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HOW TO DO

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How to do: Telerehabilitation in heart failure patients

Ewa Piotrowicz

Department of Cardiac Rehabilitation and Noninvasive Electrocardiology, Institute of Cardiology, Warsaw, Poland

Abstract

According to the present guidelines for heart failure patients, regular exercise training has obtained the class of recommendation I, level of evidence A. Despite the benefits of cardiac rehabilitation, many heart failure patients are inactive. Common patient's rejection of existing forms of rehabilitation and limitations resulting from the disease itself hinder the outpatient cardiac rehabilitation. That is why home telerehabilitation seems to be the optimal form of physical activity for heart failure patients. (Cardiol J 2012; 19, 3: 243–248)

Key words: telerehabilitation, heart failure

Introduction

Thanks to the progress in various scientific fields, medicine is capable of saving more and more lives. Yet, paradoxically, this situation generates an increasing number of patients with heart failure (HF). Heart failure is a crucial problem in modern cardiology. Statistics show that more than 10 and 4 million people suffer from HF in Europe and in the USA, respectively. According to the present guidelines for HF patients, regular exercise training has obtained the class of recommendation I, level of evidence A [1]. The problem medicine needs to deal with is the provision of cardiac rehabilitation (CR) to all HF patients and thus complying with these recommendation.

Despite the benefits of CR, many HF patients are inactive [2, 3]. Common patient's rejection of existing forms of rehabilitation and limitations resulting from the disease itself hinder the outpatient CR. That is why home telemonitored CR seems to be the optimal form of physical activity. Telemedicine can be most useful in performing exercise training for two reasons: it can control the stability of clinical status and help supervise training sessions [4–9]. In order to fulfill these two tasks, symptoms (fatigue, dyspnea, chest pain) and parameters (electrocardiogram [ECG], heart rate, arrhythmias, ischemia, blood pressure, body mass, saturation, medication taken, etc.) need to be monitored. These procedures should render home telerehabilitation (TR) safe and secure.

Despite the fact that telemedicine is highly applicable and effective, there are very few papers dedicated to the study of TR in HF patients [9–16]. Until recently only a couple of home rehabilitation monitoring models have been presented. From the simplest (1) heart rate monitoring [10] and (2) transtelephonic electrocardiografic monitoring [11], through more advanced (3) tele-ECG-monitoring via a remote device [12] and (4) real-time ECG and voice transtelephonic monitoring [13]. It seems the last two are the most useful and reliable.

Model of telerehabilitation

There are no guidelines about TR in HF patients. On the basis of research data and our experience the following model of TR for HF patients can be proposed.

Address for correspondence: Ewa Piotrowicz, MD, PhD, Department of Cardiac Rehabilitation and Noninvasive Electrocardiology, Institute of Cardiology, ul. Alpejska 42, 04–628 Warszawa, Poland, fax: +48 22 343 4519, e-mail: epiotrowicz@ikard.pl

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Table 1. Responsibilities of telerehabilitation team members.

