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The Importance of Exercise Programs in Haemodialysis Patients

Susanne Heiwe[1], Andrej Ekholm[2] and Ingela Fehrman-Ekholm[3,4]
[1]*Dept of Physiotherapy, Karolinska Institutet, Dept of Medicine & Dept of Clinical Sciences,*
[2]*Karolinska Institutet*
[3]*Dept of Renal Medicine, Karolinska University Hospital,*
[4]*Stockholm and Transplantation Centre, Sahlgrenska Academy, Göteborg,*
Sweden

1. Introduction

The lifestyle today is new. We sit with our computers, televisions etc. Usually, we do not carry heavy things. We gain weight and loose muscle strength. Through history the life has included moments with physical efforts. The body has not changed. It still needs physical training and efforts. The person who is untrained gets quickly tired. Therefore it is important to make the efforts regularly. The capacity of the heart to transport oxygen increases and the energy increases with physical training. The muscle condition is important. The mitochondria in the muscles cells may increase with 30-40 % after one month of exercise. With more mitochondria more fat is consumed and less carbohydrate is needed. Consequently, less lactic acid is formed and the blood does not change the pH towards acidosis as easily.

Thus, modern people need exercise. You need not to go to a gym or run every day. It is more about having an active life. Take the cycle or walk to the job or to the shop, take the stairs instead of escalator or elevator. The exercise is a part of the natural common life and the body is a tool which needs to be used. It could be enough with 30 minutes of activity to reach physical efforts the heart rate has to increase, maybe to 120 beats/minute. This could be a dilemma for many patients since they have decreased maximal capacity and interacting medication. The training program has to be individualized but the goal is to improve the capacity. If success the daily normal activities feel easier and the patients get more improved trust and comfort. Physical activities mean also better control and less fear of having fall accidents. With a feeling of control there are fewer obstacles.

Thus exercise and effort are important to all of us which are true for many people with different diseases. For patients with cardiac diseases, hypertension, diabetes mellitus there are often exercise programs but for patients with different stages of chronic kidney disease, CKD, there is no obvious exercise treatment program. However, more and more evidence exists that exercises are important for these patients. The dialysis treatment hours have increased more and more to increase KT/V, the dialysis dose, but this also means less time for activities like exercise, work, family life and spear time. How could we help these patients?

Hence, this chapter is chosen with the intention to provide the reader with information concerning exercise capacity and level of physical activity in adults with chronic kidney disease. It also has the aim to make health-care providers within renal medicine aware of exercise training as an evidence-based intervention to improve health and well-being in adults with CKD. Despite the fact that exercise training is easy, cost effective and preventive, exercise training has not been implemented into clinical practice. We hope that this chapter will stimulate to action and provide some knowledge about these patients and their problems in order to understand why exercise training should be included in the standard care for adults with CKD. The chapter also contains general information about exercise and expected effects in healthy individuals.

2. What is a training program for grown-up people?

It is important to consider the training models, methodology, and expected changes that happen at regular physical activity in general. We consider different measures to describe the activities.

- *Frequency* - That means how often we do the training. A daily dosage of effort like taking walks, taking stair-cases is basic.
- *Intensity* - This is how the levels of efforts are. A common used definition is RM that is repetition maximum. One RM is the weight or load you are able to lift once but not twice. It has been shown that 60-70% of 1 RM could be enough for the starter to give an increase of muscle strength. For the well-trained it is necessary with almost 70-84% for the increase of muscle mass and strength (Kramer et al 1997).
- *Duration* - It is the length of the exercise period at a time. A 30 minute period of physical exercise is nowadays a common, recommended duration. A simple and common instrument is the pedometer, which could quantify the number of steps and calculate the calories, the walking distance one could obtain during a period.

Concerning intensity this could be varied by adding different muscle groups. The level of effort and the muscle groups involved are important for the results. If you add walking with sticks, the shoulder and arm muscles become involved and increase the results. In these moments also the important coordination becomes involved.
The general effects of training are many. Below are some aspects and findings.

