Review paper

Modified cardiological physiotherapy model

Zmodyfikowany model rehabilitacji kardiologicznej

Katarzyna A. Bogacz[1,2], Zbigniew Śliwiński[3,4], Tomasz Dybek[2], Marcin Krajczy[2,5], Jacek Łuniewski[2,6], Dagmara Matelonek[7], Jan Szczegielniak[1,2,8]

[1]Vital Medic Hospital, Kluczbork, Poland
Head of the Hospital: President Piotr Duch
[2]Faculty of Physical Education and Physiotherapy, Opole University of Technology, Opole, Poland
Head of the Faculty: Prof. Zbigniew Borysiuk
[3]Manual Medicine Department, Institute of Physiotherapy, Faculty of Medicine and Health Science, Jan Kochanowski University, Kielce, Poland
Head of the Department: Prof. JKU Zbigniew Śliwiński MD, PhD
[4]Faculty of Health Sciences, Wroclaw Medical University, Wroclaw, Poland
Head of the Faculty: Prof. Joanna Rosińczuk
[5]Hospital, Nysa, Poland
Head of the Hospital: Norbert Krajczy PhD
[6]Stobrawski Medical Center, Kup, Poland
Head of the Center: Pressident Mirosław Wójciak
[7]Medical Center, Strzelin, Poland
Head of the Center: Pressident Jarosław Sołowiej
[8]MSWiA Hospital, Glucholazy, Poland
Head of the Hospital: Mariusz Grochowski MD

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Abstract

According to the World health Organization (WHO), "physiotherapy is a comprehensive and coordinated use of medical, social, professional supplies and educational measures in order to adapt patients to new lifestyle and allow them to get better physical fitness." In the case of patients who suffer from cardiovascular diseases it refers to complex cardiological rehabilitation (CRR). Constant elements of CRR: review of clinical status of patient, optimization of pharmacological treatment, rehabilitation — gradual and controlled exercises adapted to individual possibilities. At the time of CRR implementation, the period of early rehabilitation (stages I, II) and the period of late rehabilitation (stage III) are distinguished.

Streszczenie

Według Światowej Organizacji Zdrowia (WHO) „rehabilitacja jest kompleksowym i skoordynowanym stosowaniem środków medycznych, socjalnych, wychowawczych i zawodowych w celu przystosowania chorego do nowego życia i umożliwienia mu uzyskania jak największej sprawności". W przypadku osób z chorobami układu sercowo-naczyniowego mówi się o kompleksowej rehabilitacji kardiologicznej (KRK). Stałymi elementami KRK są m.in. ocena stanu klinicznego chorego, optymalizacja leczenia farmakologicznego, rehabilitacja fizyczna – stopniowe i kontrolowane podejmowanie wysiłku fizycznego, dostosowanego do indywidualnych możliwości chorego. W trakcie realizacji KRK wyróżnia się okres wczesnej rehabilitacji (etap I i II) oraz okres późnej rehabilitacji (etap III). Etap II rehabilitacji pacjentów po zawale serca i po zabiegu pomostowania aortalno-wieńcowego jest realizowany wg jednego z czterech modeli.

According to the World health Organization (WHO), "physiotherapy is a comprehensive and coordinated use of medical, social, professional supplies and educational measures in order to adapt patients to new lifestyle and allow them to get better physical fitness." In the case of patients who suffer from cardiovascular diseases it refers to complex cardiological rehabilitation (CRR). Constant elements of CRR: review of clinical status of patient, optimization of pharmacological treatment, rehabilitation — gradual and controlled exercises adapted to individual possibilities [1, 2, 7–9, 11, 22–25].

At the time of CRR implementation, the period of early rehabilitation (stages I, II) and the period of late rehabilitation (stage III) are distinguished.

The second programme of patients' rehabilitation after a heart attack and coronary artery bypass grafting surgery is implemented according to one of four rehabilitation models. Patients are qualified on the basis of clinical examination, results of physical capacity test, and functional classification according to the NYHA's models: A, B, C, D [1–5, 8, 12–16, 22–25].

The training programme consists of particular models of post-hospital early stage rehabilitation:

1. Group exercises:
   a) breathing,
   b) general gymnastics.
2. Exercises on a cycle ergometer.
3. Walking.
4. Recreational activities.

The applied programme of post-hospital early rehabilitation is different in the matter of exercise intensity and activity programme during the day. The right selection of exercises and individualized way of rehabilitation, the expansion of breathing exercises, time extension and increased regularity of doing exercises are taken into consideration in the modified rehabilitation programme (Table 1) [10, 17–20].

After coronary artery bypass grafting surgery it is important to pay attention to wound stabilization on healing by using a harness or corset, inhalation and longer exhalation activities, exercises that prevent contraction of chest muscles, exercises that help to relax the shoulder girdle, and anticoagulant activities [18–21].

Contradictions:

1. Isometric exercises.
2. Exercises that lead to asymmetry of the chest.
3. Exercises that involve a large group of muscles.
4. Co-ordination exercises.
5. Breathing exercises.

