CyberTherapy & Rehabilitation

Issue 1 / 2011

The Official Voice of iACToR

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Contact Lens with Integrated Sensors

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and much more...

ISSN 2031 - 278

Letter from the Secretary General and Editor-in-Chief

Professor Dr. Brenda K. Wiederhold

"A recent report summarizes: '[mHealth] will reduce financial strain throughout the system (providers, payers, and patients) while promoting far better overall health. In practice, edge care will enable better preventive care so that many patients will avoid major problems altogether.'"

Dear Reader,

In just two more years, people will access the Internet from their cell phones more often than from their PCs. Now that some of the early challenges such as compact-format data, data synchronization, and secure data transmission protocols have been met, patients and providers are looking to cell phones as a cost-effective delivery system to manage a variety of chronic conditions, including mental disorders.

Mobile health is variously known as mHealth, ubiquitous or pervasive healthcare computing, "edge" care (care in homes, workplaces, or mobile environments), or personal health systems. To be sure, health providers have been using handheld technology for almost 15 years to manage patients at nonclinical sites. Four years ago, the European Commission convened a Personal Health Systems conference, which attracted 400 participants. What is new in 2011 is the move to empower patients by putting mental health applications on their cell phones.

In an overview of the potential for wireless mental health monitoring, Varshney (2009) proposes that certain mental health conditions – such as posttraumatic stress disorder (PTSD), obsessive-compulsive disorder, panic disorder, eating disorder, and major depression — are particularly well suited to remote monitoring. A context-based algorithm could be used, for example, to weight activity monitoring and sleep monitoring variables that might suggest the possibility of PTSD.

The U.S. Army is made up of 86% males, and 68% of soldiers are less than 29 years of age – the profile of the typical smartphone user. The RAND study found that 14% of Operation Enduring Freedom/Operation Iraqi Freedom veterans screened positive for PTSD, 14% screened positive for major depression, and 19% reported a probable traumatic brain injury during deployment. The use of smartphones is perceived as a way to overcome the stigma attached to seeking mental healthcare for this highly mobile, computer-literate population. In addition to scheduling and reminder capabilities, smartphones are evolving into devices capable of delivering podcasts, engaging patients in game-like simulations, and providing automated assessments and other evidence-based tools. Smartphones can provide immediate self-management of mild symptoms, as well as immediate two-way contact with support systems during crisis.

In the U.S., insurance reimbursement is the biggest barrier to adoption, with Food & Drug Administration regulations, liability questions, and an entrenched healthcare establishment, among other barriers. Conversely, mHealth enablers include the rise in the number of smartphone users, next-generation wireless chips that will make healthcare delivery more seamless, algorithms enabling richer and more useful data sets, and the government's interest in wireless health. Indeed, support for wireless mental health was originally included in President Obama's healthcare plan.

Europe was ahead of the curve on mHealth, and today the European Union is supporting research

Letter from the Secretary General
(continued from page 1)

into personal health systems under the Seventh Framework Programme (FP7). The U.S. is catching up quickly, convening a Digital Health Summit at the January 2011 International Consumer Electronic Show. Today, there are about 5,000 health-related applications for smartphones.

"To be sure, health providers have been using hand-held technology for almost 15 years to manage patients at nonclinical sites ... What is new in 2011 is the move to empower patients by putting mental health applications on their cell phones ... Today, there are about 5,000 health-related applications for smartphones."

In both Europe and the U.S., the cost of caring for aging populations is a driver of mHealth. The total cost of chronic diseases in the U.S. is more than $1.4 trillion. By 2014, using mHealth, public and private payers may save up to $6 billion.

A recent report summarizes: "This new approach to healthcare will reduce financial strain throughout the system (providers, payers, and patients) while promoting far better overall health. In practice, edge care will enable better preventive care so that many patients will avoid major problems altogether. Patients will be far more knowledgeable about their own health status, and empowered and motivated to maintain their health. All of this should lead to greatly reduced spending while providing improved patient outcomes."

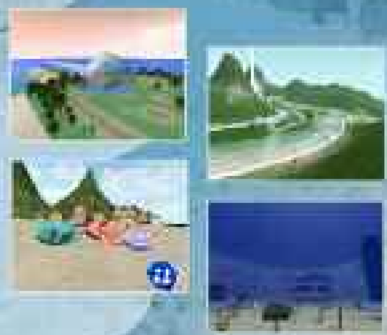
I invite C&R readers and researchers to look at the cell phone in your hand and embrace it as an extension of your arm, enabling you to begin to change eHealth into iHealth, truly individualized healthcare.

Create your own reality!
Brenda Wiederhold

The Virtual Reality Medical Center Provides

Pain Management

- Interactive Method of Treatment
- Fun and Exciting
- Create Your Own Experience
- Instant Therapeutic Feedback



Combat Medic Training

- Medical Skills Assessment
- Shallow Learning Curve
- Preparedness Enhancement
- Methodical Execution
- Instant Feedback

PTSD Treatment

- Benefitting Results
- Reclaim Normalcy
- Emotional Balance
- Sense of Clarity and Purpose

Rehabilitation System

- Fun and Entertaining
- Cost Effective
- Rapid Recovery
- Real Life Practice

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Wounds of War III: Coping with Blast-related Traumatic Brain Injury in Returning Troops

EDITED BY:
Professor Dr. Brenda K. Wiederhold, Ph.D., MBA, BCIA

WOUNDS OF WAR III: COPING WITH BLAST-RELATED TRAUMATIC BRAIN INJURY IN RETURNING TROOPS
On February 20-22, 2011 the NATO Advanced Research "Wounds of War III: Coping with Blast-related Traumatic Brain Injury in Returning Troops" drew over 30 eminent experts from 11 countries to discuss the topic of increased Traumatic Brain Injury (TBI) in our service men and women.

Held in Vienna, Austria at the Hotel Regina, discussion topics included increased TBI as a result of missions, as well as how TBI may be prevented. Research has shown that those who have served in both combat missions and peacekeeping operations are at an increased risk for TBI. The ultimate aim of the workshop was critical assessment of existing knowledge and identification of directions for future actions. The co-organizers of the workshop alongside Professor Brenda K. Wiederhold included Professor Kresimir Cosic, Professor Mark D. Wiederhold and Colonel Carl Castro.

Full papers were published with IOS Press
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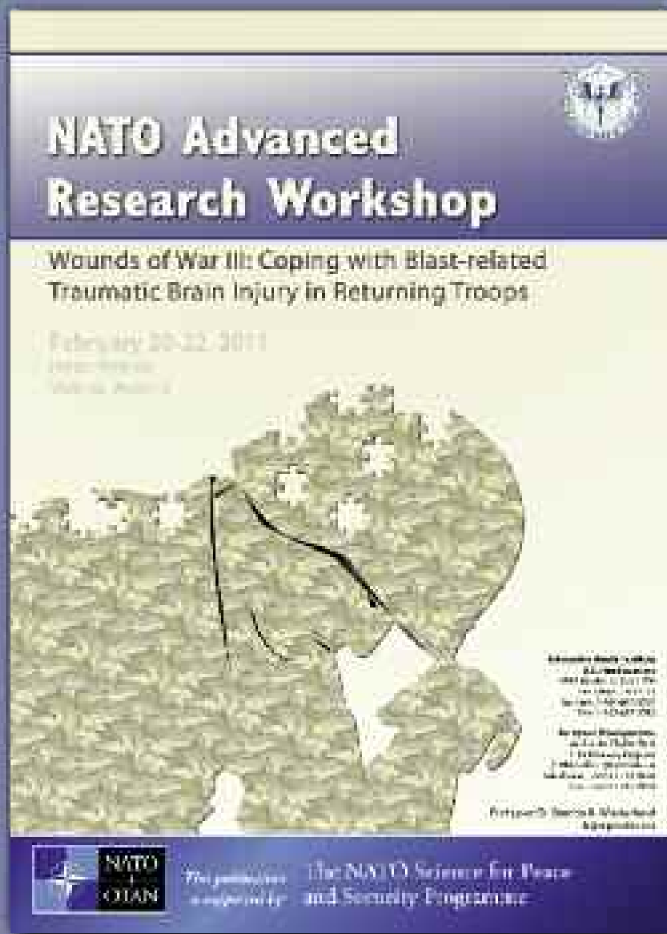

The post-conference book reflects the key topics discussed in the four sections at the workshop:

First session - Characterization of TBI
Second Session - Diagnostic and Assessment Issues Surrounding TBI
Third session - Treatment of TBI
Fourth Session - Quality of Life

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GENERAL INFORMATION

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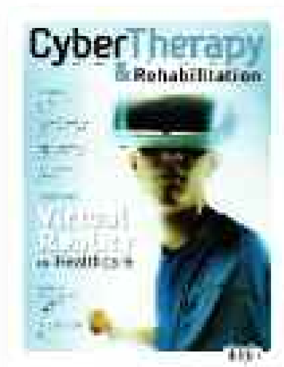

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Moving to "Patient-centric Care"

A key trend in personalized health systems is utilizing user-friendly devices for patients, such as the imec/Holst Centre 8-ch EEG wearable headset, above. Products using sensing technologies not only monitor health status, but also measure stress and other factors that may not be readily identifiable to the user. Increased wearability and ease-of-use continue to be areas in which huge strides are being made, while overall, helping to improve healthcare.

Advancements in Telehealth

The use of ICT-based devices such as the TeleMedCare system, above, not only help to keep caregivers updated on patient status and health conditions, as well as lessen their workload, but also provide patients with a sense of control and empowerment since they can monitor their condition from their own home. Self-monitoring has been shown to be an important factor in improvements in health outcomes.

Conference Participation Report Spring 2011

Medicine Meets Virtual Reality 18 Conference

Newport Beach, California
February 8-12, 2011

The 18th annual Medicine Meets Virtual Reality (MMVR) conference was held February 8-12, 2011 at the Newport Beach Marriott Hotel and Spa in Newport Beach, California.

MMVR18 offered an opportunity for attendees to discuss their virtual reality (VR) modalities in medicine, mental health, rehabilitation, robotics, engineering, biomedicine and education. Many mental health providers met to share their efforts using VR and advanced technological approaches in clinical and research settings.

Dr. Jim Spira led a one-day workshop addressing "VR Assisted Exposure Therapy in PTSD." Here, he works with a clinician to familiarize him with a VR system.

In addition, the iACToR Military SIG and the Interactive Media Institute co-organized a one-day VR and physiology clinician training workshop entitled "VR- Assisted Exposure Therapy in PTSD." The American Psychological Association Continuing Education (APA-CE) workshop, conducted by Dr. James L. Spira, was very well received and aimed to introduce clinicians to the use of VR to facilitate exposure-based treatment of PTSD, including combat-related and civilian

MMVR18 offered an opportunity for those attending to discuss their virtual reality (VR) modalities in medicine, mental health, rehabilitation, robotics, engineering, biomedicine and education.

forms of the condition. Major approaches discussed included maintaining maximum exposure and arousal, gradual exposure (to be used with physiological monitoring and feedback to achieve systematic desensitization) and training in attentional engagement and arousal control (such as stress inoculation training.)