Muscles

Skeletal muscle is not a simple homogenous group of fibers. Type I fibers are characterized by slow speed of contraction, low activity of myosin ATPase and are well suited for prolonged aerobic exercise. Type II fibers have the ability to generate energy for quick and forceful contractions. At training there is an increase in both muscle fibre size and muscle number, the largest effect being increase of muscle size. The number of mitochondria and the small vessels in the muscles increase. Interestingly, even very old people could increase the strength. In an interesting study it was shown that 90-year old persons living at a nursing home could double the muscle strength, increase the quadriceps muscular volume with 10 % as well as increase the daily function after 8 weeks of bodybuilding (Fiatarone et al 1990).

Cardiosvascular system

The cardiac output will increase. The normal pulse will be reduced. The small arteries will dilate which contribute to decreasing blood pressure. The blood circulation to the heart and muscles will increase and both the blood volume and the haemoglobin level will increase.

Many patients with CKD have hypertension. In dialysis the hypertension is most linked to salt and water over load. After kidney transplantation the immunosuppressive drugs CNI (calcineurin inhibitors such as tacrolimus and ciclosporin) and corticosteroids contribute to hypertension. In transplants patients with CAN (chronic allograft nephropathy) ischemia in the kidneys aggravate the situation and give severe hypertension with often therapy resistant blood pressure.

The basis of treatment in hypertension is life style changes, exercise, stop smoking habits and decrease of the sodium chloride in the diet. These are basic advice applicable also to the CKD patients. Many patients have treatment with diuretics to decrease salt and water. Beta-blockers protect the heart from stress and lower the pulse rate, sometimes hamper maximal training efforts. Calcium blockers are frequently used, cause relaxation of the muscles and vasodilatation.

ACE-inhibitors block the angiotensin system and are often well tolerated. It could however be important to be aware of the fact that severe dehydration could be dangerous due to risk of high serum potassium and loss of blood pressure which is a severe condition. This information is important to give to the patient in case of any situation with loss of water like gastrointestinal acute diseases.

Regular physical activity lowers the blood pressure but the blood pressure increases during exercise, mostly the systolic blood pressure. With a stress ECG the individual patient could get information about the level of blood pressure and ECG changes during efforts. There are recommended levels not to exceed.

Nerve system

Regular physical activity affects the nerves. The coordination, the balance and the ability to react becomes better. Most of the persons who do regular exercise have better sleep, less depressions and more self-esteem.

Hormone system

The exercise increases the insulin sensitivity in the skeletal muscle and decreases the insulin in the blood. This means less adiposities and a more healthy profile of the lipids with increased HDL-cholesterol and decreased triglycerides. For body builders the growth hormone may increase. Also testosterone levels have been found to increase and androgen receptors which increase the effect of testosterone (Kraemer et al 2005). Added testosterone has a much stronger effect, both increasing the muscle mass and adding new cells. However, this substance is classified as doping preparation. Cortisol is a catabolic substance and could be increased at stress caused by some exercises and exercisers. However, cortisol is a life-necessary substance. Catecholamine (noradrenalin and adrenalin) are also produced in the moments of stress, fight and flight response. There is probably an anabolic effect on the skeletal muscles which has been shown in certain animal studies. That is why these preparations are on the doping list. Insulin-like growth factor (IGF-1) could also be produced locally in the muscle but the systemic effect is unclear.

3. Physical fitness and physical functioning and self-evaluation in patients with CKD

The physical fitness and physical functioning (= the ability and capacity to perform activities of daily living) is severely reduced in adults with CKD (Kettner-Melsheimer et al 1987;

Kouidi et al 1998; Heiwe et al 2003; Johansen et al 2003; Heiwe et al 2005). It is declining from 70% of the expected norm in a pre-uremic phase to 50% of the expected norm when starting dialysis therapy (Painter et al 1986; Kettner-Melsheimer et al 1987; Brodin et al 2001). However, also ageing decreases muscle mass. The median age at dialysis start in Sweden is 66 years. The muscle mass in 70-year old person is 25% lower compared with 25-year old persons (Klitgaard et al 1990).

