



## SPECIAL POINTS OF INTEREST:

- On-line education and coaching tool for the patient
- Medication management tool for the healthcare professional
- Sensors
- Consortium

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## Welcome to our 3<sup>rd</sup> newsletter

HeartCycle is about to enter its fourth year and is coming closer to the realisation of the final systems for Heart Failure Monitoring and Guided Exercise. Advanced prototypes are available while tests and validation are in place or planned.

As the start of the clinical trials is approaching, writing of the clinical study protocols and the preparation for ethics approval are now in the final state.

With a new clinical partner on board, Hospital Universitario German Trias I Pujol, in Barcelona, the HeartCycle consortium is enriched and clinical trials are expanded.

On the research line, the Assessment Use Cases have been further elaborated and significant progress has been made in the development of innovative sensors and decision support algorithms. Within the business assessment activities, the partners have continued to carry out interviews with Healthcare stakeholders and studying the business models of the tele-monitoring / tele-medicine systems available in the market.

The current issue features two articles on interactive personalized disease management applications: an on-line education and coaching tool for the patient with heart failure and a medication management tool for the healthcare professional.

Finally, an overview of the HeartCycle sensors and sensor systems is presented showing state-of-the-art and next-generation patient monitoring capabilities.

## Consortium Enhanced

The HeartCycle consortium agreed to add an extra partner for the purposes of the Heart failure clinical study.

The new partner, the Hospital Universitario German Trias I Pujol (old name Can Ruti) in Barcelona, will be represented by Dr. med. Antonio Bayes and Dr. med. Josep Lupon, both recognised experts in Heart failure.

To optimally prepare and run the clinical study, especially to enroll and keep/support the selected patient groups there are high requirements with respect to staff and infrastructure.

The Barcelona hospital provides all of these and is already experienced in telehealth trials and we are therefore happy that they show a high interest to participate in this clinical study.

The Hospital Universitario German Trias I Pujol in Barcelona will enrich the HeartCycle consortium and help to make the clinical trial a success.



**Germans Trias i Pujol**  
Hospital

The Germans Trias hospital of the Catalan Institute of

Health acts as a basic general hospital for a population of over 200,000 people in Badalona and Sant Adrià de Besòs, but also as a referral hospital for nearly 800,000 people living in North Barcelona and Maresme.



The  
widely  
approved  
Heart Manual  
approach  
sets the  
basis for the  
HeartCycle  
on-line  
tailored  
education  
system

# A tailored on-line education and coaching programme

## Purpose

In Europe 14 million people suffer from heart failure (HF), which is associated with high mortality rates and frequent re-hospitalizations. It is estimated that a considerable number of readmissions may be prevented by appropriate self-care (medication adherence, physical activity, symptoms monitoring, low-salt diet, and fluid restriction). However, the level of self-care is low, often due to misconceptions and a lack of self-efficacy among patients with HF.

One of the goals of the EU-funded HeartCycle project is to increase self-care of HF patients by means of an on-line education and coaching programme. When HF patients better adhere to their treatment and recommended lifestyle activities, readmission rates are expected to decrease. Furthermore, this programme is expected to free HF nurses to work on other challenging aspects of their role.

## Methods

Based on the Heart Manual, a well-established and evidenced home-based cardiac rehabilitation programme, Philips Research, NHS Lothian, and Linköping University together developed a tailored education and coaching programme. Currently, this programme is offered by trained facilitators via home visits and telephone support. We have mapped the approach onto the Philips Motiva telehealth system.

The development team consists of a medical informatician, a health psychologist, a senior nurse, and a doctoral student in health psychology. Based on the current programme, the informatician proposed system designs which were reviewed and adapted by the other team members.

The result was reviewed by a professor in caring sciences with special attention to patient education and nursing.

## Results

We have succeeded in developing an on-line education and coaching programme that is tailored to the knowledge and behaviour of the individual patient. These two characteristics are assessed by means of questionnaires.



The patient's readiness for change is determined by letting the patient express how important the self-care activities are, and how confident he or she is to do these activities.

Furthermore, misconceptions about heart failure are addressed at an early stage in the programme.



Patients are guided through a goal setting process that they conduct at their own pace through the support of the on-line system.

To raise commitment, patients set their own goals and make their own action plans. They record their progress in an electronic diary such that the system can provide appropriate feedback.

## Conclusions

A tailored on-line education and coaching programme was developed. With this program we hope to increase the self-care compliance of heart failure patients. The HeartCycle trial, planned for 2011, will provide insight into the effectiveness of this approach.

