because the risk of hypoglycaemia or hyperglycaemia is particularly high in unregulated diabetes during physical activity [26].

Other effects of physical exercise

Malnutrition increases the risk of morbidity and mortality and reduces quality of life in patients with end-stage kidney disease [27]. Several studies have suggested that improv-

ing muscle strength is the most effective way to encourage lipid synthesis in muscles, to reduce their catabolism and to improve muscle hypertrophy [28-32]. Kouidia et al. [28]. and Sakkas et al. [32] found a decrease in tissue atrophy from 21% to only 2%, after six months of exercise.

A vascular approach to hemodialysis requires special care during physical activity. It is not advisable to wear a watch or bracelet on the hand at which there is vascular access. The hand should be protected during swimming or any contact sports. It is recommended to avoid picking up heavy objects, and to exercise with light objects (especially designed objects, balls, etc.). The activation of the arm with vascular access for hemodialysis improves blood flow, and elasticity of the blood vessels [33].

In most hemodialysis patients, the skin is vulnerable to injuries, especially in diabetics, as well as in patients who are on anticoagulant or antiaggregation therapy, where increased bleeding is anticipated. Therefore, it is recommended to avoid any activity that can lead to skin damage [34, 35].

Daul et al. [36] found that loss of muscle strength resulted from degenerative changes in muscle cells, a condition known as uremic myopathy. The most frequent changes occur at the lower extremities, in 50-70%, and fatigue is the most obvious indicator of such changes. Lower extremities are also susceptible to uremic polyneuropathies, as well as muscular atrophy. Therefore, physical activity should be focused on the systematic strengthening of the lower extremity muscles.

About 70% of dialyzed patients suffer from some form of kidney bone disease complicated by fractures, which are 3-4 times more common than in the healthy population. They occurred most commonly in the ribs, joints, spinal vertebrae, legs, wrists and hips. The prevalence of musculoskeletal complications increases with the age of hemodialysis patients. Together with other complications, they are responsible for the rapid deterioration of the functional abilities necessary for independent life and therefore for the poor quality of life. The most common symptoms of such disorders are pain, limited dynamics, decreased muscle strength,

early fatigue, etc. Most disorders are caused by structural changes due to uremia, but also by other causes such as sedentary lifestyle and other constraints related to the treatment of the dialysis procedure [5].

Dialysis patients have extremely low physical fitness and durability. The right cause was not detected, but it was found that important factors that adversely affect the physical fitness are anemia, uremic myopathy, reduced oxygen use by the muscular system and physical inactivity which is a common feature of many dialysis patients. In general, fatigue is described as weakness, feeling of exhaustion and lack of energy. The prevalence of fatigue reaches 60-97% and can be three times higher than in the healthy population. The physiological and psychological causes of fatigue are hypoparathyroidism, uremia, anemia, depression, decreased sleep quality, psychosocial stress, physical inactivity, muscular contraction disorders, which occur as a symptom of uremic polyneuropathy and myopathy [13].

Uremic polyneuropathy is one of the most common neurological complication in patients with end-stage kidney disease, with the prevalence of 60-100%. It manifested itself in lower limbs and was characterized by atrophy and weakness of muscles, lack of deep tendon reflexes, reduced or complete loss of sensitivity and a gradual enlargement of neurological deficit. More than 50% of patients with end-stage kidney disease suffer from neurological complications. The greatest damage is found in the ulnar and medial nerves. The carpal tunnel syndrome, as one of the complications, is treated surgically, especially in the case of blockage of the nervous system of the ulnar, when the motoring deficit is worse. In the context of the application of physical activity attention should be paid to the decline in concentration ability, reaction of the organism to physical exertion, fatigue, co-ordination of the muscular motoring, muscular atrophy, the occurrence of orthostatic collapse, especially during the change of position. It is recommended to increase gradually the level of physical activity during the workout, especially in patients with peripheral polyneuropathy and inadequate coordination movements of the lower extremities [37].

Restless leg syndrome is an uremic complication characterized by sensorimotor neurological disturbances, continuous movement of the legs, uncomfortable sensations in the lower limbs, such as itching, burning, cramping, pain during sleep and rest, with occasional relief after carrying out regular activities. The etiology of restless leg syndrome is not known but it is assumed that it can initiate peripheral neuropathy and reduced physical activity. The prevalence of restless leg syndrome ranges between 10-60%. Patients with this syndrome have not been able to relax, have a sleep of a low quality, suffer from insomnia and depression and are under constant emotional stress [38]. Physical activity, in particular aerobic strengthening exercises three times a week, can reduce symptoms by 39% [13].