Medical indications:

1. Exercises that make breathing easy.
2. Exercises that involve a small group of muscles.
3. Easy exercises.

The aim of breathing exercises after a heart attack and coronary artery bypass grafting surgery is to strengthen the respiratory muscles (mainly the diaphragm and abdominal muscles) and improve the

Table 1. Modified post-hospital programme of early rehabilitation

Stage II	Exercise test	Model	Programme	Heart rate signals according to Karvonen formula
2–4 weeks after heart attack or operation Length 4–6 weeks	Submaximal to 70% of maximum heart rate	A	• breathing exercises – 1 time a day for about 30 min, 5 times a week physical activities – 1 time a day for about 30 min, 5 times a week • broken training on cycle ergometer – 1 time a day, 5 times a week • walking • recreational activities	$(HR_{str.} - HR_{res.})$ *80% + $HR_{res.}$
		B	• breathing exercises – 1 time a day for about 20–25 min, 5 times a week physical activities – 1 time a day for about 20–25 min, 5 times a week • broken training on a cycle ergometer – 1 time a day, 5 times a week • walking • recreational activities	$(HR_{str.} - HR_{res.})$ *70% + $HR_{res.}$
		C	• breathing exercises – 1 time a day for about 15–20 min, 5 times a week physical activities – 1 time a day for about 15–20 min, 5 times a week • broken training on a cycle ergometer – 1 time a day, 5 times a week • walking • recreational activities	$(HR_{str.} - HR_{res.})$ *60% + $HR_{res.}$
		D	• cardiopulmonary activities, individually • walking	Heart rate acceleration during activities about 10–15% in relation to resting heart rate

$HR_{str.}$ – heart rate stress, $HR_{res.}$ – heart rate resting.

movement of the chest, shoulder girdle and respiratory activity.

Before exercises it is important to pay attention to the correct use of them. Exercises begin with breathing. The ratio of the inhalation time through the nose to the exhale time through the mouth should be 1 : 2, sometimes even 1 : 3. It is aimed at maximizing exhalation, until the sense of "no air".

During inhalation the patient's stomach rises but during exhalation it declines. To control the correct use of exercises, the physiotherapist lays hands on the chest or near the upper stomach and measures the time of exhalation and inhalation (Figure 1). The number of repetition should not be more than 3–4 times in one series. The principle of frequent repetition with lower intensity is adapted. Patients often do exercises according to their course. The physiotherapist controls the correctness of exercises [18–21].

Figure 1. Monitoring the correct use of breathing exercises

Group exercises (model A, B, C, D)

Breathing exercises include:

- relaxation activities,
- long exhalation activities,
- teaching of breathing through diaphragm,
- increase movement of lower parts of chest for respiratory activity,
- exercises that stimulate chest,
- regular breathing exercises with special attention paid to abdominal muscles and diaphragm activities.

Before exercises it is necessary to achieve general relaxation of muscles and lower muscle tension in the chest. The reduction of external intercostal muscle tension is achieved by keeping the chest in the exhalation position for several minutes. The chest should be encircled with inflexible material at the height of the lower chest, which tightens during exhalation. This way the diaphragm is also forced to work intensively (Figure 2). Stimulation of the chest is fostered by relaxation exercises such as rhythmic bends and torso turning in a sitting position (Figure 3) [19–21].

Figure 2. Exercise that relax chest muscles

An important element is to teach the patient how to take a short breath with relatively small involvement of inspiratory muscles and slow, long exhalation through the narrowed mouth (lips made into a puckered shape) while at the same time pulling the stomach without pushing (Figure 4). Exhalation exercises are done by the patient whose lower chest is wrapped in inflexible material. Crossed ends of material are held by patients. During exhalation patients remove material far from themselves. In this way patients press the chest (to assist breathing), and during inhalation loosen ends of material (Figure 5) [19–21].

Figure 3. Relaxation exercises in sitting position

Diaphragm activities are done by the patient who lies supine with a pillow under his/her head with lower limbs bent and the feet base on the floor. The described position allows the muscles to relax, which is necessary to start doing exercises.

Figure 4. Exercise of long inhalation

Figure 6. Diaphragm activities

Figure 8. Exercises that help to increase respiratory movement of lower ribs

The physiotherapist lays a hand on the hypogastrium and presses during inhalation (resistance). Another hand is placed on the breastbone to control the correct way of breathing. The resistance to move the diaphragm during inhalation is obtained by laying a small sandbag on the patient's epigastric region. Initially the sandbag weighs about 3 kg and its weight is increased to 4–5 kg during the following days. The sandbag rises during inhalation and falls during exhalation (Figures 6, 7) [19–21].

Figure 5. Exercise of long exhalation

Figure 7. Diaphragm activities

Figure 9. Increase of respiratory movement of lower parts of chest

Increased respiratory movement of lower parts of the chest and diaphragm movement is obtained by stabilization of the rim of the thoracic limb which causes limited movements of upper parts of the chest during inhalation. A sitting position with holding of the stool's seat is adopted (Figure 8). A similar effect is obtained when the patient has 3 kg sandbags laid in the subclavicular regions (Figure 9) [19–21].

