Rehabilitation of patients after kidney transplantation

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Patients undergoing kidney allotransplants need help in recovery. Improvement of health status after the intervention depends in large measure on cooperation of the therapeutic team. For many physiotherapists, rehabilitation after transplantation becomes a problem with such patients, and there is scant data in the literature about methods for encouraging patients to exercise.

The aim of this study was to analyze the accessible literature relating to physical activity and rehabilitation of patients dialyzed after kidney transplant. Also the performance of proceeding in improving the patients after kidney transplant and the continuation of the farther physical activity.

The review was based on articles relating to the rehabilitation of patients with kidney disease.

Based on the literature we can state that kidney transplant patients may sit upright as soon as the 3rd day after transplantation if there are no medical contraindications. Regular supervised physical activity allows initiating training with the submaximal workload not greater than 80% Vo2max.

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Key words:
• rehabilitation
• kidney transplantation
• physical training

Rehabilitacja pacjentów po przeszczepie nerki

Przeszczepy allogeniczne nerek w oparciu o dotychczasową wiedzę stanowią procedurą niestwarzającą większych problemów wśród chirurgów. Poprawa stanu zdrowia po zabiegu zależy w dużej mierze od współpracy wielu członków zespołu terapeutycznego. Rehabilitacja po transplantacji staje się dla wielu fizjoterapeutów problemem w postępowaniu z takim pacjentem a zbyt mała ilość literatury na ten temat nie wyjaśnia, jakimi metodami można się posługiwać, żeby bezpiecznie doprowadzić chorego do stanu zdrowia.

Celem pracy była próba analizy dostępnej literatury poruszającej tematykę aktywności fizycznej i rehabilitacji u chorych dializowanych i po przeszczepie nerki.

Opracowanie przygotowano w oparciu o zbiór artykułów poruszających tematykę rehabilitacji osób z chorobami nerek.

W oparciu o dostępne piśmiennictwo można stwierdzić, że brak przeciwwskazań medycznych pozwala na pionizację chorego w trzeciej dobie po zabiegu. Regularna nadzorowana aktywność fizyczna umożliwia wprowadzanie ćwiczeń z obciążeniem submaksymalnym nie większym niż 80 %Vo2max.

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Słowa kluczowe:
• rehabilitacja
• transplantacja
• nerki
• trening fizyczny

Introduction

Many epidemiological and experimental studies have investigated the beneficial effects of physical exercise, which is one of the best ways to prevent diseases of the cardiovascular system in primary and secondary prevention. The increase of physical activity in the population has a number of beneficial health implications. Regular physical exercise improves blood circulation and lowers blood pressure and heart rate at rest and during exercise. It acts as a stimulant on the endothelium of blood vessels and stimulates the growth of muscle and bone mass. It affects metabolic processes of oxidation of glucose and fatty acids, and lowers cholesterol. Physical exercise regulates the secretion of systemic hormones through adipose tissue. It reduces oxidative stress and influences the secretion of cytokines. An important aspect of increased physical activity is improved quality of life. Low-level physical activity, smoking, hypertension, diabetes, and hypercholesterolemia are of the 5 main risk factors for diseases of the cardiovascular system. As demonstrated by van Wyk, at least 1 of the above risk factors [1] is present among 75% of the people diagnosed with heart disease (women and men).

The definition of chronic kidney disease (CKD) was introduced by the American National Kidney Foundation (NKF) [2] in 2002. This term defines kidney damage confirmed by biopsy test. The diagnosis is performed on the basis of the exponents of kidney damage present for at least 3 months, irrespective of the glomerular filtration rate (GFR), or on the basis of GFR lower than 60 ml/min/1.73 m^2, lasting for at least 3 months. The exponents of kidney damage include: increased excretion of albumin in the urine, proteinuria, and other abnormalities in the urine sediment examination or abnormalities in the imaging examinations of kidneys.