A number of iACToR members, as well as board members from C&R and the Journal of CyberTherapy & Rehabilitation, were in attendance during conference proceedings, and enriched the meeting with their contributions and presentations on their current lines of research.

Prof. Giuseppe Riva's research group presented a poster titled, "NeuroVR2 – A Free VR Platform for Assessment and Treatment in Behavioral Health Care." The NeuroVR2 allows users to adapt the content of 14 pre-designed virtual environments to the specific needs of the clinical or experimental setting. Additionally, Major Melba Stetz organized a session on "VR for Psychology's Clinical and Research Use", and Dr. Dennis Patrick Wood presented a paper titled "VR Graded Exposure Therapy with Physiological Monitoring for the Treatment of Combat Related PTSD." This study, funded by the Office of Naval Research, was completed by the Virtual Reality Medical Center and the Naval Medical Center San Diego. Participants who engaged in 10 90-minute VR sessions showed a significant reduction in the severity of their PTSD symptoms.

Two projects currently funded by ICT for Health, European Commission, teamed up as well for a symposium. Members of INTERSTRESS (Interreality in the Management and Treatment of Stress-Related Disorders) and OPTIMI (Online Predictive Tools for Intervention in Mental Illness) presented their projects to conference attendees. Chaired by Prof. Giuseppe Riva, the symposium was intended to enlighten attendees on research advances being made in Europe with new tools and technologies. Other members of the symposium were Prof. Rosa Banos, Prof. Cristina Botella, Prof. Andrea Gaggioli, and Prof. Brenda K. Wiederhold. An abstract of the resulting MEDLINE-indexed paper is now published and discusses INTERSTRESS, Monarca, OPTIMI, and Psyche (all funded by ICT for Health). To view the abstract, please visit http://www.ncbi.nlm.nih.gov/pubmed/ 21335846.

The success of the 18th MMVR conference further affirms the fact that VR is quickly gaining ground in many different areas of research and application. C&R is proud to be a part of these developments and meetings involving top researchers from around the world. For more information on the conference, please visit www.nextmed.com.

Members of the symposium included Prof. Giuseppe Riva, Prof. Rosa Banos, Prof. Cristina Botella, Prof. Andrea Gaggioli, and Prof. Brenda K. Wiederhold.

NATO Wounds of War III

Coping with Blast-related Traumatic Brain Injury in Returning Troops

Vienna, Austria/ February 20-22, 2011

The third NATO Wounds of War Advanced Research Workshop, entitled "Coping with Blast-related Traumatic Brain Injury (TBI) in Returning Troops," was held February 20-22, 2011 at the Hotel Regina in Vienna, Austria. The workshop was the third in a series of successful workshops that aim to address "invisible" injuries sustained as a result of both peacekeeping and combat missions, including "Wounds of War I: Lowering Suicide Risk in Returning Troops," held October 14- 17, 2007 in Südkärnten, Austria, and "Wounds of War II: Posttraumatic Stress Disorder," held October 19- 21, 2009, also in Südkärnten, Austria.

The workshop, organized by the Virtual Reality Medical Institute (VRMI) (Belgium) and the Interactive Media Institute (IMI) (USA), was convened to discuss TBI topics including characterization, diagnostic and assessment issues, treatment, including cutting-edge technologies being implemented and tested at this time, and quality of life of those affected by TBI. The workshop drew 35 top-level participants, representing 10 NATO and PfP countries.

Professor Dr. Brenda K Wiederhold, IMI and VRMI, and Professor Dr. Walter Mauritz, International Neurotrauma Research Organization served as Co-organizers and Professor Dr. Kresimir Cosic of the University of Zagreb, Croatia, Colonel Dr. Carl Castro of the United States Army Research and Materiel Command, and Professor Dr. Mark D. Wiederhold of the Virtual Reality Medical Center, San Diego, California served on the Program Committee. Additional sponsors included NATO, the Virtual Reality Medical Center, Social Welfare Croatia, the Austrian Worker's Compensation Board, the United States Army Medical Research and Materiel Command, the Austrian Ministry of Defence and the International Neurotrauma Research Organization.

The fourth WoW workshop, "Pain Syndromes – From Recruitment to Returning Troops," is scheduled for June 3-5, 2011 in Salzburg, Austria. A fifth workshop will focus on Military Families and a sixth on Substance Abuse. For further information, please visit: www.interactivemediainstitute.com/conferences.

Blue Helmet Forum Austria 2010

Stress Management and Peace Soldiering

Vienna, Austria/ October 5-7, 2010

The annual Blue Helmet Forum Austria (BHFA) took place October 5-7, 2010 in Vienna, Austria. The conference, organized by the Association of Austrian Peacekeepers in cooperation with the Austrian Ministry of Defence, focused on "Stress Management in Peacekeeping" and discussed different types of stress and ways to manage stress as it relates to international peace operations.

General (ret) Günther Greindl and General Raimund Schittenhelm, Commandant of the National Defence Academy, opened the forum by addressing international participants including researchers, experts, and practitioners. Overall, issues discussed included preventative psychological care; ways in which pre-deployment training can better teach soldiers to effectively manage stress, new therapies to treat stress, and lasting psychological effects on the military population, as well as the civilian population.

On the topic of pre-deployment training, Dr. Brenda K. Wiederhold presented a paper on "Pre-Deployment Stress Inoculation Training" in which virtual reality is used to prevent or attenuate stress-related reactions soldiers face during deployment.

The conference series continues to promote Austria's engagement in peacekeeping activities and works to promote societal ideals as outlined by the United Nations. This year's conference will be held September 21-23, 2011. More information can be found at www.austrian-peacekeepers.at/content/content15.html.

News from iACToR Members

Organization grows worldwide as Special Interest Groups/Regional Chapters are established

As the official association of CyberTherapy & Rehabilitation, we will be bringing you updated news of various special interest groups and regional chapters of the International Association of CyberPsychology, Training & Rehabilitation as they grow and expand throughout the year. As the organization becomes more well-established, it is further strengthened by growing numbers from around the globe. We welcome iACToR members, as well as our readers, to submit content and updates, as well as suggestions for new groups. You can do so by reaching the Managing Editor at office@vr-phobia.eu.

Mexican iACToR Chapter

Information provided by Georgina Cardenas

The Virtual Teaching Cyberpsychology Laboratory was founded by Georgina Cárdenas, Ph.D., on April 23, 2001 as a Research, Education and Clinical Unit of the Faculty of Psychology of UNAM. The main purpose of this laboratory is to create shared participative knowledge for the incorporation of advanced technologies to the virtual teaching of psychology and psychological treatments for the solving of individual and collective problems.

The Virtual Teaching Cyberpsychology Laboratory has research projects devoted to the technological development and research in psychology, such as the: "Development and Evaluation of Virtual Reality Technology Based Systems for Anxiety Disorders, the "Development and Evaluation of Expert Systems for the Teaching of Professional Competencies in Psychology" and the "Online Teaching of Professional Competencies for Domestic Violence Interventions."

One of the principal objectives of the lab is to open new research lines devoted to technological development and research in psychology, focusing on solving and addressing psychological problems of high social relevance. For example, the case of Posttraumatic Stress Disorder in victims of criminal violence, and the treatment of Complicated Grief and Depression in residents of Cd. Juarez, among others. It is also an aim of the lab to collaborate with other groups and institutions from different countries, and to create collaborative interdisciplinary groups.

The lab is currently made up of 26 members including professors, researchers, graduate students and undergraduate students who continue researching and using advanced technologies and Virtual Reality in a variety of fields. These individuals are highly motivated in developing virtual environments and analyzing patterns of human behavior, as well as communicating and collaborating with other scientists.

Stay abreast of new topics and technology by following or joining the gorup on http://iactor.ning.com.

Student Special Interest Group

SIG Leader: Willem-Paul Brinkman

The International Association of CyberPsychology, Training & Rehabilitation's Student Special Interest Group supports fellow students with their research and education in this area. Our members are primarily students, but membership is also open to other iACToR members that like to help students to become professionals.

The group aims in connecting students and encourages the exchange of information among members that are of interest to students, dealing with issues such as conducting research, publishing your work or developing a career in this area. Furthermore, the group also helps in bringing members in contact with the leaders of the community. It promotes the interests of students in general, and specifically in the association, the events it organises or endorses.

By joining the group, you will have access to online material relevant for students. You will be able to develop your international network, and have an opportunity to interact with your peers.

Become a member today by joining the Student Special Interest Group on http://iactor.ning.com.

Military Special Interest Group

SIG Leaders: Melba Stetz and Dennis Wood

The Military iACToR Special Interest Group (SIG) recently met during the Medicine Meets Virtual Reality 18 Conference (MMVR) held February 8-12, 2011 at the Newport Beach Marriott Hotel & Spa, Newport Beach, CA (USA) to discuss their virtual reality (VR) modalities in medicine, mental health, rehabilitation, robotics, engineering, biomedicine and education.

Additionally, in a recently completed study at Naval Medical Center San Diego and Naval Hospital Camp Pendleton (USA), Robert N. McLay et al. investigated the effects of VR Exposure with Arousal Control (VRE-AC) versus Treatment As Usual (TAU) for combat-related PTSD. Result suggests that VRE-AC can be a useful modality in treating combat-related PTSD. Of note, this study will be published in Cybertherapy, Behavior and Social Networking in April, 2011.

Dr. Spira and Dr. Stetz, with the help of other VR "gurus," plan to collaborate on a study investigating Performance Improvement/Quality Project at the Department of Psychology of the Tripler Army Medical Center, Hawaii. This project will aim to create a "VR stand-alone station" where clinicians and mental health students can learn/re-learn to integrate VR and biofeedback technology into their sessions.

To read about how VR therapy may assist in the treatment of combat-related PTSD and to hear an audio interview with Dr. Robert McLay (CDR MC USNR), please access the following web page: http://www.medpagetoday.com /MeetingCoverage/APA/20309.

Stay abreast of new topics and technology by joining the Military Special Interest Group on http://iactor.ning.com.

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Personalized Health Systems Today

"Personalized Health Systems encompass an array of different eHealth technologies that range from electronic health records, to body monitors and implantable systems, all of which have helped improve healthcare, especially with an aging population and prices of treatment constantly rising."

