Towards as SAR system for personalized cardiac rehabilitation

A patient with PCI

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Problematic: High Drop-out rate

England [1]:
- in 2001 only 14% to 23% of infarct patients actively continue with the programme

Irán [2]:
- 1115 patients between 2000 and 2005 (44.8% completed the programme)

Australia [3]:
- 573 patients tracked during 4 months (49.6% attended the programme)

Evidence

- According to the World Health Organization, around 17.5 million people die each year from CVDs[1].
- In 2015, two CVDs were leading cause of death in the world[2].
- Cardiac rehabilitation is commonly used to prevent CVDs or to treat a patient post a CVD event.

Cardiac Rehabilitation (Phase II)

- Is an outpatient phase.
- Lasts around 3 months and consists of weekly sessions (two times per week).
- Education program: covering risk factors, healthy habits, adhesion to the treatment and motivation
- Exercise (typically on a treadmill) and physiological intervention.
What has been done: SAR in Rehabilitation Scenarios

Spirometry

Embodied Agents and why to use this approach


- Wilma A. Bainbridge et al., 2011. The benefits of interactions with physically present robots over video displayed agents.
Hypothesis

- The robot agent reduces drop-out rates in the rehabilitation program
- The robot behaviour has a positive impact in the patient’s performance
Approach

Questionnaire: 83 females and 155 males
age M=62.3 years, SD=14.3, weight (M=68.46 kg, SD=12.12), height (M=1.64 m, SD=0.09)

Pilot study: 1 patient with PCI
Age: 63 years, weight: 70 kg, height: 1.65 m
16 sessions
Questionnaire

“What aspects do you like about the cardiac rehabilitation session on the treadmill?”

Physical ability improve 37%
Technology 8%
Institution 10%
Results 13%
Sessions 4%
Others 28%

“How would you feel about a social robot accompanying you throughout the rehabilitation process?”

Curiosity 39%
Interest 27%
Prefers without robot 23%
Doubts 8%
Disconfort 3%
Pilot Study: Human-Robot Interface
Architecture
Experimental Setup

- **Memory Scenario**: Robot can recognize the patient and remember previous sessions.
- **No Memory Scenario**: Patients interact with the robot without recognition memory.
- **No Robot Scenario**: Patients interact only with the interface to submit Borg Scale and BPS measure.
Human-Robot Interface

**Motivation**

The robot encourages the patient to increase or maintain motivation, every 5 minutes.

**Warning**

When any of the risk factors is perceived the robot asks the patient whether everything is fine or medical staff should be called.

**Emergency**

The robot alerts the medical staff the emergency.

1. Change of warning state to the emergency state,  
2. Detection of an excessive increase in heart rate, and  
3. Alarm triggering by the patient through the GUI (pain, dizziness or fatigue).
Human-Robot Interface

Initial and final heart rate level

Heart rate recovery (1-2-3-4-5) min

Posture correction during exercise

Response time (BS request)
Results

[Graphs showing various metrics such as heart rate, cadence, step height, speed, incline, and Borg scale over time and sessions.]
Results

[Charts and graphs related to the Results section]

- Motivation
- Borg Scale
- Borg Scale correction
- Cool down phase

[Graph showing time and posture corrections over sessions]
Conclusions

- A first evaluation for the system was performed with a real patient during a conventional session.
- The Human-Robot interface was validated as well as the interaction with the patient.
- Further work is required to determine the impact that the interface has in the long-term.