There are 5 stages of CKD based on GFR. The 5th stage, referred to as renal failure (NN), is the most advanced and requires renal replacement therapy. Before patients are qualified for transplantation, they must undergo dialysis, which greatly affects quality of life and takes much time. In turn, this situation leads to decreased phy-

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sical activity. The ill patients avoid not only regular exercises; they are also reluctant to perform daily activities [3-9,10] due to complications occurring in patients with chronic kidney disease and renal replacement therapy, which affect the ill patient's ability to engage in physical exercise. Protein-energy malnutrition causes increased degradation and reduced protein synthesis, as well as impaired immune defense mechanisms, leading to increased susceptibility to acute and chronic infections [11,12]. In addition, uremic atrophy, skeletal muscle dysfunction, and anemia, as well as increased oxidative stress and neurohormonal disorders, should be mentioned. The observational studies conducted by Stack et al [3], showed that 56% of patients starting dialysis therapy engage in physical exercise only once per week or less.

A few years ago, the problem of insufficient physical activity of patients with chronic kidney disease led to the establishment of the European Working Group on Renal Rehabilitation and Exercise Physiology, affiliated with the European Renal Association (ERA - EDTA) [13]. The Group is engaged in promoting physical activity, especially among dialysed patients.

The aim of the present study was to analyze the accessible literature relating to physical activity and rehabilitation patients who were dialyzed and after kidney transplant. Also the performance of proceeding in improving the patients after kidney transplant and the continuation of the farther physical activity.

The main causes of insufficient physical exercise are concomitant diseases that can lead to death and not, as one might guess, to the underlying disease. Reference materials report that up to 57% of deaths of the patients dialysed in Poland in 2004 was due to CVD. The presence of these diseases in patients who died due to renal failure increased by 10% in the period from 1999 to 2004 [14].

CVD risk factors such as diabetes and hypertension are classified as traditional and non-traditional factors specific for kidney failure and various forms of renal replacement therapy [15].

Influence of the lack of the physical activity

A well-functioning neuromuscular and skeletal bone system is essential for physical activity. Many functional and structural disturbances occur in these systems in the fifth stage of chronic kidney disease. In 1967, Serratrice et al [16] described a patient with chronic renal failure, in whom progressive muscle weakness was observed, probably due to uremia. They used the phrase 'uremic myopathy' for the first time.

Another cited element playing an important role in insufficient physical activity is active vitamin D_3 deficiency. This condition is noticeable from the second stage of chronic kidney disease. In addition, these ill patients have reduced glucose utilization, which is needed for high-energy tissue regeneration, caused by, among others things, aerobic glycolysis disorders [17,18]. As a result of these changes, glycogen deposits form and a tendency to metabolic acidosis is noticed during physical exercise as a consequence of increased production of lactic acid [19].

Another important domain, although it is not of primary concern, is damage to the skeletal structure. This issue is rarely mentioned because such changes do not occur in every patient. Histological imaging shows atrophy, mainly among type II fibers (white fast fibers).

Patients with chronic renal failure are often malnourished. This condition is present in the early stages of the disease, and deepens with the progression of renal failure.

Left ventricular hypertrophy occurs in 74% of patients starting dialysis treatment. According to the results of epidemiological studies, it is an important risk factor for hospitalization and mortality [20,21]. Hypertension and anemia cause cardiac hypertrophy.

The kidneys are very efficient organs and most people can live a normal life while retaining only 15% of renal functions. However, in the event of a total kidney failure, they are not able to excrete toxic products present in the urine and the concentration of these substances in blood increases.

Chronic renal failure is progressive, and renal function decreases irreversibly. This condition may occur as a result of recurrent infections, diabetes, hypertension, or congenital anomalies of the urinary tract. In the final stage of the disease, the kidneys completely cease to function and excrete urine.

People with kidney diseases additionally suffer from weakness, easy fatigability, loss of appetite, swelling around the ankles and lower legs, difficulty in breathing, shortness of breath, and many other symptoms resulting from the ongoing complications of the disease in the later period.

Treatments ranging from pharmacotherapy to dialysis are merely substitutes leading to kidney transplant. Sometimes, this process takes quite a long time and affects patients' well-being and performance of their daily physical exercises. The patients who are chronically hemodialysed lead a sedentary lifestyle. They are not only very inactive during the inter-dialysis period, but also remain immobilized during dialysis for many hours a week, as well as during travel time to undergo dialysis. The ill patient spends on average approximately 500–800 hours per year on dialysis alone. Additionally, commuting to a place where dialysis is performed takes about 400–500 hours per year. Physiotherapist's planned training also comes across difficulties. Theoretically, kinesis therapy could be conducted between dialyses or in the period around dialysis. Unfortunately, dialysed patients mostly feel bad during this period. These factors limit the possibilities of physiotherapy in this group of patients. The only solution is to perform simple exercises during dialysis, which will not involve large joints, but rather help them to relax. We speak here about the exercise of the distal parts of the lower limbs and breathing exercises [22].