Patients with a renal transplant have a lower physical fitness of approximately 70-80% of the age-matched controls (Painter et al 1986). Here, the corticosteroids, still a basic immunosuppressive treatment, contribute to muscular atrophy. Thus, the physical fitness in adults with CKD is reduced and affects the capacity of the patients to perform activities in everyday life and occupational tasks.

Physical functioning in patients with CKD is affected by several factors like consequences of CKD in it-self, the original disease process that brought about the patient's kidney disease and the treatment of CKD which may have further detrimental effects (Marlowe et al 2001). The main factors causing reduced physical fitness are anaemia (Clyne et al 1987; McMahon et al 1999) and muscular weakness (Bohannon et al 1994; Johansen et al 2003). This results in fatigue and increasing inactivity, which in turn reduces physical fitness even further and increases impairments in physical functioning (Bohannon et al 1994; Nielens et al 2001; Johansen et al 2003).

Today, anaemia is successfully corrected by erythropoietin treatment and results in an improved, but not normalised, physical fitness (McMahon et al 1999). When analysing muscle biopsies it has been shown that adults with CKD have muscular histopathological abnormalities already in the pre-uremic phase (Heiwe et al 2005). The causes of muscular weakness in patients with CKD have, however, not been fully elucidated. Muscle atrophy, a neuropathic process and myopathy are potential causes of the muscular weakness. It is suggested that myopathy is due to abnormal energy metabolism (Thompson et al 1993), secondary hyperparathyreoidism (Ritz et al 1980), malnutrition (Guarnieri et al 1983), prolonged physical inactivity (Jones et al 1990) and to uraemia itself (Sakkas et al 2003).

It is important that the consultant renal physiotherapist, renal nurse, renal dietician and renal physician have an understanding of limitations in physical fitness and physical functioning that adults with CKD are expected to face and how various unique issues may alter the treatment approach. All training methods have to start with cautions and feed-back to the patients.

It has been shown that adults with CKD experience limitations in their daily life due to insufficient physical fitness. In a previous study (Heiwe et al 2003) it was shown that adult with CKD experience fatigue both mental and physical fatigue. This results in a reduced physical fitness and reduced physical functioning in terms of impact on performance and endurance. The experienced fatigue appeared frequently and varied in strength.

The informants described having a more or less always-present mental fatigue, which was experienced as something that they really had to fight to overcome. Feeling listless and paralysed by fatigue was a common trait of this group of descriptions. The feeling of physical fatigue appeared as soon as they started performing a physical activity and could vary in extent from day to day. They experienced muscular weakness and rapid onset of tiredness. Pagels et al (2006) have shown that when asked to rate the level of physical activity 40% of the adults being in a pre-uremic phase had a low activity and 11% were mostly sitting or lying down. Thus, the daily basic walks became an effort.

Many adults with CKD experience difficulties in walking if the ground is not level, as in the case of stairs or steps, uphill slopes, etc. In such conditions, they experience physical resistance very quickly. Many elderly with CKD also have difficulties in performing everyday chores, such as managing their personal hygiene, making their bed, hanging up laundry, vacuum-cleaning, lifting things, rising from a squatting position, cleaning, etc. They also experience difficulty in performing a physical activity over a prolonged period of time, for instance, hanging up laundry, without having to pause several times, which they have not had to do prior to the disease. Most of the patients also have difficulties in performing physical activities at the same pace as they did prior to the CKD.

Adults with CKD may also experience temporal stress since they cannot do as much as they would have liked to. They need more time to perform various activities, partly due to "internal demands", like the need for physical rest and partly due to their experiences of external demands as a result of all the medical appointments and other appointments. All these factors may have a negative impact on the patients' level of activity and participation as well as their social life (Heiwe et al 2003). It seems urgent to do something for these patients.

Rehabilitation has a positive effect on physical fatigue and improves both 'endurance' and physical 'performance', which, in turn, could reduce the need for more time to be able to perform everyday chores or other physical activities. It would then be possible for the patients to find more time for their own activities, increasing their physical activity level. It is important to make clear to patients that just by putting time and effort into physical exercise or activity they can improve several aspects of their experience of fatigue, reduced physical fitness and temporal stress. It is, though, important that appointments for physical exercise training are co-ordinated, as far as possible, with the patients' other medical appointments. This would give the patients more time to perform their own physical activities.