By Mark D. Wiederhold & Brenda K. Wiederhold

Innovations in technology have aided healthcare throughout the world in diverse ways such as developing new methods for prevention, rehabilitation or surgery, and have alleviated some of the pressures put on healthcare systems to treat a rapidly increasing population. eHeath especially has grown throughout the years and is a main area of study for many trying to make healthcare more efficient and less expensive for both patients and healthcare providers. The development of Information and Communication Technologies (ICT), which uses telecommunications to transfer information and communicate easier and faster than ever before, has allowed eHealth to branch out into personalized methods of treatment that are both cost efficient and more individually designed to patients allowing for more accurate care and independence. Personalized Health Systems encompass an array of different eHealth technologies that range from electronic health records, to body monitors and implantable systems, all of which have helped improve healthcare, especially with an aging population and prices of treatment constantly rising.

Electronic Health Records

Electronic health records have slowly edged their way into the medical system, replacing paper documentation and all forms of administrative information. Electronic health records make data storage more organized and help to cut down on time and space needed to collate and file paper documents. It also makes transporting records less time consuming, as well as allows for multiple copies to be created more efficiently and is less expensive than duplicating paper records. Furthermore, electronic health records would also give patients better access to their own health information because the records can be sent directly over the Internet. Administrative tasks would also be made easier, since scheduling and follow-ups could be easily updated on a computer database, and would allow doctors to order prescriptions, tests, and lab results with the click of a button. Although electronic health record programs have been around for the past few decades, many healthcare providers are reluctant to adopt the new system. Unfamiliar with how the system works, many would require technical training in order to use the programs, and maintenance and system incompatibility have turned some away from using electronic health record systems. Another important issue circulating is the concern for privacy. With everything digitalized, unauthorized access of medical records is harder to manage and could threaten patient privacy. However, despite these potential setbacks, electronic health records provide a more cost and space efficient alternative to paper records that is growing in popularity, and making shared information more accessible.

Medical professionals and researchers are also striving to create a collection of all data pertaining to the human body on a large online database called the Virtual Physiological Human (VPH). The framework would be all encompassing, not separating information by discipline or regions of the body, and would provide intersecting studies of both patient-specific and general data. This will be used a reference tool that would help provide the most comprehensive and thorough treatment possible, and will grow along with the medical field.

Wearables and Remote Monitoring

ICT has also paved the way for more convenient methods of monitoring patients outside medical facilities by improving medical wearable devices. Medical wearables can be as simple as a bracelet imbedded with a microchip that contains a person's medical information, to more complex tools and devices like clothing and bio-medical sensors that constantly measure vital signs such as temperature, heart rate, and glucose levels. Patient monitoring through wearable body sensors previously relied on devices that collected data off-line. However, ICT technologies now allow for data to be collected wirelessly. Personal and body area networks (PAN/BAN) bypass uncomfortable wires that accompanied traditional body sensors, and transmit data wirelessly to a medical profile in real-time, storing the data in one place. These wireless intelligent sensor networks (WISE), have given doctors the ability to monitor patients from remote locations, cutting down on related costs and time for doctor's visits and hospitalization, while giving patients more freedom to live independently, despite having an otherwise debilitating medical condition. Remote monitoring can be used for a number of different conditions ranging from high blood pressure, diabetes, and heart attack, to keeping an eye on post-surgical patients and the elderly.

MyHeart, a European collaborative project funded by the European Commission, is in the process of developing a monitoring system for cardiovascular diseases (CVD). Billions of dollars have already been spent to help treat CVD, a leading cause of death in the west, and MyHeart strives to cut costs through preventative monitoring. Early detection is key in fighting CVD. MyHeart provides patients constant monitoring through the use of pressure sensors in textiles, for example, on bed linens to monitor breathing habits while users are sleeping, and t-shirts equipped with ECG electrodes, called intelligent biomedical clothes. MyHeart gives a personalized reading of patients' condition, allowing for treatment aimed at helping patients' specific condition to be improved, and will help make diagnoses and prevention easier. Feedback devices linked to the sensors will also give patients the power to self-monitor, as well as allow healthcare professionals to monitor patients remotely, making treatment more affordable and efficient.

Some monitoring devices, like the EU-funded REACTION which measures glucose and insulin levels of diabetes patients, will trigger an emergency alarm alerting a physician when vitals reach a dangerous level for the patient, ensuring immediate care. This allows patients to live more comfortably knowing that their condition is constantly being watched by their doctor. Treatment is further enhanced since a patient's medical profile is always being recorded and updated, allowing physicians to devise a more individualized treatment plan for specific conditions.

"... future projects will continue to seek ways to increase patient autonomy so that they can live uninhibited by medical conditions."

Mental Healthcare

Mental healthcare sectors have also benefited from improved remote monitoring systems and medical wearable technology. Bio-medical sensors can be designed to measure vitals linked to depression, and also can be designed to monitor eating habits, daily activities, and sleep habits, like the MONARCA project (MONitoring, treAtment and pRediCtion of bipolAr disorder episodes), that help to regulate and treat bipolar disorders. Others utilize Virtual Reality (VR) technologies to help treat psychological disorders. The EU-funded project INTERSTRESS (Interreality in the Management and Treatment of Stress-Related Disorders), utilizes Interreality (a combination of VR and monitoring systems) to help assess and control psychological stress. INTERSTRESS monitors patients' emotional and physical activity with biomedical sensors while immersed in a virtual world. The goal is that real life behavior and experiences in the virtual world will influence each other so that over time the patient will learn to cope with stress using what is learned in the virtual environment. It can be used in a clinical setting along with an immersive VR world, and also at home or on-the-go through mobile phones and the Internet, allowing for more immediate care.

Implantable systems and the Future of ICT

One of the next steps in ICT is developing implantable systems capable of wirelessly transmitting data. Current implantable medical devices are able to monitor and treat conditions, like the Implantable Cardioverter Defibrillator (ICD) which detects heart arrhythmias and sends low to high electrical impulses to the heart when necessary to restore a normal heart rhythm. However, these systems are limited in their monitoring capabilities. ICT systems will allow medical professionals to remotely monitor a patient's condition, as well as control the device itself. The P.CÉZANNE project is in the process of producing an implantable nano-sensor device that constantly monitors blood glucose levels in diabetes patients and stores the data through wireless transmission to a mobile device. It will also be capable of regulating glucose through an insulin pump linked to the device, releasing insulin into the body when needed.

The P.CÉZANNE project is only the start of technologies of this nature and future projects will continue to seek ways to increase patient autonomy so that they can live uninhibited by medical conditions.

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MONARCA: An Innovative Approach to Bipolar Disorder Treatment

Those suffering from bipolar disorder lose an average of 13.1 years of their productive life. The MONARCA project employs cutting-edge technology to improve methods for assessment, treatment and self-management using such components as an activity monitor worn on the wrist and a sensor-enabled mobile phone. The project's innovative approach is discussed.

By Oscar Mayora Ibarra

Bipolar disorder, also known as Manic-Depressive illness, is the sixth leading cause of disability in the world according to the World Health Organization. Statistics show that people affected by bipolar disorder lose, on average, 13.1 years of their productive life as a consequence of the illness. Moreover, Unipolar major depression is considered the leading cause of disability worldwide with 43 years lost in terms of productivity. Therefore, there is a clear need to manage and reduce the negative impact that these diseases have on social and economic spheres.

Bipolar disorder is diagnosed in around 1% of the European population, 2.6% of the population in the U.S., and at least one alternate manic-depressive episode occurs in around 10% of the world population during their lifetime.

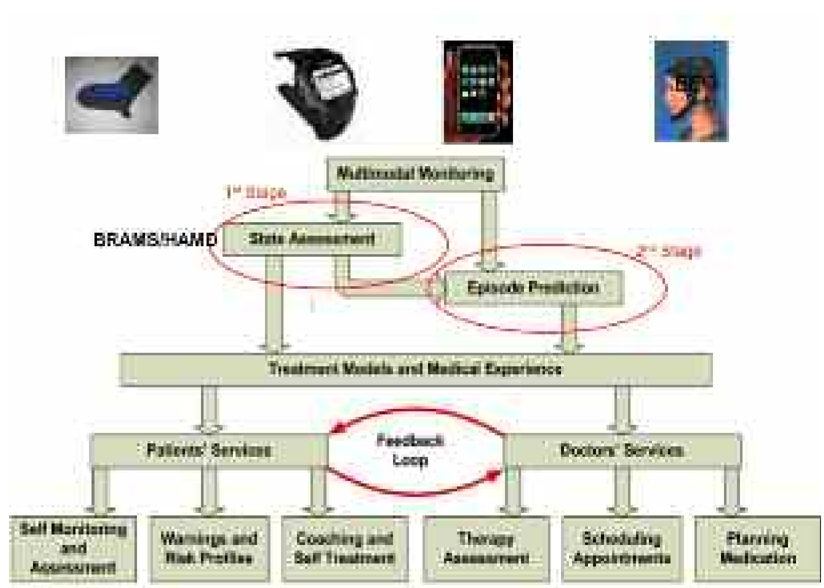

Figure 1: MONARCA Approach.

For these reasons, the European Commission decided to finance research efforts targeted at supporting therapy and self-management of people suffering from bipolar disorder.

An example of this is the recently funded EU project MONARCA (MONitoring, treAtment and pRediCtion of bipolAr disorder episodes) coordinated by CREATE-NET Research Center with the collaboration of several international partners (EC Funding of near 4 Million Euro). MONARCA is thoroughly investigating aspects of bipolar disorder by adopting a holistic approach to assessment, treatment and self-management of the disease. The project focuses on objective assessment and prediction of bipolar disorder episodes and aims to further advance the discovery of new markers for this disease.

The project utilizes state-of-the-art methodologies for treating Bipolar Disorder based on pharmacological, psychotherapeutic methods and clinical scales (e.g. BRAMS, HAMD, self assessments); developing and validating a multi-parametric, closed-loop approach to improve the treatment, management, and self-treatment of bipolar disorder disease.

Table 1: Comparison of State-of-the-Art Approaches vs. the MONARCA Approach	
State-of-the-Art Approach	**MONARCA Approach**
Assessment based on self-reported experiences typically after crisis (intrinsically subjective data)	Assessment based on objective, measurable data
Sporadic assessment through interviews	Continuous state assessment through multi-parametric monitoring
Difficulty to assess trends in the short term (implies actions only after manic/depressive episodes)	Timely warnings on "risky" trends (Prevention of crisis)
Low adherence for self-management of the disease	Increase awareness through self- monitoring and timely personalized coaching

MONARCA is an innovative system, which consists of five main components – a sensor-enabled mobile phone, a wrist-worn activity monitor, a novel sock integrated-physiological sensor (GSR, pulse), a stationary EEG system for periodic measurements and a home gateway. MONARCA will combine GPS location traces, physical motion information, and recognition of complex activities (eating habits, household activity, amount and quality of sleep) into a continuously updated behavioral profile that will be provided to doctors in a meaningful way to support treatment. The information based on sensing technologies will be used as an objective basis for discovering trends and predicting episodes of bipolar disorder.