Qualification to transplantation

To have a better quality of life associated with a graft of a new viable organ, patients in Poland must undergo a qualifying procedure for transplantation and be placed on the so-called National Waiting List (KLO) of Poltransplant, a national organization coordinating removal and transplantation of organ. The patient's personal and medical details are placed on the National Waiting List for renal transplantation after having been qualified for kidney transplantation. Waiting time ranges from 1 to several years, but varies widely, depending on the number of organs available for transplantation and individual characteristics of the recipient. In most cases, patients undergo dialysis treatments. There are exceptions to this rule if organs are transplanted from living donors [22].

The techniques of kidney transplantation were developed several years ago. The operation usually takes 2–4 hours. The recipient's kidneys usually remain untouched if they were not previously removed. The new kidney is placed on the right or left side of the lower abdomen. In some cases, a prior nephrectomy is performed, and an empty space for a new kidney is left. Blood vessels of kidneys are combined with the vessels of the recipient, and a grafted ureter is transplanted into the bladder of the patient. Usually, a drain is left near the kidney, passing through the skin outside the surgical wound and connected to the vessel receiving discharge fluid accumulating around the kidney. The amount and color of the fluid can vary on different days. The drain is usually removed a few days after the operation.

It should be remembered that, at the beginning, the human body recognizes the transplanted organ as a foreign body, and the immune system reacts with an attack directed against graft. Immunosuppressive medicines that are administered are intended to prevent rejection of the kidney by weakening the immune system response. However, at the same time, theses medicines cause the transplant recipient to become more susceptible to infections. Therefore, it is very important to maintain an appropriate balance between the inhibitory effect of rejection reaction and maintenance of the necessary capabilities to defend against infections. This issue is an equally important element in the process of rehabilitation when it is necessary to maintain absolute caution in contact with the patient and avoid unnecessary exposure to danger [23].

Rehabilitation directly after the transplant of the kidney

On the 1st day after the operation, the patient feels nausea. Therefore, in this period, fluids or food are not administered orally, but only intravenously. The postoperative fasting period lasts until peristaltic bowel movements return. Sometimes, after surgery, it is necessary to perform an enema if problems with excretion exist. Physiotherapy possibilities regarding the ill person's well-being are significantly limited and rely only on the performance of anticoagulant and breathing exercises. They are usually resistive breathing exercises, where breath is resisted by an aquatic environment. The patient can perform them individually during the day, after having been instructed by a competent person.

During the first 12 hours after surgery, visits are usually contraindicated because patients feel ill, and precautions are taken to protect patients from infection. Patient needs relaxation and tranquility during this period.

It is important to try to get up and move around as soon as possible. The objective of early verticalization is to prevent early thromboembolic complications, respiratory problems, and constipation. In this situation, the patient must be assisted by a physiotherapist who, by sequentially explaining the activities, slowly brings the patient to a standing position. The fear associated with pain makes it necessary to clearly explain to the patient what actions will be performed. On the next day a wider range of exercises involving the musculoskeletal system can be introduced. The patient learns to stabilize the postoperative wound only with the hands. For these patients, use of a stabilizing belt is contraindicated as it could constrict the transplanted organ. The health status of the patient allows performing asymmetric movements of upper and lower extremities, as well as breathing exercises during breaks. The ill patient, if educated to cough correctly, can expectorate the accumulated bronchial secretions and prevent respiratory complications. Usually, the ill patient has to take a breath through the nose and blow out secretions during quiet coughing while stabilizing the postoperative wound. Learning to correctly cough may be preceded by inhalation of saline in order to facilitate expectoration. If there are no medical contraindications listed by the attending physician, the patient is brought to the upright position, usually from lying on the side so as not overuse abdominal muscles and pelvic girdle. In the sitting position, it is easier to exercise arms and continue to perform effective coughing. It must be remembered that the patient must be continuously belayed by a physiotherapist, and that blood pressure and heart rate must be measured. Any indicates that something is wrong with the patient should be reported to the doctor as soon as possible. The verticalized patient begins to move within the room and with each passing day the walked distance can be increased after gaining strength [24].