It is also important that physiotherapists consider patients' views when reflecting upon and interpreting how they can support and strengthen patients in their effort to be able to perform physical activities as well as social activities that are of importance to them.

Adults with CKD are subjected to multiple physiological and psychological stressors. Welch et al (1999) have for instance showed that the most common treatment-related stressors in patients with haemodialysis are fluid limitations, the length of dialysis and vacation limitations. When adults with CKD rank the stressors that they are subjected to, it is limitation of physical activity which is the number one stressor (Lok et al 1996). Therefore, it is important to include questions concerning physical activity when meeting these patients.

Coping has been proposed as an important mediating factor with regard to adaptation to illness. Coping refers to 'an individual's efforts to master demands that are appraised (or perceived) as exceeding or taxing his or her resources. It is a process that may consist of behaviours and intra-psychic responses designed to overcome, reduce or tolerate these demands (Lazarus et al 1984). There are many ways in which coping responses can be grouped, but the two general categories of coping strategies are problem-solving efforts and strategies aimed at the regulation of emotions (Lazarus et al 1984). Problem-focused coping refers to efforts to improve the troubled person-environment relationship by changing things, for instance by seeking information about what to do. Emotional-focused (or palliative) coping refers to thoughts or actions whose goal is to relieve the emotional impact of stress (for example, bodily or psychological disturbances). Although both sets of strategies are brought to bear on most stressful events, problem-solving efforts are especially useful for managing controllable stressors, and emotional-regulation efforts are well suited to managing the impact of uncontrollable stressors.

It has been shown that in order to cope with the limited physical fitness three coping activities are used: 1) avoiding physical activities, 2) adjusting pace and 3) scheduling. The strategies were problem-focused, and patients used active-, avoidant- and social-support coping strategies. When coping with limited physical fitness, adults with CKD tend to use coping strategies that have a positive short-term outcome. These strategies are, however, also associated with negative long-term outcomes. The individual is placed in an evil circle where the physical functioning decreases as the experience of mental and physical fatigue increases (Heiwe et al 2004). It is therefore important that renal physicians and renal nurses identify these patients and refer them to a renal physiotherapist at an early stage, so that they can get information and help with physical exercise training. This could contribute to the patients' own resources which can then be used to improve the level of participation and also to improve some parts of the patient's social life.

All people employ different combinations of problem-focused and emotion-focused methods to cope with stress. The conditions determining our coping methods in specific situations are complex and at present largely unknown, but they are likely to depend on the conditions being faced, the options available to us and our personality. An issue often emerging in discussions about coping is whether some coping processes are more effective than others. For instance, whether avoidant responses to stressful events are more adaptive or whether more confrontational coping methods are superior. However, coping processes have both positive and negative consequences for an individual. A behaviour that might be effective from, say, the physiological perspective might have devastating consequences for the psychological or sociological domains. Moreover, what is an optimal response in one situation at a particular point in time may be damaging in some other situation or at a different point in time. Most people appear to use a variety of coping strategies to deal with a stressor. Successful coping may depend more on a match of different coping strategies to the features of the stressful event than on the relative efficacy of one coping strategy over another. Therefore, when meeting a patient with CKD and evaluating his or her coping and adaptation, the health-care provider must take into account diverse levels of analysis (physiological, psychological, sociological), short versus long-term consequences and the specific nature of the situation in question.

4. Evidence based effects of exercise training in patients with CKD

There is scientific evidence showing that if adults with CKD do not exercise only having a certain level of physical activity in their daily living:

- The muscle mass and physical fitness will continue to decrease (Painter et al 1986; Kettner-Melsheimer et al 1987; Bohannon et al 1994; Brodin et al 2001; Heiwe et al 2001; Sakkas et al 2003; Heiwe et al 2005; McIntyre et al 2006; Zamojska et al 2006)
- The patient's possibility to maintain, for him or her, a satisfyingly active and social life will be reduced = reduced health-related quality of life (Brodin et al 2001; Fukuhara et al 2003; Heiwe et al 2003; Heiwe et al 2004)

