INTEGRATED TRAINING SYSYEM FOR THE IMPROVEMENT OF THE PHYSICAL CONDITION OF COPD PATIENTS

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INTRODUCTION

COPD patients suffer from airflow limitation and significant extrapulmonary effects. Dyspnea leads to immobility, lack of fitness, social isolation and depression. We propose a system to break through the downward spiral of inactivity and social isolation. This integrated training system supports the maintenance and improvement of the physical condition safely at home and by using a virtual group environment social interaction is facilitated.

REHABILITATION PROGRAM

Currently COPD are enrolled in a rehabilitation program to improve their physical condition. After the program most patients are not compliant to the training advice and fail to maintain their physical condition.
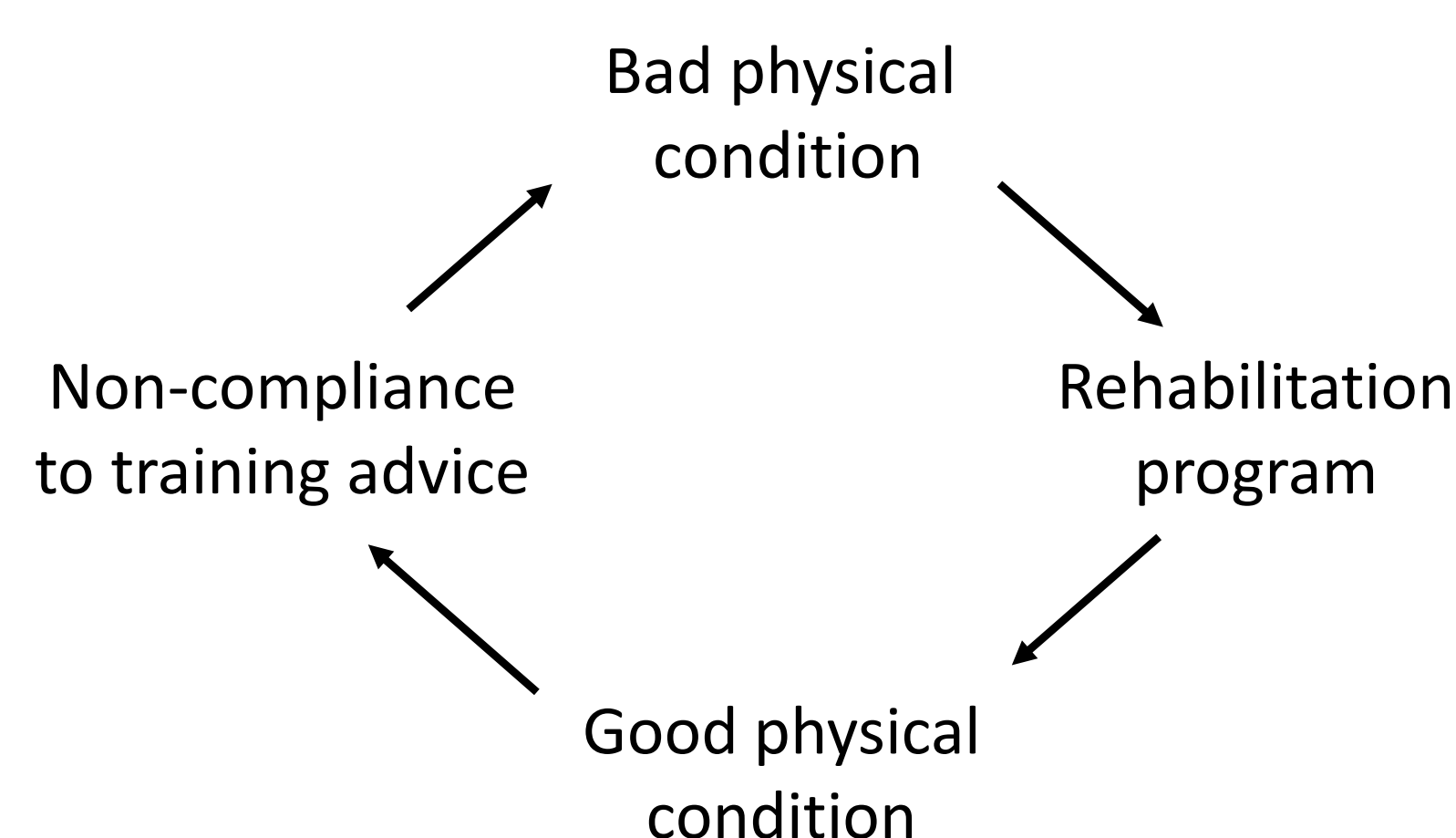

FIGURE 1: CURRENT SITUATION

INTEGRATED TRAINING SYSTEM

Patients are motivated to maintain their physical condition in an accessible way; the system will be used at home to limit possible barriers to attend training sessions. A group of patients cycle in the same virtual environment, a multiplayer cycling game, using a home trainer with a monitor in front of it. During a training session heart rate, oxygen saturation level, power and other parameters are monitored and recorded.
On the web portal patients can view their training results, communicate with the physiotherapist and exchange messages with other patients to motivate each other.

FIGURE 2: TRAINING SESSION WITH THE INTEGRATED TRAINING SYSTEM

Exercise parameters are tailored to the specific situation for each patient to achieve a safe and effective training.