"MONARCA will combine GPS location traces, physical motion information, and recognition of complex activities ... into a continuously updated behavioral profile that will be provided to doctors in a meaningful way to support treatment. The information based on sensing technologies will be used as an objective basis for discovering trends and predicting episodes of bipolar disorder."

In this manner, the patient's medical record will correspond more accurately with the patient's condition and medical staff can elaborate their diagnosis based not only on self-reported experiences by the patient, but also on objectively measured information sourced from the physical and physiological sensors.

The MONARCA system includes a closed-loop approach between patients and medical staff realized through purpose-built interfaces. On one hand, people affected by bipolar disorder will be aided by mechanisms of self-assessment, provision of warnings and risk profiles through persuasive interaction and coaching to support self-treatment. On the other hand, the medical staff will have access to interfaces for interpreting patient data, therapy assessment, medication planning and scheduling visits tools, developed by the project (see Fig. 1).

In order to become a useful tool for patients and doctors, MONARCA's research effort is based on close collaboration with two hospitals who are partners of the project, namely Psychiatric Center Rigshospitalet (Denmark) and Psychiatric State Hospital of Tirol (Austria), allowing patients and doctors to be involved from the early stages of the project.

In this way, patients and therapists can interact with researchers and provide their feedback and requirements about usability and interaction with the system in order to maximize system adoption and give patients an active role in the decision-making and self-management of their disease. The main contributions of MONARCA beyond state-of-the-art of management of Bipolar Disorder disease are shown in Table 1.

Overall, the expected results of the MONARCA project include:

- Accurate assessment of bipolar disorder episodes through objective monitoring
- Prevention of crisis episodes through event prediction algorithms
- Identification of main and eventually new markers for diagnosis and treatment of bipolar disorder
- Support caregivers for handling treatment and risk situations
- Improve patients' self-management of the disease
- Positively impact in reduction of healthcare costs
- System validation through dedicated trials in two European countries

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Wearable Health "Companions"

"Key trends [in healthcare] include the evolution from disease centric to patient centric care, the delocalization of care from hospitals to home, and a focus on prevention rather than cure. This paradigm shift calls for new technologies to enable ubiquitous personal health. Body Area Networks play an important role in enabling this change by providing people with wireless wearable solutions ideal for personal health and lifestyle monitoring."

By Linsdsay Brown & Julien Penders

Healthcare systems are changing in response to new demographic factors including an aging society, increasing number of chronic diseases and a growing interest of individuals in managing their own health. Key trends include the evolution from disease centric to patient centric care, the delocalization of care from hospitals to home, and a focus on prevention rather than cure. This paradigm shift calls for new technologies to enable ubiquitous personal health. Body Area Networks play an important role in enabling this change by providing people with wireless wearable solutions ideal for personal health and lifestyle monitoring.

Using commercially available cardiac telemetry systems such as the Corventis NUVANT system, patients' ECG can be continuously remotely monitored, with any adverse events being recorded and a physician notified for immediate care. These systems enable long-term patient monitoring out of the hospital environment, resulting in a higher quality of life for the patient.

Towards more assistive technologies, brain computer interfaces have taken a step further beyond simply monitoring and provide integrative functions for the patient. Today's brain computer interfaces can interpret commands such as yes/no, and control machine response through changes in the level of concentration. Companies such as Emotiv and Neurosky exploit the same principle for improving the gaming experience.

Figure 1: mec/Holst Centre 8-ch EEG headset.


Images credit: imec/Holst Centre

Figure 2: The emotionally-responsive photo frame changes the intensity of the light according to the level of stress detected through wireless physiological sensors worn by the user. When highly stressed, the light intensity causes the user to look at the photo frame and at the photo of their family/loved ones. This will enable them to relax and reduce the stress intensity, in turn lowering the intensity of the light.

In an effort to take EEG to the home environment, imec reported a wearable EEG headset (see Fig. 1) integrating dry electrodes. The EEG headset electronics have been optimized to cope with the specific challenges associated with dry electrodes, such as very high and varying input impedance. Optimized, ultra-low-power electronics achieve over three days autonomy while wirelessly recording brain-waves.

Body area network technology is not limited to providing health monitoring and assistive functions. Research on cognition and information processing shows that physiological activity contains much more information than a physiological state or mental choice. Tapping into this information enables personal health devices to go beyond merely measuring activity and become health companions. For example, combining measurements of sleep with external factors such as caffeine intake, the My Zeo sleep coaching system allows users to monitor and improve their quality of sleep, in much the same way a person improves their fitness by exercising. The My Zeo system also provides interpretative functions in real time that enable the user to be woken up "smartly." Using a different combination of sensors, a stress monitor may measure the physiological state related to stress and emotions. Employed appropriately, devices such as this can be used in many applications where stress and emotions influence actions and choices. For example, a stress monitor can be used to provide biofeedback on stress levels, enabling the user to maintain appropriate stress levels. Another example is a responsive photo frame that reflects the user's level of arousal in real time using physiological measurements from wearable body area network sensors (see Fig. 2).

While providing excellent wearability and ease-of-use, often today's devices are faced with making a trade-off between the overall wearability and ease-of-use of the system with the quality and accuracy of the signals and overall system. Current dry-electrode technology allows signals to be measured accurately at rest; however, challenges remain in their use during movement. Developing techniques for reducing motion artifact will enhance the robustness to motion artifact and thus overall accuracy during daily life activities. Similarly, often complicated algorithms are used in the interpretation of information, requiring high-computing power supplied only by a desk-top based device. Developing capabilities to process and integrate information at the sensor will enable local feedback to be provided directly by the wearable device. Further, today's body area network devices are still limited to easy-to-measure signals such as ECG and skin conductance. Novel sensing technologies are needed to reliably measure more complex parameters such as chemical compounds and hormones, enabling greater insight into the physiological activity and condition. While these challenges seem trivial, they are made more complicated by the need to make these advancements in a way that further reduces power consumption beyond current levels. By reducing overall consumption, the autonomy of the wearable sensors is greatly increased, ensuring minimal maintenance by the user. And finally, while wearable today, future improvements in device integration and miniaturization combined with the added intelligence and reduction of power consumption, will enable the wearable sensors to become truly ubiquitous.

Imec's Body Area Network research program addresses these key technology challenges with research focused on micro-power generation and storage, ultra-low-power radios, ultra-low-power DSPs, ultra-low-power sensor technologies and advanced electronic integration. The ultimate target is a wearable device that can be used at home, in the office, in the car, anywhere, providing functions that enhance the users' quality of life in health and/or lifestyle applications. That will become your health companion.

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Interstress Project:

The Use of Advanced Technologies for Assessing and Treating Psychological Stress

"What if lowering your stress level was as easy and as much fun as playing a video game? What if all of the work was automated for you, with reminders on your mobile phone? What if the system that achieved this was so smart it changed the program the second you changed your behavior?"

By Giuseppe Riva, Brenda K. Wiederhold & Andrea Gaggioli

What if lowering your stress level was as easy and as much fun as playing a video game? What if all of the work was automated for you, with reminders on your mobile phone? What if the system that achieved this was so smart it changed the program the second you changed your behavior?

This is the vision we used to outline a new project funded by ICT for Health, European Commission. Called Interreality in the Management and Treatment of Stress-Related Disorders, or INTERSTRESS for short, the project aims to design, develop, and test an advanced ICT-based solution for the assessment and treatment of psychological stress.

"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 Behavioral (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:

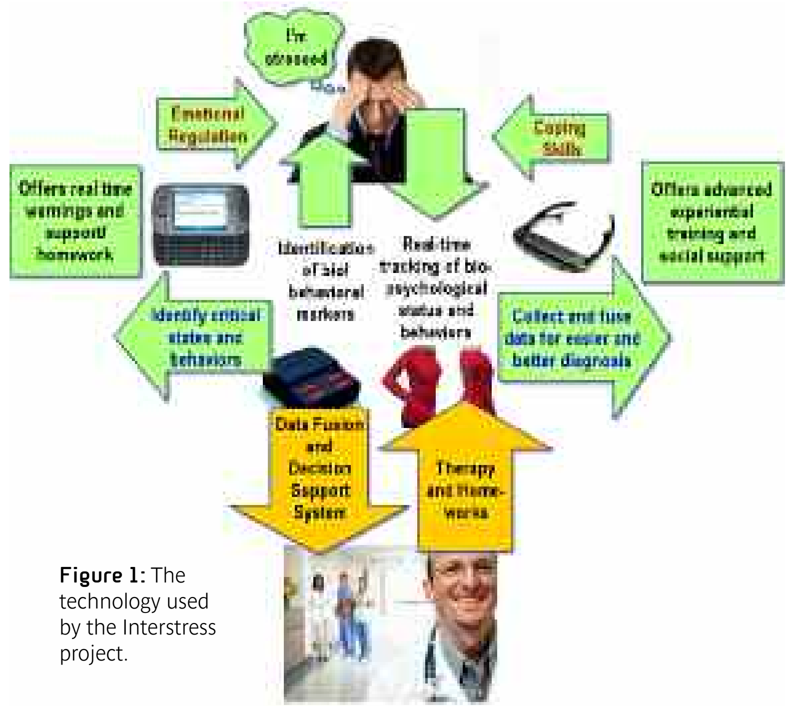

Figure 1: The technology used by the Interstress project.

