ICT4Depression

User-friendly ICT Tools to Enhance Self-Management and Effective Treatment of Depression in the EU

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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services).	
RE	Restricted to a group specified by the consortium (including the Commission Services).	
CO	Confidential, only for members of the consortium (including the Commission Services).	X

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1   Publishable summary

1.1   Project context and objectives

Within the domain of ICT support for health care, a lot of work has been devoted to treating *physical health problems* in an ICT-supported way such that it benefits the patient as well as the caretaker. Major efforts have been made to tackle the problem of the growing ageing population and research has focused on approaches whereby patients are assisted at home using ICT support (see for example the CAALYX project: http://caalyx.eu/). These approaches bring great advantages as the patients are monitored on a more continuous basis, whereas the caretakers can focus on those cases where they are most needed.

ICT systems supporting *mental health care* are, however, not widespread. The only ICT systems that have been developed in the past few years for the treatment of depression are internet-based. These internet-based treatments have been tested in a growing number of randomized controlled trials (Spek *et al*., 2007) and it has been demonstrated that these interventions are as effective as face-to-face psychotherapies for depression (Andersson *et al*., 2005). Apart from internet-based treatments, no ICT systems for improving the treatment of depression have been developed.

The overall aim of the project is to develop an intelligent (self-)support system for patients suffering from depression. Such a system can only be effective if it will be accepted by the patient and perceived as useful. Hence, the system should be as unobtrusive as possible and should provide sensible support. This leads to the two most important aims of the project: developing unobtrusive measurements of the behaviour of the patient and an intelligent analysis and communication of the progress. For the monitoring of activities, behaviour and state of the patient, a combination of novel techniques that all are beyond state of the art will be investigated. First of all, software and the necessary hardware extensions will be developed to detect the user's mobility and changes in his or her location using a mobile phone. This information will be used to derive conclusions about the activities a person is performing. Second, a discrete electronic medicine monitoring system will be further developed and integrated in the system. This component will be able to detect medicine intake used in the treatment of depression using a pill box and communicate this information via the cellular network to a server. Third, wearable biosensors will be developed that, together with signal processing algorithms, will be able to measure several reactions of the body to emotional changes, such as changes in the heart rate and breathing rate, and the sympathetic response observed at the sudation level of the hands. These measurements are also wirelessly communicated to a mobile phone. Finally, the mobile phone itself will be used to prompt the patient for a self-assessment of his mood and feelings, using an intuitive (graphical) interface. Together, these measurements will give a wealth of information about the state of a patient. Which measurements are useful in which phase of the therapy is an important research question to be answered in the project. In order to use the measurements for assessing the progress of the therapy and providing appropriate support, an intelligent analysis of the data is needed. Reasoning techniques will be developed for each form of therapy (e.g. the aforementioned psychoeducation, cognitive and behavioural therapies) that have knowledge about the phases of the specific therapies, the main factors that influence the success or indicate problems, the foreseen changes in the state of the patient, and the common problems that people encounter in following the therapy. Based on this, it will be possible to assess the progress of the therapy partly automatically. A significant part of this is that the risk of relapse will be determined. The assessment of the therapy will be used in the (self-support) system by providing the patient with motivational messages, reminders (for scheduled activities or medicine intake), and feedback about the progress and mood. This is partly done via the mobile phone, and partly via a personal website. Simple reminders and motivational messages are best suited for communication via the mobile phone, while a website is more appropriate for detailed progress feedback, such as diagrams of the changes in mood in the past period, or overviews of number of goals that have been met, etc. The feedback about the effect of their actions that is provided to the patient will stimulate them to maintain effective behaviour, or motivate them to change behaviour that is ineffective with respect to their therapy. The consequences of such changes will again be monitored and communicated to the patient.

1.2   Achievements so far

During the first year of the project, considerable achievements have been made.

First of all, usage scenarios for the system have been defined in the form of use cases, thereby making the overall expectation concerning the behavior of the system more concrete. Based upon the use cases, an overall architecture for the system has been designed, thereby addressing both the global structure of the system as well as the interactions between the measurement devices. In these interactions, the mobile phone is the central element. During 2010, all the interactions between the mobile phone and the other measurement devices have already been shown to function appropriately. Furthermore, first steps in the implementation of the overall framework have also been performed.

Next to the specification of the overall desired system behavior, progress has also been made in the transformation of the currently available therapies to the newly designed system, thereby taking advantage of all the new possibilities to monitor and communicate with the patient. Therapies that have been made, transformed and extended include (1) psycho education and motivation, (2) behavioral activation, (3) problem solving therapy, (4) cognitive restructuring, (5) exercise therapy, (6) medication use, and (7) relapse prevention. Due to the wealth of new possibilities and the uniqueness of the developed modules, some additional fine tuning of the modules is anticipated once first tests with humans have been performed (which will take place before an actual pilot study is performed with real patients).