- An already high cardiovascular risk factor and co-morbidity burden (Yao et al 2004; Venkataraman et al 2005) will increase even more due to the severely reduced level of physical activity

Published articles concerning effects of physical exercise on patients with CKD started to appear in the 1980s. Since then, interest in effects of physical exercise has increased in renal medicine, and today there are numerous published articles showing positive effects of exercise training. Data from previously and recently published studies have shown that exercise training in adults with CKD can affect the following factors:

- Muscular hypotrophy, -strength, -endurance & physical functioning (Kouidi et al 1998; Mercer et al 2002; Painter et al 2002; DePaul et al 2002; Sakkas et al 2003; Heiwe et al 2005; McIntyre et al 2006; Heiwe & Jacobson 2011)
- The structure and number of capillaries and mitochondria (Kouidi et al 1998; Sakkas et al 2003, Cheema et al 2010)
- Glucose metabolism (Goldberg et al 1983)
- Aerobic capacity (Painter et al 1986; Painter et al 2002; DePaul et al 2002)
- Blood pressure (Goldberg et al 1983; Pechter et al 2003)
- Cardiac performance (i.e. augmentation of cardiac vagal activity, decrease of vulnerability to arrhythmias) and improvement of coronary risk profiles (Venkataraman et al 2005)
- Depression, performance of pleasant activities in daily living and health-related quality of life (Suh et al 2002; Molsted et al 2004; van Vilsteren et al 2005)
- Circulating cytokines (Cheema BS et al 2010)
- Nutritional parameters and energy expenditure using SWA, SenseWear™ Armband (Cupusti A el al 2011)

A review article, based on 29 trials on this issue, shows that exercise training in dialysis patients improves arterial compliance, cardiac autonomic control and left ventricular systolic function. Moreover, exercise diminishes oxidative stress, blood pressure and inflammation. As shown in Table 1, significant effects of exercise and training were found.

It is interesting to notice that haemoglobin levels, s-albumin, PCR (protein catabolic rate) and KT/V increase. This tells us that less erythropoietin is needed, which means that training is cost-effective. The patients have better protein intake. They probably eat more to get energy. The recommended protein intake at training in general is 1.6-1.7 g/kg. The recommendations for uremic patients in dialysis are a protein intake above 1.3 g/kg body weight.

Also, the decrease in CRP is an interesting finding. CRP is connected to residual renal function (Pecoits-Filho et al 2003). The low inflammatory process in the dialysis patients becomes thus better after 6 months of repeated cycle training and this might be an adequate prescription! Actually, today the physiotherapists give prescriptions on physical activities like the doctors do on medication. The difficulties could be the compliance or adherence of the patient to the physical program suggested but the same problem exists with the prescribed drugs.

Here is a prescription or suggestions to patients with CKD. To obtain improvements it is, however, important that the exercise program has an adequate intensity, frequency and duration. Examples and type of exercises are given (Table 2).

prescription	duration	variable	% change	significance
Cycle ergometer, walking, jogging	8-9 months	HDL cholesterol Hemoglobin Plasma insulin fasting Plasma glucose	+23% +29% -40% -6.3%	< 0.05 < 0.05 <0.01 <0.01
Cycle ergometer 3 times/week	12 weeks	Max workload	Increase	< 0.05
Aerobic strength training 90 min 3 times per week	6 months	VO2 peak Peak blood lactate Isometric strength Type muscle fibre area I Type muscle fibre area II	Increase Decrease Increase Increase	< 0.05 < 0.05 < 0.05 < 0.05
Cycle ergometer 30 min 3 times per week	6 months	Albumin CRP PCR KT/V	Increase Decrease Increase Increase	< 0.024 < 0.046 < 0.001 < 0.026
Treadmill walking or cycle ergometer	3 months	Arterial stiffness Pulse pressure Systolic blood pressure	Decrease Decrease Decrease	0.01 <0.05 <0.05

Table 1. 29 studies and effects of physical activity in dialysis patients on metabolic and nutritional parameters. (Cheema BS, Sing MA 2005).