• Learning to cope more effectively with daily stressors (psychological stress) or traumatic events (post traumatic stress disorder)

• Optimizing one's use of personal and social resources

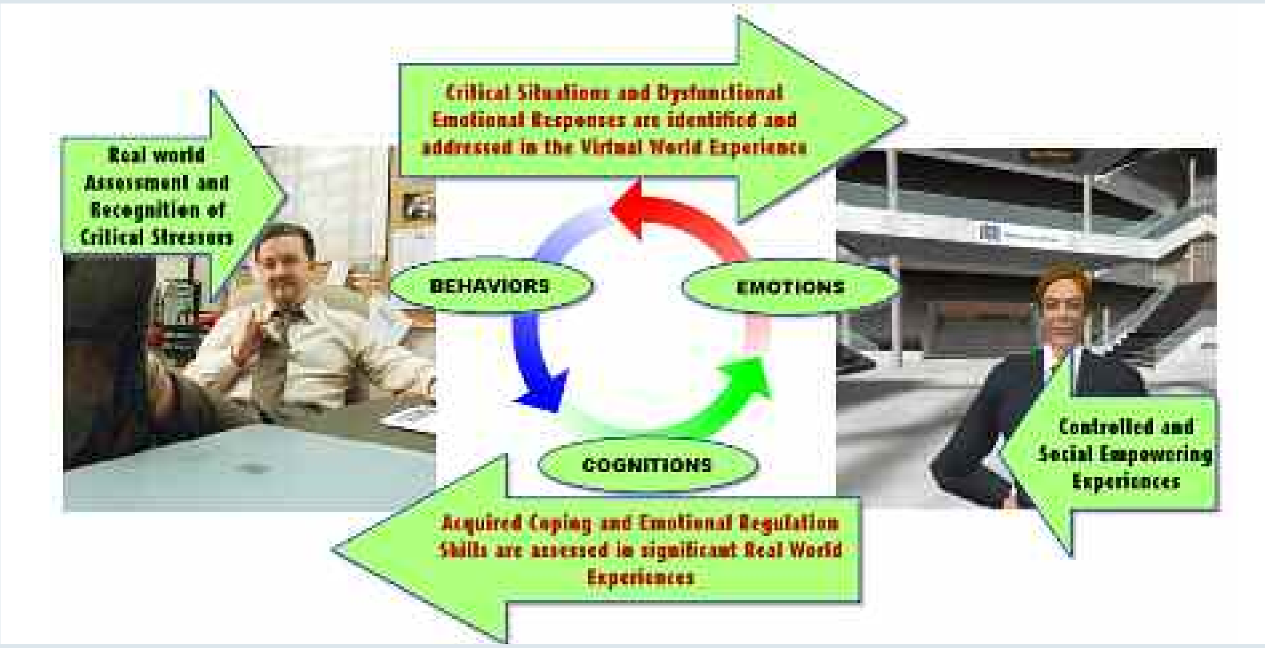

Figure 2: The clinical advantages of the Interreality approach.

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 – that integrates assessment and treatment within a hybrid environment, bridging physical and virtual worlds. Our claim is that bridging virtual experiences – fully controlled by the therapist, used to learn coping skills and emotional regulation – with real experiences allows both the identification of any critical stressors and the assessment of what has been learned by using advanced technologies (virtual worlds, advanced sensors and PDA/mobile phones). We believe this is the best way to address the above limitations.

These devices are integrated around two subsystems (see Fig. 1) – 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:

• Objective and quantitative assessment of symptoms using biosensors and behavioral analysis;

• 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 (see Fig. 2):

• 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 and creates a conditioned association between effective performance state and task execution behaviors.

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Personal Health Systems: The OPTIMI Project

"OPTIMI tries to determine the continuous effect of stress on the individual by studying patterns of behavior over a longer period in order to predict whether the user is at risk for depression. If so, it will be able to provide an intervention program to reduce stress levels and the consequent risk of depression."

By Mariano Alcañiz et al.

Currently, depression and stress-related disorders are the most common mental illnesses and the prevention of depression and suicide is one of the five key points in the European Pact on Mental Health and wellbeing. Furthermore, depression is the leading cause of disability and the fourth leading contributor to the global burden of disease. Depression and suicide are major public health challenges, with roots across all sectors of society. Depression is very prevalent, affecting 13% of Europeans during their lifetime, with high levels of suffering for individuals and families, as well as high costs due to loss of productivity and healthcare. Depression reduces productivity due to increases in sick leaves and disability pensions.

OPTIMI is a European Project funded by the European Union's 7th Framework Programme Personal Health Systems - Mental Health - Collaborative Project. The coordination of the program is led by Everis Spain SL and the OPTIMI web page is: http://optimiproject.eu/

OPTIMI tries to determine the continuous effect of stress on the individual by studying patterns of behavior over a longer period in order to predict whether the user is at risk for depression. If so, it will be able to provide an intervention program to reduce stress levels and the consequent risk of depression.

The OPTIMI project is based on Personal Health Systems (PHS), a new and fast growing concept that has become more widely used over the past few years. The concept focuses on the individualization of prevention, treatment and wellbeing procedures for patients available through the healthcare system. In general, PHS are expected to contribute to the following major needs: (a) The need for ubiquitous, unobtrusive, pervasive bio-data acquisition, processing, management and use for medical decision support, (b) The need for the combination of multilevel medical/psychological information as well as environmental information in order to promote the individualization of healthcare, (c) The need to increase the quality of health care delivery through rigorous biofeedback mechanisms and thus, improve patient safety.

Moreover, PHS assist people in the provision of continuous, quality controlled, and personalized health services to empower individuals regardless of location. They can consist of: a) Ambient and/or body devices (wearable, portable or implantable), which acquire, monitor and communicate physiological parameters and other health-related factors of an individual (e.g., vital body signs, biochemical markers, activity, emotional and social state, environment); b) Intelligent processing of the acquired information and coupling of it with expert biomedical knowledge to derive important new insights about an individual's health status; c) Active feedback based on such new insights, either from health professionals or directly from the devices to the individuals, assisting in diagnosis, treatment and rehabilitation, as well as in disease prevention and lifestyle management.

All these features are applicable to the OPTIMI project. There is also a growing trend in psychological research to use ecological momentary assessments (EMA) that can prompt the subjects on a periodic basis to rate and give answers concerning different parameters. This approach is followed by OPTIMI since various measurements are consistently monitored.

Currently, we have pharmacology and evidence-based psychological treatments (EBT) for depression and stress-related disorders. Nevertheless, we have to point out that less than 50% of patients receive adequate treatment. The main reasons are cost and the time required for treatment, the lack of well-prepared professionals, the fact that many patients do not decide to seek help, and the provision of mental healthcare is generally less than adequate in terms of accessibility and quality. Regarding these worrying factors, the OPTIMI project is born with the aim to develop new strategies to help those people affected by depression and stress, and more importantly, given the near exponential increment in the number of sufferers, to try to develop better tools for the identification of subjects that are at risk in order to design effective preventive programs.

Goals of OPTIMI

OPTIMI approach: an important issue in the onset of depression and stress-related disorders is the individual's ability to cope with stress on a psychological and a physiological level. Some individuals are extremely resilient, but others find it difficult to cope. OPTIMI will thus attempt to predict the onset of illness by monitoring mood states, coping behavior and changes in stress-related physiological variables (e.g. heart rate, cortisol, sleep, etc.).

Based on these premises, OPTIMI has been created with two goals in mind: first, the development of new tools to monitor coping behavior in individuals exposed to high levels of stress; second, the development of online interventions to improve this behavior and reduce the incidence of depression. The emphasis in this project is to develop tools that will lead to prevention and identification of illness in support of CBT and CCBT treatments. In other words, OPTIMI is focused on the prediction and prevention of depression.

OPTIMI Trials

To achieve its first goal, OPTIMI will develop technology-based tools to monitor the physiological state and the cognitive, motor and verbal behavior of high-risk individuals over an extended period of time and to detect changes associated with stress, poor coping skills and depression.

A series of "calibration trials" will allow the project to test a broad range of technologies. These will include wearable EEG and ECG sensors to detect subjects' physiological and cognitive state, accelerometers to characterize their physical activity, and voice analysis to detect signs of depression. These automated measurements will be complemented with electronic diaries, in which subjects report their own behaviors and the stressful situations to which they are exposed. All participants will be regularly assessed by a psychologist who will use standardized instruments to detect stress, poor coping skills and depression. A few will also be asked to wear implanted devices to test levels of cortisol in the blood, an objective physiological correlate of stress. The project will use machine learning to identify patterns in the behavioral and physiological data that predict findings from the psychologist and the cortisol measurements.

Figure 1: Screens illustrating some aspects of the Home PC application developed for the OPTIMI project: voice analysis, EEG and self-reporting examples.

To achieve its second goal, OPTIMI will adapt two existing systems already used to provide online CBT treatment for mental disorders. The project tests the treatment systems in "intervention trials" targeting individuals at high risk of exposure to chronic or acute stress. Examples include persons with personal responsibility for the long term care of elderly or disabled patients, individuals (especially unemployed individuals) in situations of acute financial stress, and students preparing for important examinations.

OPTIMI Contributions

The final OPTIMI monitoring system will consist of the subset of tools that proves useful for the detection of significant changes and are acceptable to users, taking into account ergonomics and usability. OPTIMI's tools are meant to obtain relevant information in a constant and systematic way, and apart from providing consistent feedback to the users about their current situation regarding coping, mood, and stress, the feedback provided by the system is one of the core aspects in the management and prevention of depressive symptoms.

In a preventative role, OPTIMI tools, combined with CBT techniques, provide feedback to the user when the system can detect a combination of stress and a period of negative behavioral response. On-going monitoring with the OPTIMI tools will make it possible to assess the effectiveness of treatment and to optimize the treatment cycle.

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Creating Personalized EEG Systems for Personalized HealthCare

The electroencephalogram, or EEG, works similarly to the ECG but records electrical signals from the brain, making it ideal to track changes that might help to predict seizures, among other uses. Here, the author discusses the benefits of implementing personalized EEG systems that are miniaturized and user friendly, while providing a high level of accuracy.

By Alexander J. Casson

The increasing global population and increasing average age in many countries is driving a change towards providing personalized healthcare. In turn, this change is driving the development of highly miniaturized, wearable sensors that can be placed on the body to monitor a variety of vital signs. For example, it is common for even amateur runners to wear a heart rate (electrocardiogram, ECG) monitor while training. These devices allow the runner to better focus their training for improvement, and moreover, allow them to monitor their own heart and health so that they can focus on living a healthy lifestyle. In terms of providing personalized healthcare, there is even a heart rate monitor extension available for the Texas Instruments eZ430-Chronos programmable watch. This is a wireless development platform incorporating Texas Instruments' low power microcontroller and transceiver components, and keen users can use this to design, program and customize their own personal heart rate systems.

The electroencephalogram, or EEG, is in principle exactly the same as the ECG but with electrodes placed on the head to record the electrical signals that arise from the brain rather than the ones which arise from the heart and are recorded from the chest. In practice, however, the EEG is much more difficult to record than the ECG. This is due to a variety of reasons – EEG signals are much smaller than ECG signals and as a result, more sensitive and noise-free equipment is required; more electrodes are usually required; there is generally more hair on the head than on the chest making the electrodes more difficult to connect correctly; and moreover, the head is less physically and visually accessible than the chest, and so a single person cannot easily set up a system on themselves (see Fig. 1). Whilst some of these are fundamental restrictions, huge progress towards realizing personalized EEG systems has nevertheless been made in recent years. The emotiv EPOC and Camntech Actiwave are two examples of commercially available highly miniaturized units, and there are many more examples too numerous to discuss here.

"The aim is to create application-personalized wearable systems that utilize the medical application to ensure a robust and useful performance."