After a kidney transplant, the patient usually spends about 2–4 weeks in the hospital before being discharged home. During this time, the patient must be constantly observed and examined for signs of graft rejection, possibly indicated by fever, pain, decreasing volume of urine, and abnormal laboratory renal function test results.

Rehabilitation in the late period

In the postoperative recovery period, it is necessary to undergo intensive physical and nutritional rehabilitation, and the patient must make a great effort to be able to stand upright.

Although kidney transplantation leads to a significant improvement after the recovery period, the ill person's efficiency is lower (80%) in comparison to healthy people of the same age [25]. A sedentary lifestyle predisposes the dialysed patient to reduced ability to perform physical exercises. As far the ill persons undergoing kidney transplantation are concerned, their return to normal condition is much more difficult [26]. Therefore, the promotion of increased physical activity among transplanted patients should be a crucial element of therapy. There is no available literature on the management of patients after transplantation of kidneys. The patient's treatment and return home allow introducing physical exercises at intensity comparable with dialysis (ie, not more than 75–80 VO2max).

Physical activity is important to stimulate the improvement of overall well-being, as well as the condition of the body. The patients who regularly exercise have improved mood, enhanced willingness to work, and perform leisure activities, and establish personal relationships. Regular exercise also helps to maintain proper weight. Restoration of muscle strength after the disease is possible through daily exercises, which must be planned properly to increase daily physical efforts gradually.

The exercises can start with climbing the stairs. In this case, the patient must be careful not to become overly tired and to rest when feeling fatigued.

The NKF-K / DOQI recommendation

As recommended by the NKF-K/DOQI, all dialysed patients should be encouraged to exercise moderately for about 30 minutes per day [7,27]. Programmed physical exercise can increase muscle strength, reduce feelings of weakness, and increase independence in daily activities. Daily physical activity can be measured by pedometers. Fareze et al [28] presented another alternative—the beneficial effects of electro-stimulation of the muscles of thighs and calves using TENS currents and physical exercise on a cycle ergometer. This method reduces the incidence of comorbidities in dialysed patients. Another proposal is exercises performed at various intensities in a universal rehabilitation office (UGUL). After finishing the exercise program, increased mean physical fitness was found by the modified Harvard test, showing increased physical exercise time and number of steps walked during a physical exercise test. In addition, the average daily physical activity, expressed by the number of steps measured with a pedometer, increased.

In the studies of Deligiannis et al [29], even a 3-month physical exercise program of dialysed patients resulted in decreased vascular resistance and stiffness. In the studies of Miller et al [30], a 6-month training cycle made it possible to reduce the demand for hypertension medications.

It is important to draw attention to the fact that, despite the positive aspects of physical exercises and awareness of patients, many patients stop exercising, explaining that they lack motivation or time. This issue is presented by Wnuk et al [31], who found that as many as 52% of patients withdrew from the conducted exercises, despite their earlier statements of willingness to participate.

In 2005, the Polish Sports Association after Transplantation was established. The main objective of this organization is to promote the idea of transplantation through the promotion of physical activity and conscious donation of organs for transplantation. Encouraging exercise among those who underwent transplantation allows them to regain their physical condition before organ failure, and allow dialysed patients to overcome the hardships of everyday life.

After mastering general rehabilitation and respiratory exercises, it is possible to try other forms of physical activities such as cycling, swimming, walking, tennis, and running as soon as 3 months after the operation.

The patients should consult their transplantation team physician before increasing physical effort.

Return to normal life is to a large extent conditioned by physical fitness. The exercises already carried out during dialysis constitute the basis for post-operative reha-

Table I

The summary of training cycles and their effectiveness.

Podsumowanie cyklów treningowych I ich efektywność.