Authors: W. Stut, C. Deighan,  
W. Armitage, M. Clark, T. Jaarsma



# Fly Your Own Future

According to recent clinical studies patient education and motivation can increase adherence to treatment and potentially improve clinical outcomes. It has been demonstrated that informing patients about the effectiveness of the prescribed medication and exercise on their vitals can improve treatment adherence.

In this context, a joint research effort by the AUTH and VTT teams has lead to the development of the **Fly Your Own Future (FYOF)**, an interactive tool that can help the patient realize the expected effects of his/her medication and exercise on his vital signs and understand the benefits of being compliant.

Currently, three major components of FYOF have been developed: **medication effects**, **medication management** and **exercise effects**.

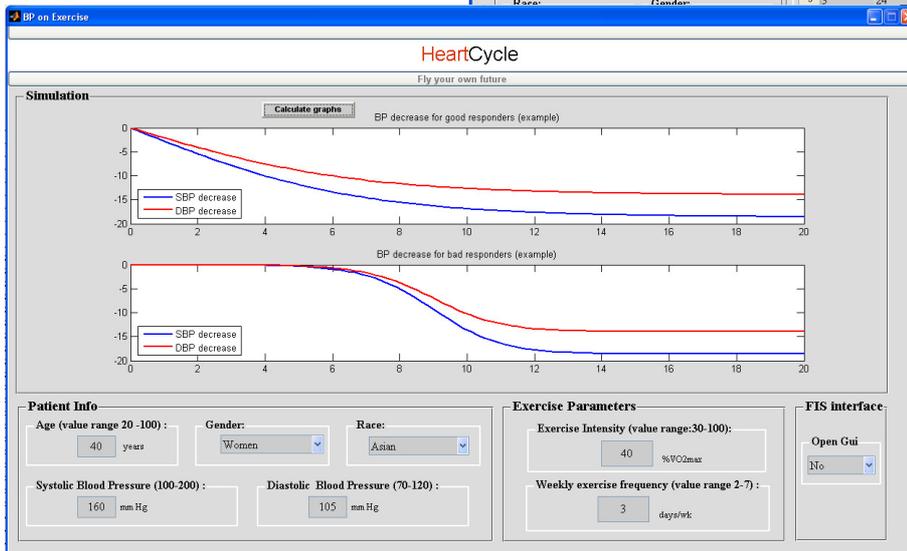
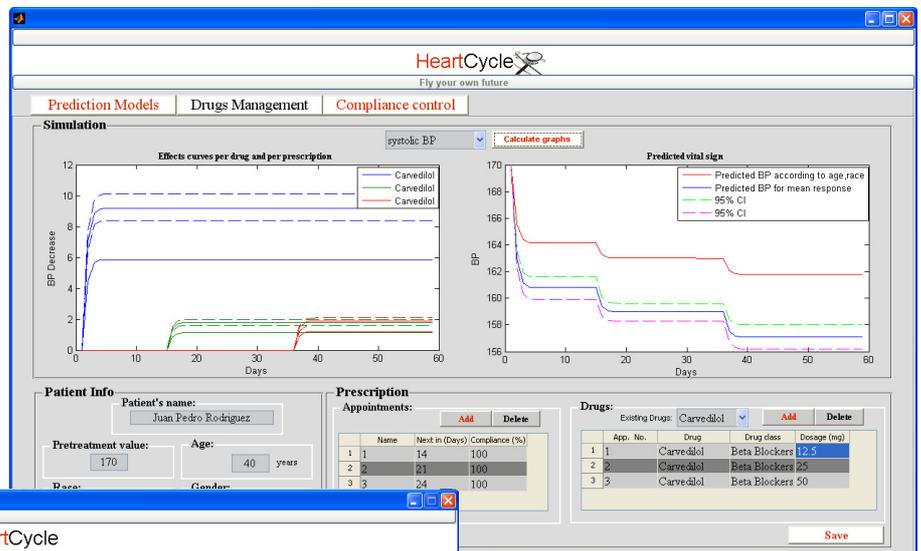
Predictions of medication and exercise effects on vitals are produced by theoretical models based on published medical evidence. Personalized parameters currently taken into account are age, race, sex, baseline values (prior to initiation of medication/exercise treatment) of Blood Pressure (BP) and Heart Rate (HR), and exercise-dose related variables (for the exercise component).

Expert knowledge or medication/exercise dose-response data where available will contribute to the fine tuning of the models.

## Helping patients take an active role in their care



FYOF can be used during the patient – health professional encounter to demonstrate the (causal) effect of medications and exercise on patients vitals.



The healthcare professional enters personal information about the patient, medication and dosage, exercise intensity and frequency as well as baseline BP and HR measurements. FYOF predicts medication effect and evolution of BP and HR (figure above) and exercise effects on BP (figure on the left).