In addition, research institutes around the world are tackling the issues highlighted above to create *truly wearable* EEG systems. These will require mitigating, or devising techniques to tolerate, the electrode attachment issues. The total system power consumption must also be reduced. For user acceptability decreased power consumption means that battery changing and charging can become a thing of the past, making the devices easier to use. They just turn on and work. For social acceptability, decreased power consumption means that the EEG unit can be smaller, more discrete and more easily tolerated (see Fig. 2). To create these *highly miniaturized* systems the problems highlighted above must be overcome, requiring innovations at the system design, electronic design and mechanical design levels. However, to realize *truly wearable* systems, innovations at the medical, application and personalization levels are also essential.

In many medical applications which use the EEG at present, such as epilepsy diagnosis and sleep disorder diagnosis, diagnostic patterns in the EEG are identified by eye by a highly trained physician. This isn't practical for future wearable systems where ever longer recordings are generated from a larger number of users. Instead, automated, real-time, signal analysis is mandatory, although this introduces new challenges and necessitates application-personalization in the design of future EEG systems.

As an example, research into automated seizure detection algorithms has been going on for more than forty years. Unfortunately, despite the huge increases in computational power available during that time, a definitive, clinically accepted procedure has yet to emerge. No algorithm has perfect accuracy. The key challenge in creating truly wearable systems is not just in implementing seizure detection algorithms in very low power consumption circuits to stay within the limits highlighted above, but also in devising applications and situations where the performance of the EEG system is robust and reliable, despite the fact that no algorithm is perfect.

Expanding on the seizure detection example, false detections inevitably mean that automated algorithms integrated into miniaturized EEG systems cannot be used to produce a fully accurate and reliable diary of seizure activity. This does not mean that such systems are of no benefit, just that a different application must be pursued. The detection algorithm could be used to highlight sections of data that are of *potential* interest, decreasing the analysis time for a trained physician even when some false detections are present; or algorithms can be used to decrease the average power consumption of the EEG system by turning parts of the system off when no interesting activity is present. The longer monitoring enabled could potentially detect previously unknown phenomena which would impact both diagnosis and treatment decisions.

Thus, realizing truly wearable EEG systems also relies on realizing personalized EEG systems, tailored for the particular medical situation at hand. For ECG monitoring user personalization is already becoming available. The EEG equivalent is inevitably more difficult, but at Imperial College in London we are continuing the required research into system, algorithm, and circuit design. The aim is to create application-personalized wearable systems that utilize the medical application to ensure that robust and useful performance is maintained, despite the fact that the algorithm performance cannot be perfect. In addition to addressing the electronic and mechanical issues, this focus on the application aim and application-personalization is essential as we move from highly miniaturized to truly wearable devices.

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Figure 1 (right): Setup of a standard EEG recording. The EEG is generally much more difficult to record than the ECG and hence future systems require innovations on a number of fronts. For example, as the head is not visible and electrodes must make contact with the scalp through the hair a trained second person is required to setup the system. Photo: Neville Miles.

Figure 2 (bottom): The scale required for future truly wearable EEG systems: a standard recording electrode, a large coin cell battery, unpackaged electronics and a British one pence piece for scale. Ideally the recording electrode would be the single largest component present. Photo: Eduardo Aguilar-Pelaez.

To Telehealth and Beyond

By offering many advantages to patients and caregivers alike, telehealth is becoming increasingly popular and also more streamlined as related technologies are further developed.

Figure 1: A patient uses TeleMedCare's telehealth system to record a single lead electrocardiogram.

▸ By Nigel H. Lovell & Stephen J. Redmond

In developed countries, chronic disease now accounts for nearly 80% of healthcare expenditure and nearly an equivalent percentage of disease-related deaths. The burden of chronic disease (often, but certainly not exclusively, associated with aging) includes asthma, hypertension, diabetes, congestive heart failure (CHF) and chronic obstructive pulmonary disease (COPD). Over the past half century there has been an epidemiological shift in disease burden from acute to chronic diseases that has rendered acute care models of health service delivery inadequate to address population health needs.

In response to these changes in disease demographics and the economic imperatives caused by an aging population, service delivery models are shifting their focus from episodic care to continuity of care, from institutional care to community and home-based care, and from disease treatment to disease prevention.

To support this change of focus, information and communications technology (ICT) infrastructure is required to facilitate shared services such as virtual health networks and electronic health records, knowledge management (care rules and protocols, scheduling, information directories), as well as consumer-based health education, demographic data, clinical signs monitoring and evidence-based clinical protocols.

The application of a broad range of ICT as it applies to managing disease and wellness is termed "telehealth." It is broader than the concept of "telemedicine," which is typically defined as a system of healthcare delivery in which physicians examine patients through the use of telecommunications technologies – that is, remote diagnosis. Telehealth incorporates a wider range of health-related activities including patient and provider education, point-of-care diagnostics, clinical decision support services, and most importantly, provides tools for self-management of disease and wellness.

The work of our research group in the telehealth area dates back some 15 years. We began by designing appropriate technologies for use in primary health care. There are many examples of ICT applications in chronic disease management. However, many are ill-conceived in that they are driven by the underlying technology and not by a clinical problem that needs to be addressed. Specifically, in 2001, we began to trial home telecare technology for the management of chronic disease. At that time, much rhetoric existed about the perceived patient benefits and potential cost savings of the "tele" word when applied to healthcare. How important is the clinical need in terms of improving health care and reducing current costs? Does the proposed technology impact significantly on the clinical problem? Is there adequate input from all stakeholders including patient groups and end-user representatives? Surprisingly, in many forums the questions that were being asked then are still being asked today.

Over the last eight years the telehealth technologies developed at UNSW have been commercialized in Australia by a start-up company (TeleMedCare Pty. Ltd., http://www.telemedcare.com.au) and extensive product and clinical trials have been undertaken both in Australia and the U.K.

While it was, and still is, an evolving process, appropriate home telehealth technologies were engineered into health care solutions that were then integrated with existing health service delivery models. These systems were researched, constructed and trialled. A range of health management solutions are now being sold and deployed throughout Australasia and the U.K. to hospitals, local health authorities, residential aged care facilities, community care centers, medical insurers, health and lifestyle centers and individuals.

"Telehealth incorporates a wider range of health-related activities including patient and provider education, point-of-care diagnostics, clinical decision support services, and most importantly, provides tools for self-management of disease and wellness."

In more recent times, the telehealth space has attracted interest from bigger multinational companies. Examples include the Viterion product from Bayer-Panasonic, HomMed from Honeywell, TeleStation from Philips and the PHS600 from Intel-GE. In general, all the units are designed to record clinical indicators of a patient's health status including weight measurement, single lead electrocardiogram, blood pressure, spirometry, body temperature and oxygen saturation (pulse oximetry). Some systems provide feedback to patients, including medication reminders and measurement scheduling, as well as video conferencing.

Just as the clinical interventions when managing chronic and complex disease require a holistic approach, so too does the home telehealth approach. There exists no single silver bullet for design of an effective telehealth system. The chronic disease conditions by their nature are complex and multi-factorial – and so too are the requirements for a telehealth management system. The critical issue in deploying a usable system is to firstly have a deep understanding of the healthcare sector and to use this understanding to appropriately hide the layers of complexity from the end-users. A patient interacts with the system by way of scheduled measurements and medications reminders. By default, a clinician views management reports from only his or her patients with adverse or deteriorating clinical measurement trends.

From a systems viewpoint, to make such complex tasks appear simple and be time and cost effective requires a convergence of many factors – integration of innovative, low-cost sensors to perform clinical measurements, scheduling for medications and measurements, a longitudinal history of past measurements and appropriate tools including targeted patient education to facilitate patient self-management, remotely maintainable client-side software, and web services for case management by health care workers and administrators.

Research and trials in Australia and the U.K. have clearly demonstrated that the TeleMedCare system is a viable and important way of providing monitoring and follow-up care to patients suffering the burden of chronic disease. Studies have shown that nearly 90% of the care a person needs to manage a chronic disease must come directly from the patient. Self-management interventions, such as self-monitoring, patient education and feedback, and decision making lead not only to improvements in health outcomes, but also to increased patient satisfaction and reductions in hospital bed days and carer visits. By way of example, the Veteran's Health Administration (VHA) in the U.S. ran an extended trial of rudimentary telehealth equipment from 2003-2007. In a study group of over 17,000 patients, the introduction of home telehealth demonstrated a 25% reduction in numbers of bed days of care, 19% reduction in numbers of hospital admissions, and mean satisfaction score rating of 86% after enrollment into the program. This was also associated with considerable projected cost savings.

Another essential, on-going task is the development of a decision support framework to enhance the healthcare giver's review of the remotely acquired monitoring data and to support the clinical decision-making experience. The amount of clinical information that can be generated from a telehealth monitoring system is substantial. Analysis of these data and correlation with clinical history by the decision support system will be used to highlight important sections of patient results, provide summary analyses and recommendations, and will assist in the efficient review and risk stratification of multiple patient results. The healthcare giver will automatically be alerted if any of the monitored data indicates deterioration in the health status of a patient. Furthermore, outputs from the decision support system can be used to influence changes in work flow.

The path to creating a comprehensive and holistic home telehealth system is hugely integrative and complex. It is only now after a decade of intense development and trialling that we are beginning, in a controlled and automated way, to effectively and efficiently close the clinical care management loop. Such modifications to the clinical care workflow will flag the way for the next generation of home telehealth.