Patients on dialysis are exposed to great stress. An important component of stress is the dependence on medical staff, medical devices and the hospital. The desire for independent life is sometimes so strong that it is impossible to deal with difficulties, which results in depression, aggressive or suicidal behavior. The dialysis procedure itself is extremely stressful because it includes fear of contact with the dialysis, pain due to puncture of vascular access, as well as other complications such as potential fear of unsuccessful dialysis, inability to predict the dialysis procedure itself, fear of the presence of other patients, especially those with severe clinical conditions. Other factors affecting the psychological profile of dialysis patients include loss of a close person, nutritional disorder, restriction on free planning, the need for larger space and time, dependence on others, loss of physiological functions (ability to urinate, sexual dysfunction), increased aggression and persistent death threat. An important moment that improves the quality of life of patients is their participation in social activities, social interaction and other personal satisfactions. In realizing the quality of life, physical activity has a great impact, as an important form of re-socialization, positively influencing the suppression of everyday problems. It can improve quality and length of life, significantly reduce depressive and anxiety symptoms,

strengthen self-confidence, improve sleep, adaptation to stress, social interaction, as well as the support of the program of resocialization and mutual understanding [13].

Many hemodialysis patients describe regular exercise as the first activity which allowed them to feel normal again. Motivation, even if only for a short time, helps them to feel better and strengthen their health. The patients describe that they feel again as before the illness: they are able to work, to continue with a healthy sex life, to manage their health care, to perform simple tasks. Unfortunately, it is difficult to motivate hemodialysis patients with the rationale that they are too tired for such kind of activity, believing that they will be even more tired after exercise. The fact is, however, that even a physical treatment of 15-20 min helps them feel less tired [9].

Conclusion

Exercise, within the program of regular physical activity, is performed in the first two hours during hemodialysis or between two hemodialysis procedures. It is important to emphasize the necessity of individualizing physical rehabilitation programs due to numerous comorbidities and complications that are a significant follower of patients with end-stage kidney disease.

Although there is no doubt that the effects of physical activity on the survival and the quality of life of patients on hemodialysis are positive, rehabilitation program still falls under the routine practice program in a small number of dialysis centers. It seems that one of the biggest obstacles to the implementation of the physical therapy program in hemodialysis patients is the lack of a clearly defined program that defines all the needs of dialysis patients.

Recommended physical activity indicates that at least 30 minutes of moderate daily activity for two or more days during the week will have a significant benefit for dialysis patients, assessing all risk factors.

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Efikasnost fizikalne terapije kod bolesnika lečenih redovnim hemodijalizama

Radojica V. Stolić¹, Branko Mihailović², Ivana R. Matijašević³, Maša D. Jakšić³

¹Univerzitet u Kragujevcu, Fakultet medicinskih nauka, Katedra Interne medicine, Kragujevac, Srbija

²Univerzitet u Prištini/Kosovskoj Mitrovici, Stomatološki fakultet, Priština/Kosovska Mitrovica, Srbija

³Univerzitet u Prištini/Kosovskoj Mitrovici, Medicinski fakultet, Priština/Kosovska Mitrovica, Srbija

Poznato je da je fizička aktivnost značajan činilac u prevenciji mnogih hroničnih nezaraznih bolesti ali se retko primenjuje kao redovan postupak kod bolesnika na dijalizi. Iako savremeni vodiči dobre kliničke prakse preporučuju fizičke vežbe kao deo rutinskih aktivnosti, one se primenjuju u samo malom broju centara za hemodijalizu. Faktori koji doprinose održivim programima vežbanja su: profesionalna posvećenost multidisciplinarnog tima koji čine fizioterapeut, nefrolog, gerijatar, socijalni radnik i sestra, podrška i zainteresovanost celokupnog osoblja za dijalizu da se aktivne vežbe obavljaju, kao i postojanje adekvatnog prostora i opreme za vežbe koje treba prilagoditi svakom bolesniku posebno. Kod bolesnika u terminalnoj insuficijenciji bubrega kod kojih se primenjuje fizikalna terapija pokazano je značajno poboljšanje funkcije mnogih sistema, posebno kardiovaskularnog, respiratornog i mišićnog sistema, kao i bolji kvalitet života. Ne postoje podaci o ozbiljnijim oštećenjima izazvanih učešćem bolesnika u programu vežbanja. Sve to ukazuje da je vreme da se fizikalna terapija uključi u redovnu rutinsku proceduru lečenja bolesnika na hemodijalizi. Istovremeno, neophodno je da se utvrdi optimalan režim treninga u skladu sa individualnim karakteristikama svakog bolesnika

Ključne reči: fizička aktivnost, hemodijaliza, intenzitet vežbi