Activity	Example	Intensity	Duration	Frequency
Muscular Sustained training	Sequential exercise Individual program with weight cuffs as resistance	50 % 1RM	Maximal number of correctly performed repetitions. Corresponding to self-rated total exertion 13-15 according to Borg's RPE-scale	3 times/w
Functional training (including walking-, balance- and coordination-training)	Walking, eg on treadmill or balance carpet. Standing on balance plate Knee bow Stairs Standing up from knee bow		Maximal walking and number of correctly performed repetitions. Corresponding to self-rated total exertion 13-15 according to Borg's RPE-scale	3 times/w
Isometric strength	Sequence training Individual training with weight cuffs or other things as resistance	80% 1RM	1 set á 8-10 reps	3 times/w

Borg´s RPE scale = Borg rating of perceived exertion. It was constructed in the 60-ties by Gunnar Borg, professor in perception and psychophysics in Stockholm. The scale indicates different degrees of effort from 6 to 20. The rated RPE shows a linear relation to workload and heart pulse frequency. It is used within rehabilitation and training (Borg 1970).
VO2 peak: This is the oxygen uptake which reflects the maximal performance of the individual. This has to be measured before start of programme and this helps to adjust the programme for each individual.
Reps = repetitions, **RM** repetition maximum see page 2

Table 2. Prescription on physical activities in patients with CKD and explanations

5. Details and aim of physical training

- Get the patient informed about the importance of physical training in CKD both in dialysis and after kidney transplantation.
- To make the patient independent in the daily life and to keep/increase the quality of life.
- Diminish the risk of cardiovascular disease, osteoporosis and loss of muscle mass. Increase/maintain muscular strength and endurance, balance as well as the sub maximal oxygen uptake.
- Minimize the risk of fall accident.
- Minimize depression.

Dynamic muscular endurance	• Maximal number of muscle contractions with a strain corresponding to 50 % of 1RM and at fixed frequency. • Standing heel-rise test. • Sit-to-stand-to-sit
Static muscular endurance	• Maximal number of seconds the patient is able to maintain an isometric muscle contraction, for example knee extension, with loading corresponding to 50% of 1RM. • Unilateral isotonic shoulder flexion, bilateral isometric shoulder abduction
Functional capacity	• 6-minutes walking test with patient's experienced leg fatigue, breathlessness and possible cardiac pain is rated by the patient according to Borg's CR-10 scale and the total effort according to Borg's RPE-scale before and after the test performed • Walking 30 meters in self-selected normal rate and maximal rate • Timed "Up & Go" • Stand on one leg Functional reach • Stairs
Muscular strength	• One repetition maximum (1RM) • GRIPPIT(grip strength), Jamar hand dynamometer: correlating to muscular mass • Isometric leg strength.
Self-rated physical level of activity	• Disability Rating Index (DRI). Activity rating according to Grimby Frändin
Physical capacity	• Standardized, symptom limited ergometer cycling with patient's experienced leg fatigue, breathlessness and possible cardiac pain is rated by the patient according to Borgs CR-10 scale and the total effort according to Borg's RPE-scale.
Quality of life	• SF-36

Notes: **General about CKD 4-5**

- For patients with secondary kidney diseases it is important to consider the original disease at assessment of physical capacity, general advice and follow-up. For patients with diabetes mellitus for instance it is important to consider the present foot status and the insulin regimen.

- Patients with polycystic kidney disease should avoid contact sports like karate since hard hits against the kidneys may cause bleeding and pain. There is also a higher risk of hernia of the abdominal wall in this disease. Patients with kidney transplants should also avoid contact sports like ice-hockey and land-hockey due to risk of tackling moments.
- Patients with CKD 4 and 5 suffer more easily from tendinitis. Treatment with chinolones means increased risk of tendinitis. Because of this it is important with heating and cool-down to be prolonged. Also the training of mobility and agility should be prolonged and the training intensity and duration increase smoothly.