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Product Comparison Chart: Personalized Health Systems

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PRODUCT	DESCRIPTION OF PRODUCT	FUNCTION	MANUFACTURER
IVT Mobile Health Management and Rescue System	S120 mobile phone, wireless blood pressure meter, a wireless ECG monitor, a wireless pulse oximeter, a wireless glucose meter and a wireless PSTN access point	user can measure related criteria, upload to personal E-Health record on a remote server where data is saved and analyzed in real time, rescue center provides 24-hour service	IVT Corporation
HealthPal	cuff that straps around the upper arm that corresponds to a cell-phone-sized transmitter	sends blood pressure wirelessly to online database, where if abnormalities occur, a doctor will be alerted and call the patient	MedApps, Inc.
INTERSTRESS– Interreality in the Management and Treatment of Stress-Related Disorders	monitors patients' health, emotions, behavior, and activities while immersed in a shared 3-D virtual world; can be used in health care centers and at home, also utilizes mobile phone and PDA technology to provide support	ICT strategy for the assessment and treatment of psychological stress by regulating patients' emotional coping skills and physiological responses to virtual worlds, through the use of biosensors and behavioral analysis that can be applied to the real world	an EU-funded project
VeriChip RFID Tag	an 11 mm long RFID tag that is inserted just below the flesh of a person's upper arm	contains a personalized 16-digit number, that once scanned will provide immediate identification and medical records	Applied Digital Solutions
E-Textile Pants	pants lined with e-TAGS (small circuit boards that contain microcontrollers, sensors, and communication devices), gyroscopes and accelerometers at the ankles, knees and hips	designed mainly for the elderly, it monitors motion and activity; it is able to detect the motion of falling, which then results in a signal for help through a wireless transmitter	Virginia Tech
SensorART	remote controlled Sensorized Artificial heart designed for treating patients with heart failure	provides constant monitoring that will help doctors to better treat heart failure in patients, and aid in the recovery process through close analysis of heart patterns	an EU-funded project
REACTION	wireless wearable non-invasive and minimally invasive sensors monitor physiological vitals of patients with diabetes and transmits data to healthcare professionals	regulates insulin dosages, gives personalized feedback to patients and healthcare providers, and ensures emergency and crisis support to enhance therapy management and self-monitoring capabilities	an EU-funded project
LifeVest – Wearable Defibrillator	an electrode belt worn around a patient's chest and includes a small monitor weighing about 2 lb. that hangs from a shoulder strap	electrode belt senses abnormal heart rhythms that cause wearer to become unconscious and delivers electric shock, restoring normal heartbeat and consciousness	Zoll
MONARCA – MONitoring, treAtment and pRediCtion of bipolAr disorder episodes	includes sensor-enabled mobile phone, a wrist-worn activity monitor, a sock with GSR and pulse sensors, an EEG system, and a home gateway	utilizes GPS tracking, physical motion information, recognizes eating habits, etc.; information is updated onto a profile that aids diagnosis and treatment	an EU-funded project

INTERSTRESS

Interreality in the Management and Treatment of Stress-Related Disorders

The INTERSTRESS project aims to design, develop and test an advanced ICT-based solution for the assessment and treatment of psychological stress.

Context

Stress contributes to many chronic diseases suffered by citizens in today's society. It is known to increase one's risk of developing disease, and may trigger or worsen such illnesses as depression, diabetes, and cardiovascular disease.

What if lowering your stress level was as easy and as much fun as playing a video game? What if all of the work was automated for you, with reminders on your mobile phone? What if the system that achieved this was so smart, it changed the program the second you changed your behaviour? This is the vision of our project.

Clinical use of Interreality is based on a closed-loop concept that involves the use of technology for assessing, adjusting and/or modulating the emotional regulation of the patient, his/her coping skills and appraisal of the environment based upon a comparison of the individual patient's behavioural and physiological responses with a training or performance criterion. The project will provide a proof of concept of the proposed system with experimental trials.

Objective

- Achieve quantitative and objective assessment of symptoms using biosensors and behavioural analysis
- Provide decision support for treatment planning through data fusion and detection algorithms
- Provide warnings and motivating feedback to improve compliance and long-term outcome

Project goals

To reach these goals, INTERSTRESS will use a new e-Health concept: Interreality.

Interreality is the integration of assessment and treatment within a hybrid, closed-loop empowering experience, bridging physical and virtual worlds into one seamless reality. Within Interreality:

- Behaviour in the physical world will influence the virtual world experience
- Behaviour in the virtual world will influence the real world experience

CASE STUDY

Rosa relies on support from her elderly mother to cope with her husband's death. But when Rosa's mother also falls ill, Rosa is forced to assume the role of caretaker, and her coping efforts seem ineffective: Rosa is affected by chronic stress. In the INTERSTRESS system, Rosa is exposed to virtual scenarios simulating real-life stressors, allowing the therapist to index their impact. At home, Rosa can practice stress management skills in simulated environments and meet others in the virtual community to share experiences.

INTERSTRESS is funded by the European Commission

The Approach

These goals will be achieved through:

- 3D Shared Virtual World role-playing experiences in which users interact with one another
  - Immersive in the healthcare centre, yet non-immersive in the home setting
- Bio and Activity Sensors (from the Real to the Virtual World)
  - Tracking of emotional/ health/ activity status of the user and influencing the individual's experience in the virtual world (aspect, activity, and access)
- Mobile Internet Appliances (from the Virtual to the Real World)
  - Social and individual user activity in the virtual world has a direct link with the user's life through a mobile phone/PDA.

Expected Results & Impacts

Stress is an increasingly recognized phenomenon that has negative effects on growing numbers of people. Chronic stress is responsible for premature mortality in Western countries, and work-related stress accounts for premature cardiovascular mortality rates. In 2006, Health Canada released a report indicating that work stress accounted for $1,950,000 of organizations' losses.

INTERSTRESS aims to improve links and interaction between patients and doctors, facilitating more active participation of patients in the care process. Also, it expects that there will be a reduction in hospitalization and improved disease management and treatment at the point of need, through more precise assessment of health status. This will reduce healthcare costs and provide greater accessibility for individuals.

Overall, INTERSTRESS envisions a better quality of life, where personalized, immersive e-therapy in which biosensors, VR simulations, and presence allow the ability to detect and manage stress anytime, anywhere are key components of the INTERSTRESS solution.

This speaks to the continued call for the active participation of individual citizens in their own health and well-being, and the need for affordable healthcare in the palm of the users' hands.

INTERSTRESS

INTERSTRESS

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Consiglio Nazionale Delle Ricerche (Italy)

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Total cost: €4,017,451

EC funding: €3,005,653

Instrument: CP — ICT Grant

Project Identifier: FP7-247685

KEYWORDS

Stress, Virtual reality, Biosensors, Healthcare, eHealth

INTERSTRESS is funded by the European Commission

Contact Lens with Integrated Sensors for the Next Generation of Human Health Monitoring

With 6% of the world population suffering from diabetes in 2010, the far-reaching impact of the disease cannot be ignored. Monitoring blood glucose remains an important step in treatment, although the finger-prick method deters many patients from consistently tracking data. Here, the authors discuss cutting-edge technology implementing contact lenses to continuously monitor glucose levels and wirelessly record data.

By Huanfen Yao, Ilkka Lähdesmäki & Babak A. Parviz

For the past number of years diabetes mellitus has gained importance globally as a major public heath concern. The chronic high glucose levels in blood can be a further risk for other serious micro-vascular complications, such as stroke, atherosclerosis, and coronary artery diseases. The data provided by the International Diabetes Federation shows that, for the year 2010, more than 6% of the world population suffered from diabetes mellitus.

Self-monitoring of blood glucose is widely used for controlling glucose levels. This is usually performed by a "finger prick" test using a portable meter. However, this sensing method is invasive; it requires direct contact between the sensor and the blood. More importantly, it can provide only a single temporal value – it cannot follow the rapid fluctuations of blood glucose levels during diabetes medication. Hence, a non-invasive continuous glucose sensing method would be strongly preferred for the next generation of human health monitoring.

Non-invasive detection is usually achieved by placing the sensing element on the skin, and sensing tissue glucose without piercing the skin, using techniques such as absorption spectrometry and polarimetry. But these methods require both the sensor and various auxiliary components for practical operation, which make them less portable. An alternative way of non-invasive sensing can be achieved by taking measurements from body fluids, such as urine, saliva, sweat or tear fluid. Besides the drawback of the variable water content, or dilution effect, urine cannot be accessed in a continuous basis, and placing sensors in the mouth is uncomfortable. Compared with the difficulty encountered in sweat harvest, tear fluid is directly accessible on the eye and can provide a unique interface between the sensor and the body. As reported in prior clinical studies, there is a correlation between the tear glucose and the blood glucose, for both nondiabetic and diabetic groups.

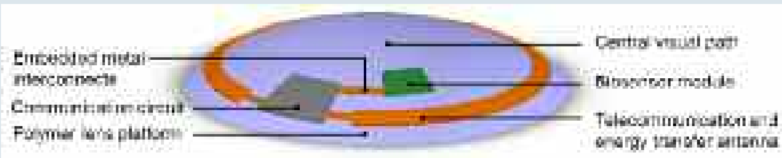
Our group aims to build a contact lens complete with sensors and radio to sample the tear fluid, perform an analysis, and wirelessly transmit the results. The contact lens allows for monitoring human health non-invasively and continuously through the tear fluid. This contact lens can be built on a polymer platform, complete with a biosensor module, communication circuit, antenna and embedded interconnects, leaving the central area clear for the visual path (Fig. 1). Sensor placement in tear fluid permits the use of continuous sensing mode, which would provide a more complete understanding of the human health status. The contact lens may have the potential benefit of eliminating the finger prick test and increase compliance with glucose monitoring among diabetic patients.

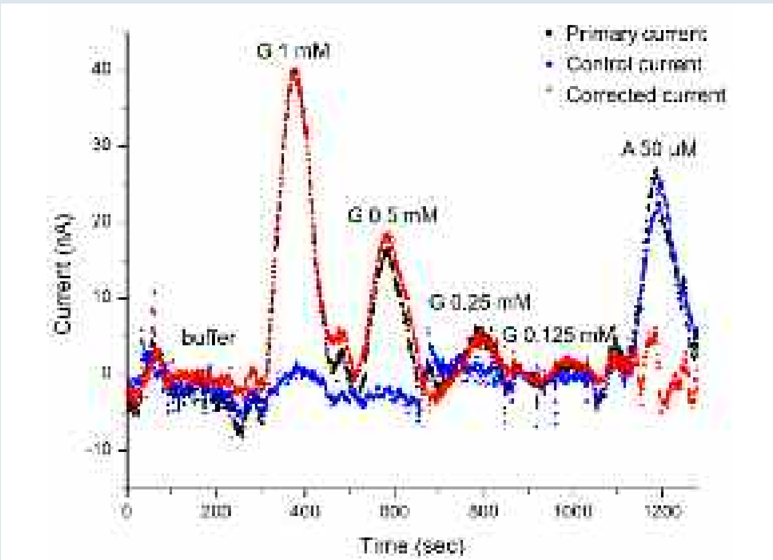
Challenges for glucose sensor design include the need for enhanced sensitivity and interference rejection, especially for glucose measurement in the tear fluid, because the glucose levels in tears are much lower (0.1~0.6 mM) compared with blood concentration (4~6 mM), and there are various interfering molecules, such as ascorbic acid, lactate, and urea present on the surface of the eye. Also, different proteins could influence the sensor output. As a result, detection requirements for a tear glucose sensor are more stringent than those for a blood glucose sensor. In our project, we chose an electrochemical sensing method to analyze the tear fluid due to its real-time, fast, and easy operation. We developed a dual microscale sensor design for interference compensation (Fig. 3), where the primary sensor responds to glucose while both the primary and the control sensor respond equally to the interferences. Different response behavior on the primary and the control sensor is due to different surface treatment. When a difference signal is calculated, the interference response is removed while the glucose response is preserved. We have fabricated such a dual sensor on a PET (polyethylene terephthalate) substrate and demonstrated that it can be successfully used for sensing low concentrations of glucose in the presence of interfering chemical ascorbic acid (Fig. 2).

