

# Personal Health Systems for Mental Health: The European Projects

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**Abstract.** Since the European funded project VREPAR - Virtual Reality in Neuro-Psycho-Physiology (1995) – different European research activities have been using virtual reality and advanced information and communication technologies to improve the quality of care in the treatment of many different mental health disorders including anxiety disorders, eating disorders and obesity. Now the European Commission funding is shifting from the traditional hospital-centred and reactive healthcare delivery model toward a person-centred and preventive one. The main outcome of this shift is the “Personal Health Systems” (PHS) paradigm that aims at offering continuous, quality controlled, and personalized health services to empowered individuals regardless of location. The paper introduces four recently funded projects – Interstress, Monarca, Optimi and Psyche – that aim at using PHS based on virtual reality, biosensors and/or mobile technologies to improve the treatment of bipolar disorders, depression and psychological stress.

**Keywords:** Virtual Reality, Assessment, Therapy, Personal Health Systems, Biosensors, Mobile Technologies, Stress, Depression, Bipolar Disorders.

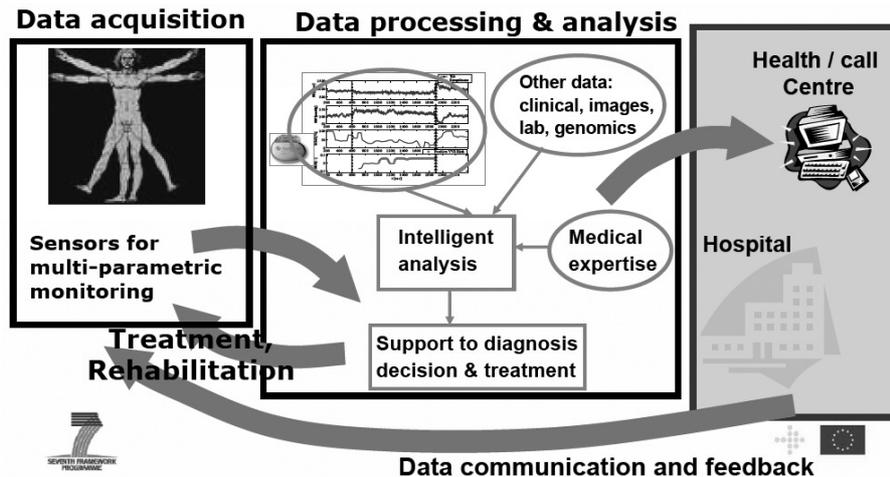
## 1. Introduction

New Information and Communication Technologies (ICT) offer clinicians significant new abilities to monitor patients’ conditions, thereby enabling them to diagnose problems earlier and treat them more effectively. For this reason, since the European funded project VREPAR - Virtual Reality in Neuro-Psycho-Physiology (1995 – 4<sup>th</sup> Framework Programme) – different European research activities have been using virtual reality and advanced information and communication technologies to improve the quality of care in the treatment of many different mental health disorders: anxiety disorders, male sexual disorders, eating disorders and obesity.

Recently, the European Commission focus shifted from the traditional hospital-centered and reactive healthcare delivery model toward a person-centered and preventive one. The main outcome of this shift is the “Personal Health Systems” (PHS)

paradigm that aims at offering continuous, quality controlled, and personalized health services to empowered individuals regardless of location [1].

PHS cover a wide range of systems including *wearable, implantable or portable* systems, as well as *Point-of-Care (PoC)* diagnostic devices. Typically, the functioning of PHS is related to three main blocks as shown below [2]:



**Figure 1.** The structure of a Personal Health System (from [3])

1. *Data Acquisition:* Collection of data and information related to the health status of a patient or healthy individual, e.g., through the use of sensors and monitoring devices.
2. *Data Analysis:* Processing, analysis and interpretation of the acquired data to identify what information is clinically relevant and useful in diagnosis, management or treatment of a condition. This entails processing of data at both ends: locally at the site of acquisition (e.g., with on-body electronics) and remotely at medical centres. Data processing and interpretation takes into account the established medical knowledge and professional expertise where appropriate.
3. *Patient/Therapist Communication:* Communication and feedback between various actors, in a loop: from patient/individual to medical centre; from medical centre that analyses the acquired data to doctor/hospital; and back to the patient/individual from either the wearable/portable/implantable system itself or the doctor or the medical centre (e.g., in the form of personalised feedback and guidance to the patient, adjusted treatment via closed loop therapy, control of therapy devices).

## 2. Personal Health Systems for Mental Health

The European Commission is supporting research in this area under the Seventh Framework Programme (FP7). FP7 funds are used to support research into monitoring systems for patients with chronic diseases. In particular, such tools should provide improved quality of life for chronically ill patients, enabling them to stay at home

rather than have to be admitted to hospitals. With ICT systems able to monitor a range of parameters related to the patient's condition, medical professionals can take timely decisions on the most effective treatment. Automatic alerts ensure doctors are immediately made aware of changes in the patient's condition and can respond to prevent severe deteriorations.