Physician's responsibilities
1. Clinical assessment of patients before inclusion, during and after CR
2. Optimization of medical treatment
3. Assessing patients' exercise tests
4. Planning exercise trainings and optimal workload
5. Educating patients on their illness basics (how to self-evaluate worrying signs and symptoms and the level of perceived exertion according to the Borg scale)
6. Telephone consulting with patients, if need arises (nurses asses problems prior to physician's counseling)
7. Reacting to urgencies
8. Recording patients medical history
9. Obtaining patients' consent for CR (compelling patients to fill in and sign patient's consent form)
Nurse's/an ECG technician's responsibilities
1. Educating patients (*how to measure heart rate, blood pressure, and body weight, *how to operate the tele-monitoring equipment)
2. Enlisting patients into the electronic telemonitoring database
3. Programming the assigned exercise training in the telerehabilitation device
4. Admitting patients (daily) to begin CR
5. Analysing ECG (subsequent to consulting the physician)
6. Assessing patients perceived exertion in Borg's scale
7. Receiving telephone information from patients regarding potential problems and necessity to consult a physician
8. Reacting to urgencies
9. Recording patient's medical history
10. Ensuring that patients fill in the CR questionnaire
11. Registering, distributing and ensuring the return of CR devices
12. Ensuring patients sign the CR device lease form
13. Conducting antropometric measurements prior to and following the CR (weight, height, waist and hip circumference)
Physiotherapist's responsibilities
1. Planning exercise trainings and optimal workload
2. Educating patients
— teaching how to perform the exercises prescribed and conducting educational training sessions
— providing patients with a short lecture on the technicalities of exercise training
— deciding whether patients are sufficiently trained and capable of safely conducting CR at home
3. Assessing (daily) the correctness of the exercise training, reacting to improper/incorrect course of exercise training
4. Telephone consulting and counseling
5. Recording patients medical history
Psychologist's responsibilities
1. Conducting psychological assessment
2. Providing psychological support. Each patient should receive psychological care that includes discussing and commenting the disease itself, its course, its treatment and patient's rehabilitation acceptance. The patients should also be offered, if necessary, individual psychological support in the form of conversations over the phone. Such conversations should be carried out regularly within the tele-monitoring programme

CR — cardiac rehabilitation

Telerehabilitation medical team and device

Telerehabilitation is carried out by a medical team and advanced monitoring systems are used. A TR medical team should be composed of: a physician, a physiotherapist, a nurse, an ECG technician, and a psychologist. The responsibilities of TR staff members are shown in Table 1.

Telerehabilitation equipment and infrastructure

Currently available monitoring systems include:

1. A special remote device for tele-ECG-monitored and supervised exercise training-TR set (Pro Plus Company, Poland), which consists of: EHO mini device, blood pressure measuring and weighing machine (Fig. 1).

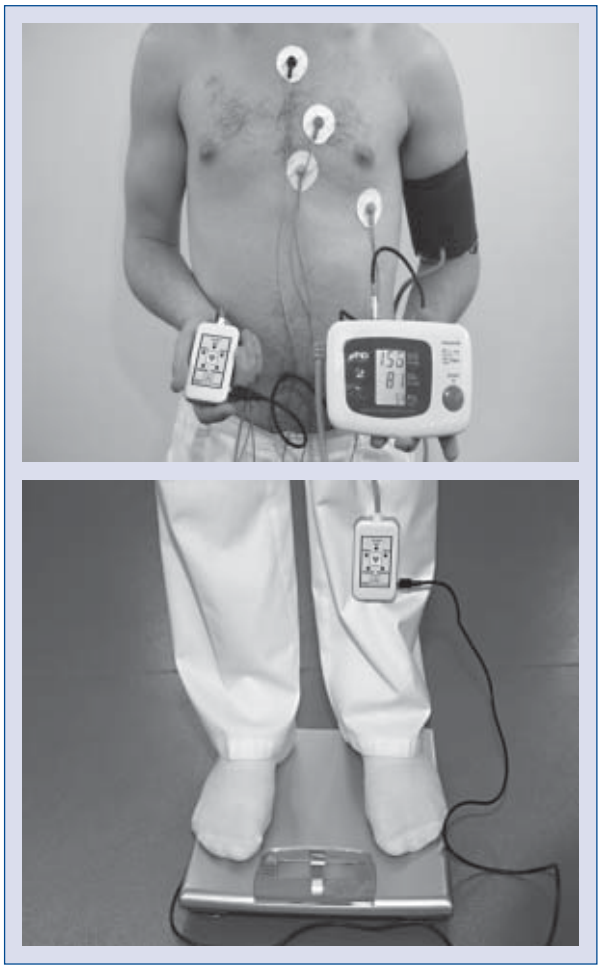

Figure 1 Telerehabilitation set — a manometer and a weighing machine, which both are compatible with the EHO mini device.