The authors of the research	Training cycle and its effects
Kouidi et al. [26]	Performing exercises on days without dialysis in varied environments lasting one year; improvements in maximum oxygen consumption - VO2max (47% vs34% practicing in dialysis centre) noted, as well as physical exercise time in a modified Bruce test (38% vs. 26%) increased
Deligiannis et al. [29]	6-month training cycle applied, an increase in stroke volume of the heart and its fractions observed; 3-month training reduced resistance and stiffness of peripheral vessels
Miller et al. [30]	6-month training cycle made it possible to reduce the demand for overpressure medicines
Malagoni et al. [33]	6-month training in the form of walks taken twice a day for 10 minutes on days without dialysis at the speed of 50% of maximum attainable time during the monthly control test; after this time, general health condition and quality of life improved and the ailments occurring after dialysis reduced
Nowicki et al. [32]	3-month mid-dialysis training in the form of walks assessed with Harvard test, average physical fitness, physical exercise mean, time of effort and distance walked increased
Wruk et al. [31]	5-month training cycle including breathing exercises, abdominal muscles strengthening, back muscles stretching and relaxation exercises
Painter et al. [25]	Regular physical activity of dialysed patients, additional home exercises

bilitation. It greatly helps the physiotherapist if the patient has already begun to exercise, and this speeds recovery, which in turn impacts comorbidities and chronic kidney disease complications. The available literature analyzes most of the conditions before transplantation. Nowadays, with physiotherapy, intervention speed is important, as well as avoiding prolonged hypokinesia (staying in bed), which may result in thromboembolic complications, constipation, respiratory problems, and a general weakening of the body. The vertical position of the body enhances the activity of internal organs, enables the patient to return to independent activities, and improves quality of life. Therefore, post-operative rehabilitation is an integral part of the recovery of the patient after transplantation.

Conclusions

On the 3rd day after the operation, patients can sit upright if there are no medical contraindications. Regular supervised physical activity allows starting training with submaximal workload of no more than 80% Vo2max.