This approach can also be used to improve mental health treatment. While most of us immediately think of either drugs or traditional talk therapy as the primary tools for mental health problems, there is a long history of using technologies for the diagnosis and treatment of psychological disorders. Specifically, PHS help us to connect on a level never seen in history; and for individuals less likely to seek professional help, they provide a confidential self-paced avenue towards change.

For these reasons, the FP7 decided to support ICT based research projects providing solutions for persons suffering from *stress, depression or bipolar disorders*. These projects should address the parallel development of technological solutions, as well as new management or treatment models based on closed-loop approaches. Emphasis will be on the use of multi-parametric monitoring systems, which monitor various metrics related to behavior and to bodily and brain functions (e.g. activity, sleep, physiological and biochemical parameters).

More, the required systems should aim at (i) objective and quantitative assessment of symptoms, patient condition, effectiveness of therapy and use of medication; (ii) decision support for treatment planning; and (iii) provision of warnings and motivating feedback. In the cases of depression and bipolar disorders, the systems should also aim at prediction of depressive or manic episodes. The solutions should combine wearable, portable or implantable devices, with appropriate platforms and services. Finally, they should promote the interaction between patients.

### **3. Personal Health Systems for Mental Health: the funded projects**

After a very demanding selection, the Commission provided financial support to the following four projects– Interstress, Monarca, Optimi and Psyche – that aim at using PHS based on virtual reality, biosensors and/or mobile technologies to improve the treatment of bipolar disorders, depression and psychological stress. Below there is a short description of their contents.

#### *3.1. Interstress*

“Psychological Stress” occurs when an individual perceives that environmental demands tax or exceed his or her adaptive capacity . According to the *Cochrane Database of Systematic Reviews* the best validated approach covering both stress management and stress treatment is the Cognitive Behavioural (CBT) approach.

Typically, this approach may include both individual and structured group interventions (10 to 15 sessions) interwoven with didactics. It includes in-session didactic material and experiential exercises and out-of-session assignments (practicing relaxation exercises and monitoring stress responses). The intervention focuses on:

- *Learning to cope better with daily stressors (psychological stress) or traumatic events (post traumatic stress disorder),*
- *and optimizing one's use of personal and social resources.*

CBT has undergone a very large number of trials in research contexts. However it has been less efficacious in clinical contexts and it has become obvious that CBT has some failings when applied in general practice.

INTERSTRESS aims to design, develop and test an advanced ICT based solution for the assessment and treatment of psychological stress that is able to address three critical limitations of CBT:

- *The therapist is less relevant than the specific protocol used.*
- *The protocol is not customized to the specific characteristics of the patient.*
- *The focus of the therapy is more on the top-down model of change (from cognitions to emotions) than on the bottom-up (from emotions to cognitions).*

To reach this goal the project will use a totally new paradigm for e-health - Interreality [4; 5] – that integrates assessment and treatment within a *hybrid environment, bridging physical and virtual world*. Our claim is that bridging virtual experiences – fully controlled by the therapist, used to learn coping skills and emotional regulation - with real experiences – that allows both the identification of any critical stressors and the assessment of what has been learned – using advanced technologies (virtual worlds, advanced sensors and PDA/mobile phones) is the best way to address the above limitations.

These devices are integrated around two subsystems - the *Clinical Platform* (inpatient treatment, fully controlled by the therapist) and the *Personal Mobile Platform* (real world support, available to the patient and connected to the therapist) – that will be able to provide:

- (i) Objective and quantitative assessment of symptoms using biosensors and behavioural analysis;
- (ii) Decision support for treatment planning through data fusion and detection algorithms; and provision of warnings and motivating feedback to improve compliance and long-term outcome.

By creating a bridge between virtual and real worlds, Interreality allows a full-time closed-loop approach actually missing in current approaches to the assessment and treatment of psychological stress:

- The assessment is conducted continuously throughout the virtual and real experiences: it enables tracking of the individual's psycho-physiological status over time in the context of a realistic task challenge.
- The information is constantly used to improve both the appraisal and the coping skills of the patient: it creates a conditioned association between effective performance state and task execution behaviours.

### 3.2. Monarca

Manic-depression psychosis also known as bipolar disease is a mood disorder characterized by alternating periods of mania and depression. The current methodologies of diagnosis of this disease are based on self-reported experiences, typically done after a crisis episode has elapsed, that intrinsically lack objectivity due to the patients' depressive or manic condition. The treatment of bipolar disorder is based on pharmacological and psychotherapeutic techniques often characterized by low compliance from patients.

In this scenario, MONARCA's aim is to develop and validate a closed-loop, multi-parametric approach to the treatment, management, and self-treatment of bipolar disorder disease and facilitate effective and efficient therapy that reduces costs and load of the health system while at the same time improving the quality of life of the patients. The main project objectives consist in:

- Bipolar disorder events assessment based on objective, measurable data.
- Continuous multi-parametric monitoring.
- Warnings on "risky" behavior (prevention of crisis).
- Increase of patients' awareness through self-monitoring and timely personalized coaching.