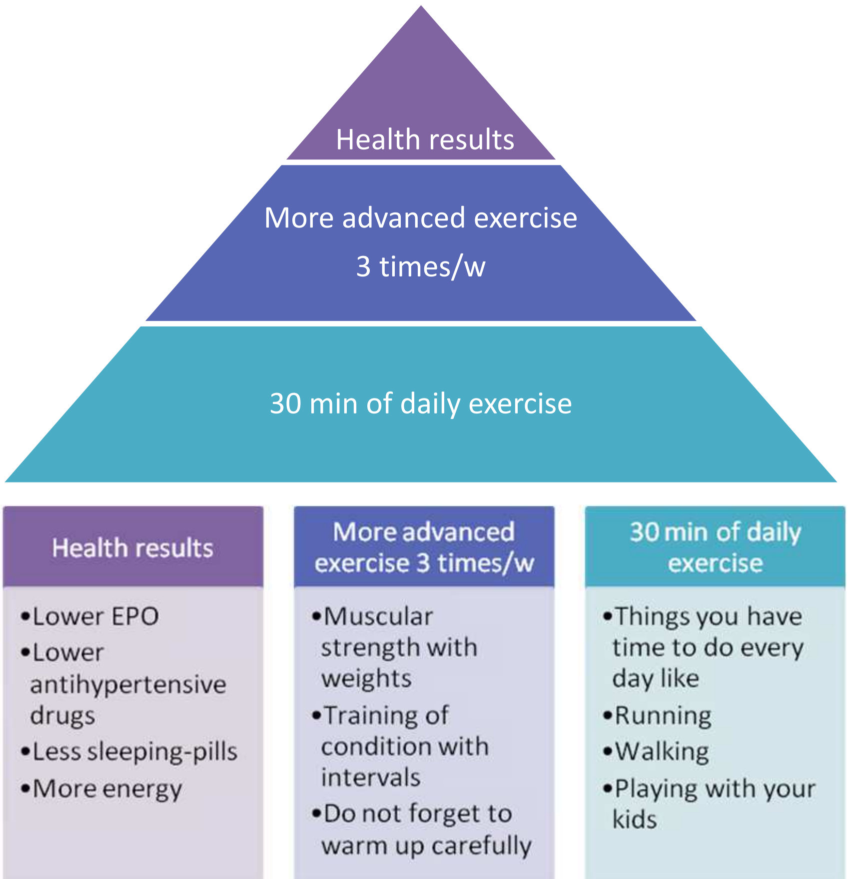

Fig. 1. The amount of training and training effects in CKD patients in a schematic form

Concerning haemodialysis patients:

- When is the physical training to be performed? It is the medical condition of the patient and the desire of the patient which decide the optimal timing for the training. The most optimal training effect is obtained with the physical activity on dialysis free days. If this is a problem for the patient, for instance far distance to travel, confinement to the hospital etc, the training may be performed before the dialysis treatment or during the first two hours in dialysis. It is not recommended to do the exercise after dialysis treatment since the patients are dehydrated and there is great risk of hypotensive episodes. Since the patients often have lack of time, it is important to coordinate the different treatments within the team.

- The amount of fluid, sodium, potassium and blood pressure is constantly variable in a dialysis patient. As a physical therapist it is important to consider these factors in planning the training schedule and in every training opportunity. Consider the restriction of water in individual patients! However, in jogging and running all need water. The simplest method is to instruct the patient to weigh himself/herself before and after the running episodes.
- The signs of exercise-induced hyponatremia should be recognized by everyone handling dialysis patients. These are symptoms of cerebral over hydration: nausea, malaise when sodium is below 125-130 mmol/L. If plasma sodium falls below 115 to 120 mmol/L there are adding symptoms with headache, lethargy, seizures, and coma. This is a risk identified in marathon runners (Ayes et al 2000).
- Avoid circular pressure in the arm with arteriovenous (AV)-fistula/graft. The blood pressure should not be measured in that arm because of risk to strangle and destroy the important blood flow to the access.
- Before surgery of AV-fistula/graft it is important to perform endurance training of the muscles in the forearm and the hand. This may increase the size of the vena cephalica which is valuable. During a short period after the surgery the patient should not use watches, bracelets or carry heavy bags which may hamper the blood flow in the important AV access. Training the arm with squeezing a soft ball could be important to increase the blood flow in the vein. This makes the AV-fistula more strong and useful. Shoulder and elbow move ability should be alerted and the arm/hand could be used for easier house and family work. Depending on the surgeon's prescription and the status of the patient it may be valuable to start strength training after 3-4 weeks to maintain muscular fitness.
- Patients with central dialysis catheters (CDK) on the neck or frontal thorax may start training of muscle and motility. If the sutures cause pain or prevent movements in the neck/shoulder, the physician is consulted for possible adjustment. Considering the risk of infection the patient with CDK is not allowed to exercise in a pool.