FYOF is complemented by the medication management feature, where the healthcare professional is able to have an overview on the supported medication classes and the included drugs for BP and HR management, as well as access information about the medication dose response relation, confidence interval and time to peak effect for the selected drug.

**Next Steps** include the association of medication effect deviation with potential incompliance to medication.

Authors: I. Chouvarda, P. Gkontra, A. Honka, M. van Gils, A. Kokonozi



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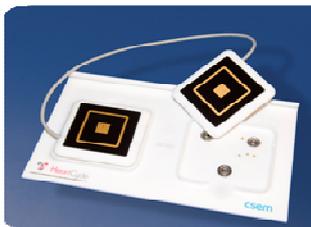
Starting in spring of 2011, the IMAGE sensor and the HFM vest will be evaluated through clinical trials in six clinical sites across Europe.

Validating HeartSounds, using standard Echo-cardiography

# HeartCycle Sensors

Development of innovative wearable sensor technologies is a primary technical objective of HeartCycle. The aim is to provide medically relevant solutions that are easy-to-use by patients with cardiovascular diseases. The project can now demonstrate integrated prototypes of sensor systems that will be evaluated through clinical trials in the last year of the project. In addition, early prototypes of state-of-the-art sensor modules are now available allowing investigations to record new signals and make contactless measurements. We present below a brief overview of the available prototypes.

The **IMAGE** sensor is a wearable unobtrusive system, consisting of two electrodes, for ECG (heart rate extraction), respiration (breathing rate extraction) and acceleration (posture and activity extraction). It includes embedded signal processing and feature



extraction software and is a major component of the Guided Exercise system (GEx) for guiding patients during the cardiac rehabilitation process. In GEx, the electrodes of the IMAGE sensor are placed in a specially designed shirt ensuring correct position and stability during movement. The sensor communicates



wirelessly with a PDA over Bluetooth.

*Developed by CSEM, VTT and UPM*

HeartCycle has improved existing sensors from previous projects by integrating them into textile and improving their usability (especially for the elderly population).

The **Heart Failure Vest** makes use of the Bio-Impedance Monitor (BIM) developed in the MyHeart project, measuring chest bio-impedances, electrocardiograms, activity levels and breathing rates. In the current setting, the BIM is fixed to a vest and connected electrically to the electrodes using washable conductive wires, woven into the garment and supports wireless communication over Bluetooth with patient's PDA.



*Developed by Philips and Clothing+*

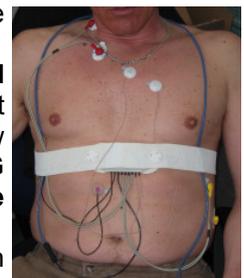
**Bio-impedance sensor embedded in the HF vest**

**Sensatron** is an innovative sensor module offering single data acquisition device for three sensors: COMPRE, BISCUIT & HeartSounds. COMBRE uses pulse wave velocity approach for **non-invasive measurement of blood pressure** with an easy-to-use finger photo-plethysmograph device. BISCUIT uses Impedance Cardiography (ICG), a very powerful technology to measure **cardiac output** and other hemodynamic parameters easily and non-invasively. HeartSounds system detects the heart sounds through two microphones and analyzes them to provide cardiac output and diastolic blood pressure surrogate measurement.

**Sensatron is unique in the variety of vital signals** it records and on the parameters it extracts through fusion and analysis of the raw data. Parameter extraction features **ECG analysis, heart phases (PEP/LVET), Pulse Transit Times, Pulse morphologies**.

The current prototype is being validated as an investigational device through clinical pre-trials in a lab environment.

*Developed by FCTUC, Philips, CSEM*



The **Magnetometer** uses inductive magnetic impedance to measure heart rate and breathing rate contactlessly.

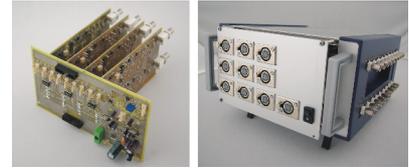
No cables or electrodes are necessary and the module could be integrated in a wearable textile or bed. Monitoring is unnoticeable to the patient and therefore can be used during sleep. It is an innovative module, currently tested in provisional setups in laboratory.



*Developed by RWTH*

**cECG (Capacitive ECG)** is a sensor module, using capacitive ECG electrode arrays to measure ECG signals without skin contact. Since the patient skin has no direct contact to conductive elements it allows a long term supervision of the heart activity. It can be integrated into objects of daily life like chairs, beds etc.