One of the goals is to interact with the patient via the mobile phone, and measure the progress of the patient in an unobtrusive fashion. Therefore, considerable steps have been set to develop unobtrusive measurement devices. In this context, a first version of a GSM reader has been developed that is able to obtain information from a pill box equipped with sensors to measure the number of openings of the box, and forward information on medicine usage to the ICT4Depression system. Furthermore, a first version of a mobile phone application to display the treatment modules has been developed, which is set up in a very generic way to enable reuse of information. The first prototype that has been fully developed based upon the generic application, encompasses the module for problem-solving. Finally, the last device with respect to the measurements is the device measuring physiological signals of the human body. Especially for such a device, the non-intrusiveness is essential. Currently, two prototypes have been developed (see Figure 1), namely a chest strap (able to measure ECG, Respiration, and Acceleration) as well as a glove (measuring Electrodermal Activity and Blood Volume Pulse). Both have been developed based upon prior experiences and are as unobtrusive as possible. Both will be used to test with humans in a preliminary stage to get feedback on the suitability of both sensor devices.
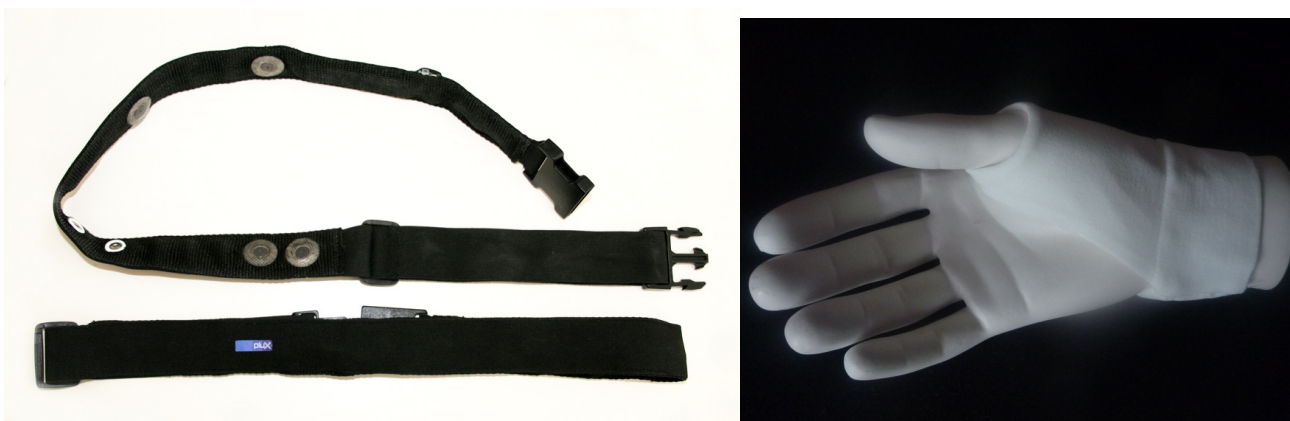

Figure 1: Prototype of chest strap and glove.

The final achievement that has been established is the first step towards an intelligent reasoning system that uses all the information obtained through the measurements, and gives intelligent support to the patient. This first step comprises of an approach that expresses the information which can be obtained through the sensor devices, and abstracts this information by means of an analysis of the information over time (by means of a

dedicated logical language). The result of this abstraction is a robust picture of the current state of the patient (i.e. how is the patient doing) as well as an idea of the therapeutic state (how well does the therapy work for this patient). This can then be used to trigger feedback to be sent to the patient as well as reasoning about the success of the current therapy and potential alternative therapies.

From a dissemination point of view, a number of accomplishments can also be noted. First of all, a website has been set up which provides information on the project, namely www.ict4depression.eu and a dedicated logo has been developed for the project. Furthermore, a number of the partners involved have announced the launch of the project on their website. A press release for the Netherlands has also been distributed via various channels, and a dissemination plan has been written. From a scientific point of view, several publications have already resulted:

- Abstracts at Med-e-Tel 2011: E. Tousset, P. Cuijpers, M. Klein, M. Hoogendoorn: Drug **Adherence data as input to an ICT-based system for the treatment of depression**. Luxembourg, G. D. of Luxembourg, April 6-8, 2011
- Both, F., Hoogendoorn, M., Klein, M.C.A., and Treur, J., **Computational Modeling and Analysis of Therapeutical Interventions for Depression**. In: Yao, Y., Sun, R., Poggio, T., Liu, J., Zhong, N., and Huang, J. (eds.), Proceedings of the Second International Conference on Brain Informatics, BI'10. Lecture Notes in Artificial Intelligence, vol. 6334, Springer Verlag, 2010, pp. 274-287.
- Both, F., Hoogendoorn, M., Klein, M.C.A., and Treur, J., **Computational Modeling and Analysis of the Role of Physical Activity in Mood Regulation and Depression**. In: Wong, K.K.W., Mendis, B.S.U., Bouzerdoum, A. (eds.), Neural Information Processing: Theory and Algorithms, Proceedings of the 17th International Conference on Neural Information Processing, ICONIP'10. Lecture Notes in Artificial Intelligence, vol. 6443. Springer Verlag, 2010, pp. 270-281.
- H. Silva, A. Lourenço, N. Paz, **Real-Time Biosignal Acquisition and Telemedicine Platform for AAL Based on Android OS**, Proc International Living Usability Lab Workshop on AAL Latest Solutions, Trends and Applications – AAL.

In addition, a significant number of oral presentations have been given.

1.3 Expected final results and potential impact and use

The following main results, impact and use are envisioned within the ICT4Depression project:
- It is the expectation of the ICT4Depression consortium that the ICT4Depression system will strongly improve disease management of patients diagnosed with depression through constant, real time monitoring of the condition of the patient and through providing feedback to both the patient and the caretaker when needed. This is a significant improvement compared to face-to-face psychotherapy were there is a large time-gap between consults, and to internet therapies that do not include continuous and real-time monitoring of progress. Moreover, the ability to monitor adherence to drug prescriptions included in the system in particular has the potential to significantly improve treatment outcomes.
- The ICT4Depression system will increase access to treatment for patients that are currently not treated. Firstly, many patients who need psychological treatment are not referred to specialists because their condition is not severe enough, while at the same time they cannot be treated in primary care. Secondly, a substantial group of patients who do have severe problems is not willing to be referred to specialised treatments. These patients might be treated using the ICT4Depression system since it has been proven that ICT solutions are more acceptable for these patients.
- Depression currently represents a major burden on the health systems due to high incidence, high mortality rates and high levels of service use. In addition absence from work and disability account for high economic costs. The system will enhance the effectiveness of the therapy, thus actually improving the quality of care available to European citizens while reducing the economic burden on the health system and society in general. Within the current study we will be able to make an estimate of the costs of the current treatment compared to existing treatments, but a full evaluation of cost effectiveness can only be made in the framework of a Randomized Controlled Trial. Such a study is beyond the scope of the present project.

- It is expected that the ICT4Depression system will strongly promote active participation of the patient in their treatment by giving them access to psychoeducation, cognitive and behavioral therapies, detailed information about the progress of their treatment, and fast feedback when that is needed for their therapy. Apart from strongly contributing to the empowerment of patients, we expect that this will increase compliance, decrease attrition, improve medication adherence, and result in better patients outcomes.
- Treatment providers will get quick access to an overview of the progress which the patient makes, and his or her adherence to their treatment. If adherence is low, or progress in terms of symptom relief is too slow, the treatment provider can change treatment type easily. The system will signal when a treatment change has to be made and will provide the best alternative treatment options. Furthermore, after successful treatment, the system will also provide (mobile phone based) relapse prevention interventions, which will also benefit both patient and treatment provider.
- Although a lot of effort has been devoted to the development of ICT-supported systems for treating physical health systems, ICT systems supporting mental health care are limited to internet-based treatments. The developments foreseen in the ICT4Depression are highly innovative and include:
  - several devices for monitoring activities and biosignals in a non-intrusive and continuous way;
  - adaptation of existing psychological treatments for depression for use in a semi-automatic setting, using mobile phone and web-based communication, and automatic assessment of the patient;
  - new computational methods for reasoning about the state of patients and the progress of therapies;
  - a flexible system architecture for monitoring and supporting people using continuous observations and feedback via mobile phone and the web.
- The ICT4Depression system will be developed using Web Services, which allows for the integration of heterogeneous systems. While the implementation of a SOA is not an innovative task per se, this effort has never been undertaken for the e-mental health and will contribute to the systematization of concepts, interfaces and encodings in this domain.

1.4   References

(Andersson *et al,* 2005) Andersson, G., Bergstrom, J., Hollandare, F., Carlbring, P., Kaldo, V., Ekselius, L. (2005). Internet-based self-help for depression: randomised controlled trial. British Journal of Psychiatry, 187, 456-61.

(Spek *et al,* 2007) Spek V, Cuijpers P, Nyklíček I, Riper H, Keyzer J, Pop V (2007). Internet-based cognitive behavior therapy for mood and anxiety disorders: a meta-analysis. Psychological Medicine, 37, 319-328.