Respiratory activities are carried out in suitable lying positions (Figures 10, 11). In this way inhalation

Figure 10. Lying position

Figure 12. Static exercise that simplifies exhalation

and exhalation can be easy or difficult, stabilize one part of chest and improve movement of the second part of the chest as well as increasing diaphragm and intercostal muscles' involvement in activities [19–21].

Examples of static respiratory activities:

1. Static exercises that simplify inhalation.

Patient breathes in the following starting positions:

- lying on the back, fingers crossed fall on the head;
- lying on the back, hands on hips;
- lying on the back, upper limbs set upwards and across (Figure 11);
- sit, hands on hips.

2. Static exercises that simplify exhalation.

Patient breathes in the following starting positions:

- lying on the back. Lower limb bent at knee joint and hip joint;
- lying on the back or sitting. Exhale isochronally while uttering vowels (Figure 12).

Examples of dynamic respiratory activities:

1. Dynamic respiratory activities that simplify inhalation and exhalation:

Figure 11. Static exercise that simplifies inhalation

Figure 13. Dynamic activity that simplifies exhalation

Figure 14. Dynamic activity that simplifies exhalation

- lying on the back, bending thigh to chest during exhalation, unbending during inhalation (Figure 13);
- exercises the same as in point number 1, but during bending thigh to chest lower limbs are folded and head is bowed towards knee (Figure 14);

Figure 15. Dynamic activity that simplifies exhalation

Figure 16. Exercise without accessories

- lying on the back, upper limbs situated upwards and across, elbows downwards during exhalation;
- lying on the back, hands rest on shoulders; elbows upwards during inhalation, elbows downwards during exhalation;
- lying on the back, upper limbs crossed rest on chest; throw upper limb to the side during inhalation, return to starting position during exhalation;
- stomach position; lean head and torso back during inhalation, return to starting position during exhalation;
- stomach position, hands rest on the floor near shoulders; raise torso on your hands during inhalation, return to starting position during exhalation;
- lying on the back during inhalation, return to curled sit during exhalation;
- sit back during inhalation, bend front with head-knee touch during exhalation;
- sit or stand up, hand on neck or shoulder, raise upper limbs during inhalation, return to starting position during exhalation;
- get down on hands, lean back your head during inhalation, lean your head front and stretch spine backwards during exhalation (arch position) (Figure 15) [19–21].

Physical activities are called dynamic activities. Endurance exercises have a positive influence on physical fitness and patients' condition. What is more, acceleration of breathing rhythm improves ventilation of lungs. The starting position should be adjusted in order to do exercises correctly. Initially sitting and lying position should be used during exercises. Described positions eliminate additional body movements. As progress is made, the patient starts doing exercises in a standing position. Exercises should be adjusted to the group. All patients should be able to do them. Patients who do exercises in a group start with easy movement of their bodies in order to prepare for more complicated exercises.

Every new exercise should be done slowly. As the exercises are done properly pace and length of activities should be increased. Because of difficulties in choice of a homogeneous group of patients, individualization of exercises should be introduced. At the beginning patients do exercises without accessories (Figure 16). As their condition and physical fitness are improved, patients use accessories such as sandbags, balls, and gymnastic poles.

Regardless of whether the exercises are well known to patients, it is necessary to do them properly [19–21].

Broken training on a cycle ergometer (model A, B, C)

It is training which provides enough time to complete rest between exercises. The described type of training prevents serious tiredness and oxygen debt which is well tolerated by patients and increases general and coronary condition.

The broken training method on a cycle ergometer consists of 4 min of patients' work and 2 min of patients' rest. During the rest blood pressure and heart rate are measured.

The following load is applied:
a) model A – 50 W, 70 W, 90 W, maximum to 150 W,
b) model B – 50 W, 60 W, 70 W, maximum to 100 W,
c) model C – 30 W, 40 W, 50 W, maximum to 80 W.

During one training session, 5–6 four-minute series are applied. It depends on the patient's condition and attainment of the determined heart rate limit.

Leisure and sporting activities without contention (model A, B, C):

- playing of ball with elements of basketball,
- playing of ball with elements of volleyball,
- bowling or other games.

Walking (model A, B, C)

Used are excellent recreational values of the hospital area, in particular the effect of mild piedmont microclimate and resinous forest landscape park "Gory Opawskie". Oxygen therapy combined with physical exercises and climatic factors is applied.

Walking takes place in the afternoon along a prescribed route around the hospital in a favoured, biometeorological area which is devoid of any air pollution [19–21].

Conflict of interest

The authors declare no conflict of interest.

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Address for correspondence:

Katarzyna A. Bogacz PhD
Vital Medic Hospital in Kluczbork
ul. Skłodowskiej-Curie 21, 46-200 Kluczbork, Poland
Phone: +48 501 550 714
E-mail: k.bogacz@interia.pl