*Developed by RWTH*



**Capacitive ECG electrode array**

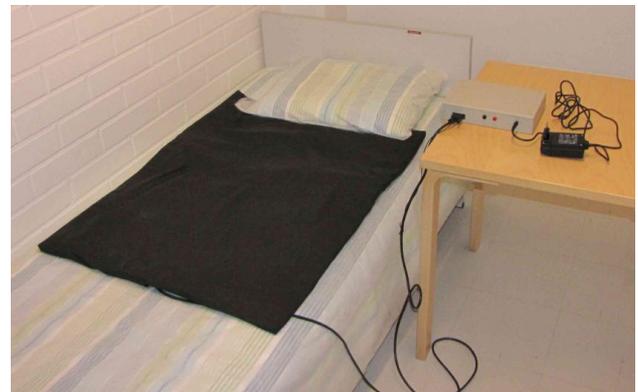
**Towards contact-less measurements for heart rate, breathing rate and ECG, eliminating the need of cables or electrodes**

**BedSensor** is a ballistocardiography (BCG) based system for unobtrusive sleep monitoring that does not require any sensors attached to the patient. It consists of pressure foil sensors embedded in bed mattress and DSP algorithms for extraction of heart beat, respiration and movement activity during sleep.

Automatic procedures for sleep analysis have recently been integrated on an external device (PC, PDA); they, or part of them, can be implemented also on board in the future. The sensor has been tested in a pre-trial during six months in a sleep lab at the clinic hospital in Tampere, Finland. Results are currently being analyzed.

The BedSensor is part of the Assessment use case, together with SENSATRON and HeartSounds.

*Developed by VTT and POLIMI*



**Bed sensor and main unit**

## General Assembly meeting



The Heartcycle General Assembly took place in Santorini, Greece on the 22nd of September 2010. During this meeting, HeartCycle's technical, medical and business representatives were brought together to be informed on project progress and to discuss management issues and the remaining workplan. The following day, during workpackage and concept meetings status and remaining tasks were discussed in detail.

## The ICT2010 exhibition

HeartCycle participated at the ICT2010 exhibition in Brussels, on September 27-29. The event, organized by the European Commission, focused on the latest research trends in information and communication technologies and offered an excellent opportunity to showcase the project's results to researchers and policy makers from all over Europe.



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# Project Details

## Contact Details

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**Full Title:** "Compliance and effectiveness in HF and CHD closed-loop management"  
**Project Identifier:** FP7 – 216695  
**Start Date:** 2008-03-01  
**End Date:** 2012-02-29  
**Duration:** 48 months  
**Contract Type:** Collaborative project  
**Project Cost:** 21.99 million euro  
**Project Funding:** 14.1 million euro

## Consortium

### Industry

Philips (Coordinator) [www.philips.nl](http://www.philips.nl)  
Medtronic Ibérica S.A. [www.medtronic.es](http://www.medtronic.es)  
T-Systems ITC Iberia [www.t-systems.es](http://www.t-systems.es)

### SME's

Clothing+ [www.clothingplus.fi](http://www.clothingplus.fi)  
Empirica [www.empirica.biz](http://www.empirica.biz)

### Clinics

Clinic Hospital San Carlos [www.hcsc.es](http://www.hcsc.es)  
Aachen (RWTH) [www.rwth-aachen.de](http://www.rwth-aachen.de)  
NHS Lothian [www.nhslothian.scot.nhs.uk](http://www.nhslothian.scot.nhs.uk)  
Hospital Universitario German Trias I Pujol  
[www.gencat.cat/ics/germanstrias](http://www.gencat.cat/ics/germanstrias)

### Research Organizations

VTT [www.vtt.fi](http://www.vtt.fi)  
ITACA [www.itaca.upv.es](http://www.itaca.upv.es)  
CSEM [www.csem.ch](http://www.csem.ch)

### Universities

Aristotle University of Thessaloniki [www.auth.gr](http://www.auth.gr)  
University of Hull [www.hull.ac.uk](http://www.hull.ac.uk)  
FCTUC University of Coimbra [www.fct.uc.pt](http://www.fct.uc.pt)  
Polytechnic University Milano (POLIMI) [www.polimi.it](http://www.polimi.it)  
RWTH Aachen University [www.rwth-aachen.de](http://www.rwth-aachen.de)  
Polytechnic University Madrid/LST [www.lst.tfo.upm.es](http://www.lst.tfo.upm.es)  
University of Linköping [www.liu.se](http://www.liu.se)  
University Clinics of Heidelberg [www.heidelberg-university-hospital.com](http://www.heidelberg-university-hospital.com)



**PHILIPS**



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