6. Nutrition and exercise

Nutrition is a most important issue in CKD patients. Before start of dialysis many patients have protein restricted diet. This has to be changed as soon as dialysis treatment is initiated. The protein intake has instead to be increased. Both the dialysis process and the physical activities need proteins and amino acids. We usually calculate the PCR = protein catabolic rate every month in the dialysis patients based on urea determinations before and after dialysis session and urea before the next dialysis. The patients could get feedback on their protein intake and add protein supplements if needed.

Carbohydrates are important to refill the glycogen stores in the liver and the muscles. The more glycogen, the more energy is available for the exercise. It is considered that 5-7 g/kg/day on training days are needed. If we eat too much more fat is stored instead.

Fats are needed, in the first hand, the essential fatty acids. But any fat to get the important energy balance is important.
Fruit and vegetables are recommended to sportsmen and sportswomen. However, due to risk of hyperpotassemia and high water content in fruits, caution is needed for patients in dialysis. The patients should have lists from dieticians to find the most proper fruits.
Vitamins are needed. Especially C-vitamins since they are removed at hemodialysis or hemofiltration (Fehrman-Ekholm et al 2008). D-vitamins are needed for the skeleton and in treatment of secondary hyperparathyroidism. Iron is necessary in anemia treatment and today most patients have intravenous iron supply at dialysis sessions.
General recommendation is to eat often and to eat after the exercise to fill up the glycogen stores again.
In co work with other team members the physical therapist works to motivate the patient to continue exercises for the rest of life. Regular check-ups by physiotherapist with knowledge of renal medicine and transplant medicine are of greatest importance to maintain maximal physical performance whatever CKD treatment the patient has. We also know that there are several national guidelines that include exercise training and physical activity as part of the treatment for problems that are common in patients with CKD, i.e. high blood pressure, hyperlipidemia and cardiovascular diseases. Within renal care and -medicine we spend a lot of time trying to find ways to optimise the outcome of the care that is given to our patients. But there is already an easy, low-tech intervention that has multiple advantages for these patients' health and well-being, but which hasn't been implemented as a part of the standard care for patients with CKD: Exercise training and physical activity in daily living!
Another question is if aerobic exercise and strength training starting early in renal disease could play an important role in prevention or progression of CKD (Moinuddin et al 2008).

7. Conclusion

- The physical fitness is severely reduced among adults with haemodialysis treatment
- Physical exercise programs should be initiated with gentle start and preferably non-dialysis days or before dialysis treatment
- Exercise training including various programs improves aerobic capacity, muscular strength and endurance, physical functioning, physical- and psychological well-being if the program is regular and monitored
- Exercise training has positive effects on the cardiovascular risk profile, oxidative stress and inflammation
- Exercise training improves protein intake (PCR), dialysis effects (KT/V), haemoglobin and the endothelial function which are important treatment parameters in hemodialysis patients.

We need to encourage our patients with CKD to get more physically active and to start exercising. We need to refer them to physiotherapists with special knowledge in renal medicine that can give them adequate, individually adapted exercise recommendations.

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Hemodialysis (HD) represents the first successful long-term substitutive therapy with an artificial organ for severe failure of a vital organ. Because HD was started many decades ago, a book on HD may not appear to be up-to-date. Indeed, HD covers many basic and clinical aspects and this book reflects the rapid expansion of new and controversial aspects either in the biotechnological or in the clinical field. This book revises new technologies and therapeutic options to improve dialysis treatment of uremic patients. This book consists of three parts: modeling, methods and technique, prognosis and complications.