2. A data transmission set via a mobile phone.
3. A monitoring centre capable of receiving and storing patients' medical data (specialized hardware and software are necessary). Thus obtained data are subsequently analyzed by the medical team and a medical report follows.

Telerehabilitation set

An EHO mini device adjusted to register 16-seconds–5-minutes fragments of ECG recording from three precordial leads and to transmit the data via mobile phone network to the monitoring center (Fig. 2). An EHO mini device has training sessions preprogrammed individually for each patient (defined exercise duration, breaks, timing of ECG recording). The moments of automatic ECG registration are preset and coordinated with the exercise training. The planned training sessions are executed with the device indicating what should be done with sound and light signals. There are sound signals in the form of bleeps and light signals from color emitting diodes. Bleeps and green diode blinking mean the patient should do exercise, another set of bleeps and red diode blinking mean stop exercise. The timing of automatic ECG recordings corresponded to peak exercise.

An EHO mini device has a tele-event-Holter ECG feature as well. Tele-event-Holter ECG is a feature that enables a patient, whenever a worrying symptom occurs, to register and immediately send the ECG recording via mobile phone network to the telemonitoring centre. The system works in a loop scheme, owing to which it is possible to analyze the part of ECG recording which directly preceded an event which made a patient press the signal button.

Patients are also able to make additional registrations and send them at any time, for example, when they felt unwell, if they experienced symptoms like palpitations, chest pain, etc.

Apart from the EHO mini device, the TR set also includes a weighing machine and a manome-

Figure 2. Electrocardiogram during telerehabilitation.

Table 2. The initial telerehabilitation phase — baseline clinical examination

Tests	Potential abnormality
Laboratory tests	
Blood count	Anemia (< 13 g/dL in men, < 12 g/dL in women)
Glycaemia	Hyperglycemia (> 6.5 mmol/L), diabetes control
Serum creatinine, electrolities concentrations (natrium, potassium, magnesium), urinalysis	Renal dysfunction
Thyroid tests	Hyper/hypothyroidism, amiodarone
BNP/NT-proBNP	Tools for diagnosis and management of heart failure
ECG	Sinus tachycardia, sinus bradycardia, arrhythmias (atrial flutter/fibrillation; supraventricular, ventricular arrhythmias)' conduction disturbances, ischemia, QRS duration-evaluation for CRT implantation
Chest X-ray	Cardiomegaly, ventricular hypertrophy, normal pulmonary findings, pulmonary venous congestion, interstitial edema, pleural effusion, Kerley B lines, hyperlucent lung fields, pulmonary infection, pulmonary infiltration
Echocardiography	Assessment of left ventricular function (global and focal), ejection fraction; end-diastolic/end-systolic diameter, left atrial size, valvular structure and function, mitral diastolic flow profile, pericardium, aortic outflow velocity time integral, inferior vena cava. Evaluation for cardiosurgery, CRT
Ambulatory ECG monitoring (Holter ECG)	Assessment of arrhythmias, conducted disturbances, silent ischemia Monitoring ventricular rate control in patients with atrial fibrillation Evaluation of functioning of implantable devices (pacemakers, CRT) If necessary, referral for ablation supraventricular or ventricular arrhythmias
Six-minute-walk test [25]	Assessment of submaximal functional capacity and evaluation of the response to intervention
Cardiopulmonary exercise test [26, 27]	Objective evaluation of exercise capacity and exertional symptoms, such as dyspnea and fatigue. Presence of exercise-induced arrhythmias, conducted disturbances, ischemia. Heart rate of onset of an arrhythmia, ischemia Assessment of chronotropic response to exercise. Obtaining data necessary to define the duration and frequency of exercise sessions and recommended training workloads. Evaluation of the response to intervention

BNP — B-type natriuretic peptide; NT-proBNP — N-terminal pro-BNP; CRT — cardiac resynchronization therapy

ter, which both are compatible with the EHO mini device and enable blood pressure results and body mass to be sent automatically to the monitoring facility. Patients' data are sent to the monitoring centre instantly after being obtained by the EHO mini device. It is of utmost importance, since such a procedure hinders patients from manipulating their medical data (i.e. the patients have to take actual measurements and cannot simply enter whatever data they wish thus providing the monitoring center with false information on their state of health). EHO mini device, apart from storing and transmitting medical data to the monitoring centre, is also a mobile phone which allows patients to be in constant touch with the centre.