ARCHITECTURE

The integrated training system consists of four components:

- Home trainer
- Virtual exercise environment
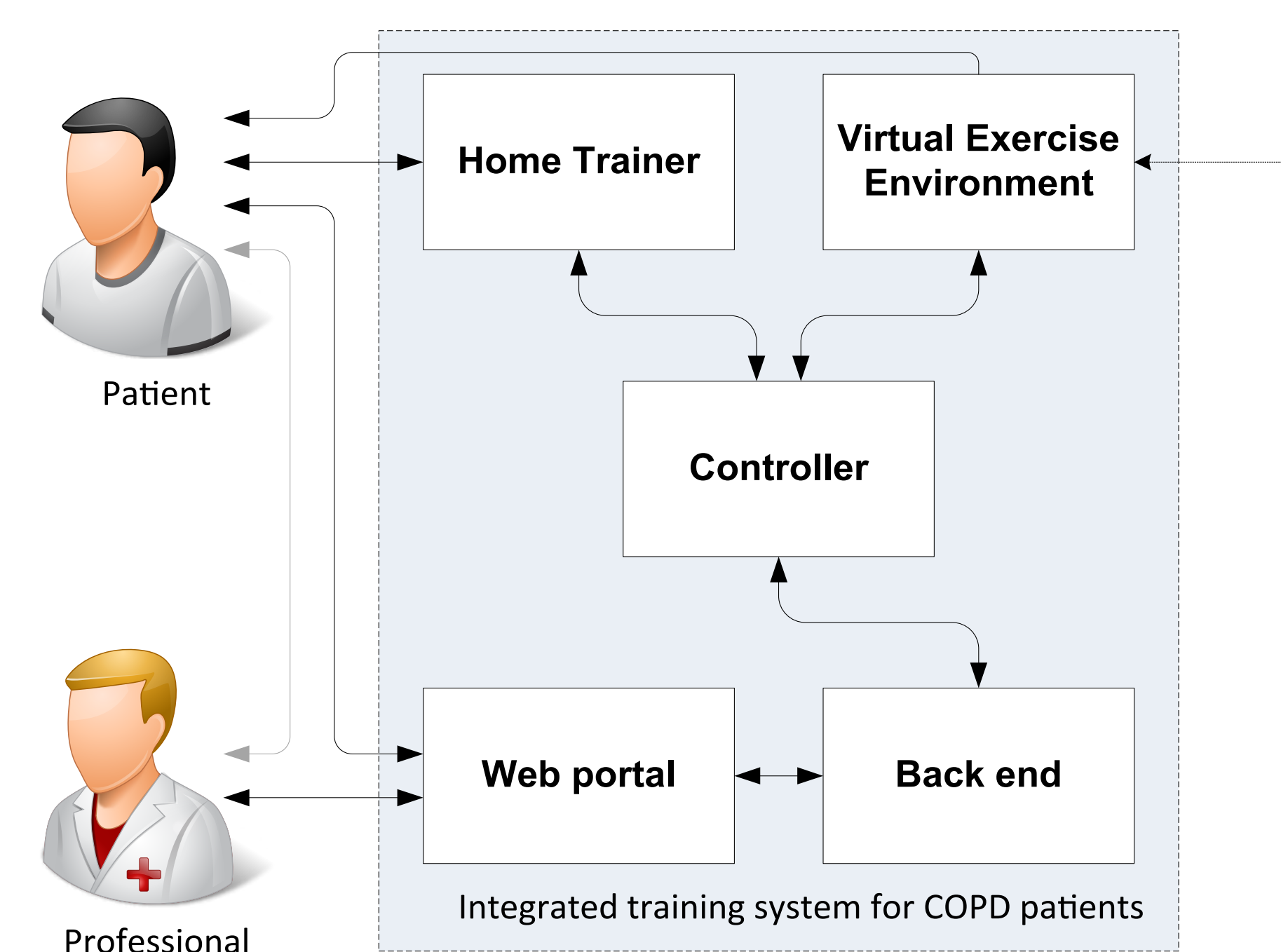- Controller
- Web portal

FIGURE 3: SYSTEM ARCHITECTURE

The home trainer is an ergo bike with a digital computer interface. Other sensors such as a pulse oximeter are included in this component as well.
In the virtual exercise environment multiple patients can cycle in the same digital environment using a computer system with a monitor in front of the home trainer. The controller monitors all sensory input from the home trainer and virtual exercise environment and sends the data to the web portal. Based on physiological parameters the controller controls the training intensity and terminates a training session when safety cannot be guaranteed.
The web portal stores, analyses and presents the training data to the patients and professionals. Also messages can be exchanged. The web portal includes a back end which receives and stores training session data.

FEEDBACK LOOPS

To ensure a safe and efficient training two feedback loops are used: the safety loop and the performance loop.
The safety loop reduces the training intensity or terminates the training based on the oxygen saturation level; when the oxygen saturation level drops below a specified threshold the intensity is reduced — when the oxygen saturation level stays below that threshold for too long the training session is terminated.
The performance loop controls the resistance of the home trainer. The resistance is increased or reduced, resulting in a power that approaches the predefined value for the specific patient. This will result in a heart rate between 60 and 80% of the maximal heart rate: the effective training zone.
The safety loop overrules the performance loop.

EVALUATION

Technical evaluation of the ITS prototype shows an accurate heart rate and cadence measurement, a moderate measurement of the power and a poor oxygen saturation level measurement. The control systems of the prototype for performance and safety work as expected.

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