References

1. **Van Wyk, Van Wijk MA, Sturkenboom MC, Moorman PW, van der Lei J**: Identification of the four conventional cardiovascular disease risk factors by Dutch general practitioners. Chest 2005; 128: 2521-2527.
2. **K/DOQI clinical Practice Guidelines for chronic kidney disease**: Evaluation, classification. Kidney Disease outcome Quality Initiative. Am J Kidney Dis. 2002; 39(Suppl. 2); 1-266.
3. **Stack AG,Molony D A, Rives T, Tyson J, Murthy VR. et al**: Association of physical activity with mortality in the US dialysis population. Am J Kidney Dis. 2005; 45: 690-701.
4. **Castaneda C,Gordon PL, Parker RC, Uhlin KL, Roubenoff R, Levey AS**: Resistance training to reduce the malnutrition-inflammation complex syndrome of chronic kidney disease. Am J Kidney Dis. 2004; 43: 607-616.
5. **Farese S.,Budmiger R, Aregger F, Bergmann I, Frey FJ, Uehlinger DE**: Effect of transcutaneous electrical muscle stimulation and passive cycling movements on blood pressure and removal of urea and phosphate during hemodialysis. Am J Kidney Dis. 2008; 52: 745-752.
6. **Stovitz SD, VanWormer JJ, Center BA, Lindstrom Bremer K**: Pedometers as a means to increase ambulatory activity for patients seen at a family medicine clinic. J Am Board Fam Pract. 2005; 18: 335-343.
7. **Zamojska S, Szkalrek M, Niewodniczy M, Nowicki M**: Correlates of habitual physical activity in chronic haemodialysis patients. Nephrol Dial Transplant. 2006; 21: 1323-1327.
8. **Tudor-Locke C, Bassett Jr R**: How many steps per day are enough? Preliminary pedometer indices for public health. Sports Medicine 2004; 34: 1-8.
9. **Hsieh RL, Weng-Chung L, H-Y H, C-H Chang**: Quality of life and its correlates in ambulatory hemodialysis patients. J Nephrol. 2007; 20: 731-738.
10. **Kalantar-Zadeh K, Ikizler AT, Block G, Avram MM, Kopple JD. et al**: Malnutrition-inflammation complex syndrome in dialysis patients: causes and consequences. Am J Kidney Dis. 2003; 42: 864-881.
11. **Yusuf S, Reddy S, Ounpuu S, Anand S**: Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. Circulation 2001; 104: 2746-2753.
12. **Guralnik JM, Branch LG, Cummings SR, Curb JD**: Physical performance measures in aging research. J Gerontol. 1989; 44: 141-146.
13. www.renalrehab.com
14. **Yao Q, Pecoits-Filho R, Lindholm B, Stenvinkel P**: Traditional and non-traditional risk factors as contributors to atherosclerotic cardiovascular disease in end-stage renal disease. Scand J Urol Nephrol. 2004; 38: 405-416.
15. **Kundhal K, Lok CE**: Clinical epidemiology of cardiovascular disease in chronic kidney disease. Nephron Clin Pract. 2005; 101: 47-52.
16. **Serratrice G, Toga M, Roux H, Murisasco A, de Bisschop G**: Neuropathies, myopathies and neuromyopathies in chronic uremic patients. Presse Med. 1967; 75: 1835-1838.
17. **Mak RH, DeFronzo RA**: Glucose and insulin metabolism in uremia. Nephron 1992; 61: 377-382.
18. **Stein PP, Hunt WA, Johnson CM, DeFronzo RA, Smith JD**: Insulin resistance in uremia: an in vivo and in vitro study. Metabolism 1989; 38: 562-567.
19. **Lundin AP, Stein RA, Brown CD, LaBelle P, Kalman FS. et al**: Fatigue, acid-base and electrolyte changes with exhaustive treadmill exercise in hemodialysis patients. Nephron 1987; 46: 57-62.
20. **Foley RN, Parfrey PS, Harnett JD, Kent GM, Murray DC, Barré PE**: The prognostic importance of left ventricular geometry in uremic cardiomyopathy. J Am Soc Nephrol. 1995; 5: 2024-2031.
21. **Paoletti E, Specchia C, Di Maio G, Bellino D, Damasio B. et al**: The worsening of left ventricular hypertrophy is the strongest predictor of sudden cardiac death in haemodialysis patients: a 10 year survey. Nephrol Dial Transplant. 2004; 19: 1829-1834.
22. **Rutkowski B, Lichodziejewska-Niemierko M, Grenda R, Czekalski S, Durlik M, Bautembach S**: Report about the condition of nephrosubstitutional treatment in Poland - 2005; Gdansk Medical University, Gdańsk 2006.
23. **Cheema BS, Fiatarone Singh MA**: Exercise training in patients receiving maintenance hemodialysis: a systematic review of clinical trials. Am J Nephrol. 2005; 25: 352-364.
24. **Zamojska S, Szklarek M, Niewodniczy M, Nowicki M**: Correlates of habitual physical activity in chronic haemodialysis patients. Nephrol Dial Transplant. 2006; 21: 1323-1327.
25. **Painter P, Messer-Rahak D, Hanson P, Zimmerman SW, Glass NR**: Exercise capacity in hemodialysis, CAPD and renal transplant patients. Nephron 1986; 42: 47-51.
26. **Kouidi E, Albani M, Natsis K, Megalopoulos A, Gigis P. et al**: The effects of exercise training on muscle atrophy in haemodialysis patients. Nephrol Dial Transplant. 1998; 13: 685-699.
27. **Guthrie M, Cardenas D, Eschbach JW, Haley NR, Robertson HT, Evans RW**: Effects of eryhtropoietin on strength and functional status of patients on hemodialysis. Clin Nephrol.1993; 39: 97-102.
28. **Farese S, Budmiger R, Aregger F, Bergmann I, Frey JF. et al**: Effect of transcutaneous electrical muscle stimulation and passive cycling movements on blood pressure and removal of urea and phosphate during hemodialysis. Am J Kidney Dis. 2008; 52: 745-752.
29. **Deligiannis A, Kouidi E, Tassoulas E, Gigis P, Tourkantonis A, Coats A**: Cardiac effects of exercise rehabilitation in hemodialysis patients. Int J Cardiol. 1999; 70: 253-266.
30. **Miller BW, Cress CL, Johnson ME, Nichols DH, Schnitzler MA**: Exercise during hemodialysis decreases the use of antihypertensive medications. Am J Kidney Dis. 2002; 39: 828-833.
31. **Wruk B**: The model of exercises to self-contained practicing for patients dialyzed protractedly. Medical News 2008; 1: 41-49.
32. **Nowicki M, Jagodzińska M, Murlikiewicz K, Niewodniczy M**: Physical activity protractedly dialized patients - the comparison of the effectiveness of various methods of it enlarging. Progr Med Sci. 2009; 10: 799-804.
33. **Malagoni AM, Catizone L, Mondini S, Soffritis S, Manfredini R. et al**: Acute and long-term effects of an exercise program for dialysis patients prescribed in hospital and performed at home. J Nephrol. 2008; 21: 871-878.