Performing telerehabilitation

Performing TR consists of two stages: an initial stage — conducted either at hospital sites or within outpatient programmes, and a basic stage — conducted at home.

Table 3. Education programme designed and run by the telerehabilitation staff.

Patients and their partners ought to be taught:

- how to measure heart rate, blood pressure, body mass
- how to self-evaluate worrying signs and symptoms
- how to perform the exercise training
- how to self-evaluate the level of perceived exertion according to the Borg scale during training session
- how to operate a telerehabilitation set
- how to give first aid in case of an emergency

The initial telerehabilitation stage

The goals of the initial stage are: a baseline clinical examination for reliable evaluation of clinical status and functional capacity (Table 2), education (Table 3), individual planning of exercise training depending on patient's exercise efficiency

Table 4. Borg's rating of perceived exertion scale.

6	14
7 very, very light	15 hard
8	16
9 very light	17 very hard
10	18
11 fairly light	19 very, very hard
12	20
13 somewhat hard	

achieved in tests, performing a few (3–6) monitored educational training sessions.

Planning the exercise training. The chosen workload should reflect individual effort tolerance with regard to: perceived exertion according to the Borg scale (Table 4) and the training heart rate range established individually for each patient depending on patient's parameters (heart rate and physical effort) achieved in cardiopulmonary exercise tests.

Having accomplished the initial stage, patients should be given a TR set.

The basic telerehabilitation stage

The basic TR stage ought to consist of two parts performed prior to each training session:

— first part — the training consent procedure required to access each training session;
— second part — the training session.

The first part — the training consent procedure. Each patient, before a training session, should answer a series of questions regarding his or her present condition via mobile phone (factors should include fatigue, dyspnoea, oedema, and medication(s) taken). Subsequently patients should transmit resting ECG, blood pressure and body mass data to the monitoring centre. If no contraindications to training are identified, patients can receive consent to start the training session.

The second part — the training session. Exercise training should be performed in accordance with the published standards for HF patients [17–23]. Three different training modalities have been proposed to improve exercise capacity in HF patients: aerobic endurance (continuous or interval), respiratory muscle and strength/resistance training. Within the TR programme, patients can perform a varied range of endurance training e.g. walking, nordic walking and cycle ergometer trainings. The intensity of exercise depends on workload achievements in tests. A training heart rate range of 40–70% HRR (HRR = difference between the basal and peak heart rate during exercise test) and 10/20–14/20 of the Borg perceived exertion are recommended [17, 24].

Telemonitoring during training sessions

TR set is used to monitor and control training in anywhere the patient has elected to exercise. If the training session is completed uneventfully, the patient transmits ECG recording via a mobile phone to the monitoring centre immediately after the end of every training session. The data are stored in a computer and are analyzed by TR team at the monitoring centre, and the safety, efficacy, and accuracy of a particular patient rehabilitation programme are assessed.

Using the data on heart rate during exercise and the patient's subjective evaluation of the perceived exertion, consultants are able to adjust the training workload appropriately or, if necessary, to discontinue the session (physicians are those who take the final decisions).

Patients can also transmit an ECG recording at any moment, e.g. due to symptoms like palpitation, chest pain etc. (thanks to tele-event-Holter ECG feature). The telephone contact is also used for psychological support.

Summary

There have been numerous papers published recently indicating that cardiac disease patients, especially those with HF, benefit from home-based CR. A mandatory element which makes this type of CR possible is its supervision by using telemedicine. If this procedure is to be implemented, it is necessary to know how to do it. That is why I believe that this paper will be my humble contribution to making the slogan 'H_2H — Hospital-to--Home' more popular [28].

Conflict of interest: none declared

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