To reach these objectives, the MONARCA tools will be designed and tested for the assessment and prediction of episodes of bipolar disorder disease. The design and tests will be carried out with the patients and healthcare professionals involvement. The system will consist of 5 main components:

- A sensor enabled mobile phone.
- A wrist worn activity monitor.
- A novel "sock integrated" physiological (GSR, pulse) sensor.
- A stationary EEG system for periodic measurements.
- A home gateway.

Additionally, GPS location traces, physical motion information, and recognition of complex activities (nutrition habits, household activity, amount and quality of sleep) will be combined into a continuously updated behavioral profile that will be provided to doctors in a meaningful way to support treatment. The system will support both the patients through personalized interfaces, helping them to better manage their disease and the medical professionals to adjust the therapy.

### 3.3. *Optimi*

Depression and Stress related disorders are the most common mental illnesses and the prevention of depression and suicide is one of the five central focus points in the European Pact for Mental Health and Well Being. Currently the main treatments for mental illness are pharmacological and evidence based Cognitive Behavioral Therapy (CBT). However little is being done to develop effective systems for prevention of the onset of the illnesses.

OPTIMI (Online Predictive Tools for Intervention in Mental Illness) is based on the hypothesis that the central issue and starting point of longer-term mental illness depends on the individual's capacity and ability to cope with stress. Many of us are lucky not to be subject to daily stressful conditions that ultimately will result in changes to our biology and personality. Some are fortunate be able to cope with enormous real pressure. Many however are in high-risk situations where despite their best efforts, they decompensate and develop a depressive disorder.

With the aim of detecting the onset of a mental illness, OPTIMI:

- will identify the occurrence of high stress in the individual on a daily basis.
- will determine the ongoing effect of stress on the individual by studying the behaviour pattern over a longer period

- will also make estimates of the base line changes in the person's state of mind using measurements that closely link depression with cognitive, motor and verbal behavior.

OPTIMI will use wearable appliances based on EEG, EGG, Cortisol levels, Voice analysis, Physical Activity analysis and a self reporting Electronic Diary in order to identify stress coping behavior patterns.

The smart identification sensors that capture stress, specific behaviors and test results, will be enhanced with a knowledge based rule system to interpret the data and provide a diagnostic tool for both pharmacological and CBT based preventative and intervening treatments. OPTIMI will augment two existing computerized CBT systems to use these tools in real time to optimize the treatment cycle.

OPTIMI will conduct two phases of trials with volunteers at high-risk situations. The first phase being held in 3 countries (China, Switzerland, Spain) over 6 months will use the tools, develop and fine tune the algorithms against the gold standard of regular therapist interviews. The second phase in 2 countries (UK, Spain) will use the calibrated tools and a computerized CBT preventative treatment system to evaluate effectiveness in reducing the impact of stress to high risk people as well as the relapse after treatment for depression.

### 3.4. *Psyche*

One of the areas of great demand for the need of continuous monitoring, patient participation and medical prediction is that of mood disorders, more specifically bipolar disorders. Due to the unpredictable and episodic nature of bipolar disorder, it is necessary to take the traditional standard procedures of mood assessment through the administration of rating scales and questionnaires and integrate this with tangible data found in emerging research on central and peripheral changes in brain function that may be associated to the clinical status and response to treatment throughout the course of bipolar disorder.

In this scenario, PSYCHE project will develop a personal, cost-effective, multi-parametric monitoring system with the aim to treat and predict depressive or manic episodes in patient diagnosed with bipolar disorder by combining wearable and portable devices, with appropriate platforms and services.

PSYCHE project will develop a personal, cost-effective, multi-parametric monitoring system based on textile platforms and portable sensing devices for the long term and short term acquisition of data from selected class of patients affected by mood disorders. The project will develop novel portable devices for the monitoring of biochemical markers, voice analysis and a behavioral index correlated to patient state. Additionally, brain functional studies will be performed under specific experimental protocols in order to correlate central measures with the clinical assessment, and the parameters measured by Psyche platform. Specifically, will focus on the following objectives:

- Integration of sensors for physiological and behavioral data into a monitoring system for patients affected by bipolar disorders.
- Development of novel portable devices for the monitoring of biochemical markers, voice analysis and a behavioral index correlated to mental illness.

- Implementation of an integrated system to collect data from bipolar patients. Bipolar patients in different states of the illness (mania or depression episodes, remission) will be considered.

#### 4. Conclusions

PHS is a relatively new concept, introduced in the 1990s, that place the individual citizen in the centre of the healthcare delivery process. PHS can bring significant benefits in terms of improved quality of care and cost reduction in patient management, especially through applications for remote patient monitoring and disease management. The paper introduced four recently funded projects – Interstress, Monarca, Optimi and Psyche – that aim at using PHS based on virtual reality, biosensors and/or mobile technologies to improve the treatment of bipolar disorders, depression and psychological stress. The expected end outcome of these projects are :

- Increased mental health practitioners productivity (i.e. reduced patient unit cost through remote monitoring and self care).
- Reduced in-patient costs (i.e. due to delay of the time between when a disease becomes complex and chronic and the end of life or to the elimination altogether of the development of pre-morbid conditions into a full-blown disease);
- Decreased diagnostic and treatment costs as less visits will be needed as a result of both preventive monitoring and chronic disease management.

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