Another challenge for developing the active contact lens is the construction of the wireless power transmission and readout circuitry parts to support the sensor. Figure 3 shows the wireless sensing system setup which we developed for test and characterization. For measurement, we used a horn antenna to broadcast radio waves towards a custom-designed radio chip designed at the University of Washington. A loop antenna, which can be fabricated on the contact lens, is used to collect the radio frequency wave power and supply it to the circuitry. The same loop antenna can also transmit data, in form of a shift in peak frequency. The current signal from the sensor is converted to a shift in the frequency spectrum through the readout circuit. Thus, glucose concentration data can be transferred from the sensor to an external storage unit as frequency spectra wirelessly.

At this stage, we have managed to fabricate the circuitry part in a small chip of 0.5 mm^2, which provides a potential to construct the glucose sensor and supporting circuit on a single contact lens in the future. We have also obtained linear measurement results for glucose up to 2 mM, by reading the frequency shift using the wireless sensing method. Combining the dual sensor and the communication circuitry part, we hope to build a wireless non-invasive continuous glucose sensor in the future.

Our active contact lens is still under development and far from complete. Future improvements will include more biocompatible encapsulation, building low noise interfaces, and complete component integration. We believe that an integrated contact lens could be the next generation system to monitor several physiological and metabolic indicators for human health, in a wireless, non-invasive and continuous way.





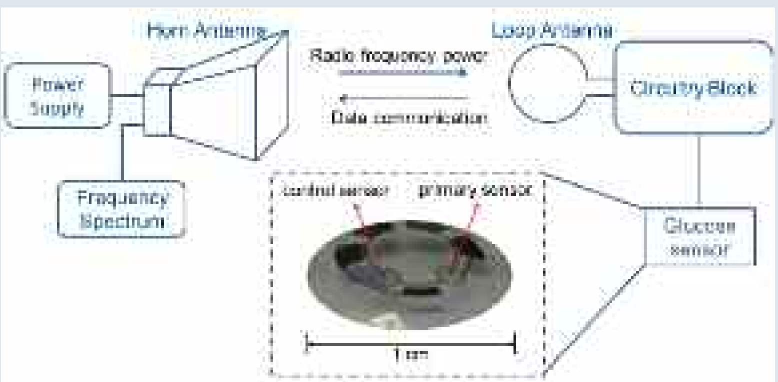


Figure 1 (top): A conceptual active contact lens; **Figure 2 (middle):** Typical measured amperometric response of the dual sensor for glucose (G) and ascorbic acid (A); **Figure 3 (bottom):** Schematic of our test set-up for the wireless sensing and image of the dual glucose sensor.

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THE SOCIABLE Project:
Motivating platform for elderly networking, mental reinforcement and social interaction

"SOCIABLE will integrate human support and care services offered by care centers, health professionals and specialized medical experts, with state-of-the-art ICT infrastructure and independent living technologies [to help enable] elderly users ..."

By Mariano Alcañiz & Irene Zaragozá

Recent research results show that mental activity, as well as social interaction, is a key prerequisite for alleviating dementia. SOCIABLE is highly motivated by the fact that a combination of physical and mental activity, along with social engagement and a brain-healthy diet, is more effective than any of these factors alone. Hence, the SOCIABLE project will pilot a radically new ICT-based approach for integrated support of mental activity, as well as boosting of social interaction for individuals that have been diagnosed with mild dementia.

Methodology of the SOCIABLE Project

This new approach will build upon three tested technological pillars, which have proven been proven to be of therapeutic value, namely: (a) Novel perceptive mixed reality interfaces based on multi-touch surfaces, (b) A modular platform for cognitive training games development, which allows the flexible creation and customization of cognitive training games and (c) "Profiling" and social "matching" capabilities boosting social networking and interaction between elderly individuals.

"Overall, SOCIABLE will integrate, deploy and operate an innovative ICT-enabled online service for assessing and accordingly reinforcing the mental state of the elderly through pleasant gaming activities for cognitive training, while at the same time boosting their social networking and activating their day-to-day interpersonal interactions."

SOCIABLE will combine the ever-important factors of human care and support with innovative ICT-enabled services (notably, services available over surface computing infrastructures) and independent living technologies. Specifically, SOCIABLE will integrate human support and care services offered by care centers, health professionals and specialized medical experts, with state-of-the-art ICT infrastructure and independent living technologies enabling elderly users to:

• Access a motivating recreational online (and offline) environment based on mixed reality interface technologies and play-related-therapeutic tools with an aim to prevent and alleviate the evolution of dementia through pleasant cognitive training-gaming activities for elderly people. This environment will include interaction ranging from individualized cognitive training, team/group play, to a network of social activation activities involving multiple elderly users that reside in geographically diverse locations.

• Provide an automated tool for managing elderly patients' related data and

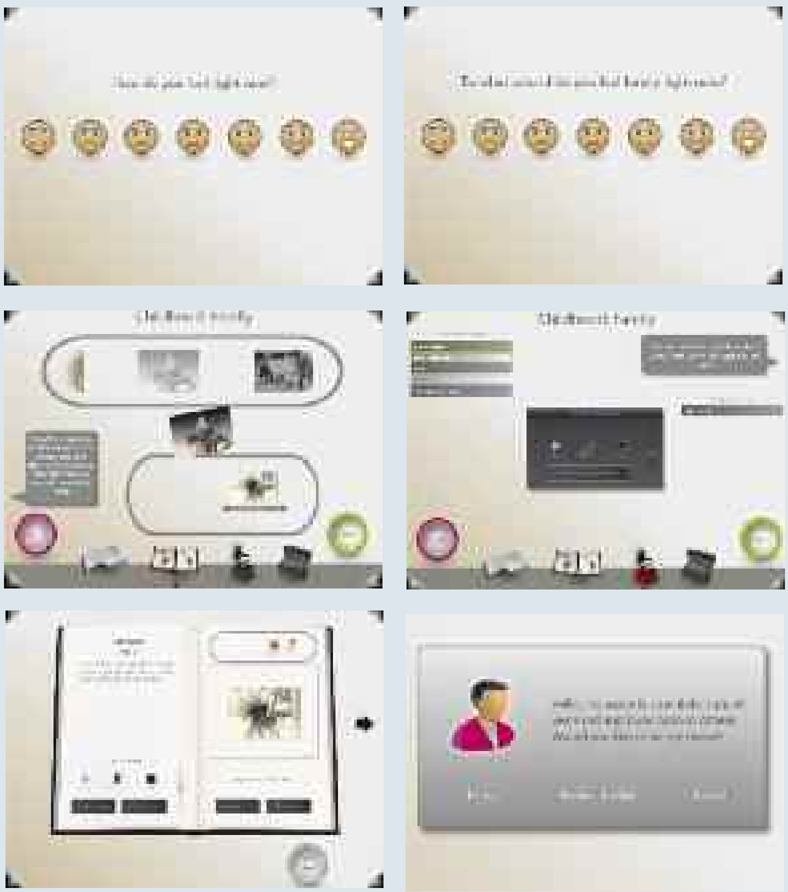

Figure 1: Screens illustrating some aspects of the SOCIABLE application.

collecting measurements that support the assessment of cognitive status (improvement or deterioration) of people with mild dementia by experts. This involves the provision of information about the elderly person's mood, cognitive/functional/affective status and mental performance, as well as context-related information. Such information will be collected, maintained and presented in a systematic way to support health professionals and medical experts in care centers in interpreting the cognitive, functional and affective state of elderly individuals with mild dementia and help in defining appropriate training programs and other therapeutic measures.

"SOCIABLE will be piloted with the participation of a minimum of 350 senior citizens in seven different pilot sites from four European countries (Greece, Italy, Norway, and Spain)."

• Activate and/or increase the quality and quantity of elderly people's social interactions with other members of the ageing society, as well as with relatives and family. This will be achieved by combining human knowledge residing with caretakers about elderly patients' profiles and preferences with an innovative ICT-based social "matching" service offered through the SOCIABLE platform that will instigate social interactions between elderly individuals and/or inter-generational interactions to the benefit of all elderly parties.

• Participate in community building activities that are instigated by and build on the results of the "matching" service. The SOCIABLE platform will support elderly-specific networking, socialization and community-building activities that will enable building and populating groups of elderly individuals that share similar problems and/or can benefit from mutual social interaction.

SOCIABLE will be piloted with the participation of a minimum of 350 senior citizens in seven different pilot sites (TRONDHEIM Kommune, Hygeia, Morgagni Pierantoni Hospital, Municipality of Forlì, Social Policy Centre of the Municipality of Kifissia, Santa Lucia Foundation and PREVI S.L) from four European countries (Greece, Italy, Norway, and Spain).

Conclusion

Overall, SOCIABLE will integrate, deploy and operate an innovative ICT-enabled online service for assessing and accordingly reinforcing the mental state of the elderly through pleasant gaming activities for cognitive training, while at the same time boosting their social networking and activating their day-to-day interpersonal interactions. SOCIABLE is envisaged as a service with a high potential for societal impact that could add significant value to current services offered for care services providers.

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Developing Personalized Solutions for the Treatment of Traumatic Brain Injury:

The TBIcare Project

"Providing an objective and evidence-based solution for the management of traumatic brain injury, by improving diagnostics and treatment decisions for an individual patient."

By Mark van Gils & Olli Tenovuo

TBIcare scenario: Harry has been in a serious car accident. When entering the University Hospital, he is conscious but somnolent, confused and suffers from severe headache. Other bodily injuries include a pelvic fracture with moderate intra-abdominal bleeding, as well as external wounds and crushes. All clinical parameters are checked carefully, including detailed assessment of vital and neurological functions. A laboratory screen is carried out, including available measures of brain injury biomarkers and general physiologic state. A head and body CT-scan is taken after stabilizing the vital functions. Brain CT reveals diffuse axonal injury and fronto-temporal contusions.

The main question is: should the pelvic fracture be stabilized operatively due to bleeding or is external stabilization sufficient – which solution forms a smaller risk for the injured brain? All clinical, imaging, and laboratory values have automatically been transferred into the TBIcare software which calculates the expected risks for the available treatment alternatives in regard to TBI outcome, thus helping the treating clinician to make the best choice. Corresponding treatment decisions will be made several times during the acute in-hospital care period, each time with the help of TBIcare which has collected the relevant variables during the stay, thus guiding the care to produce an optimal outcome.

Traumatic brain injury (TBI) occurs when a sudden trauma causes damage to the brain. Every year, over 1,600,000 patients sustain a traumatic brain injury in the EU, and 70,000 of these die, with a further 100,000 being left handicapped. Significantly, 75% of the victims are children and young adults, and TBI is the leading cause of disability in people under 40 years of age. TBI results in more lost working years than cancers, stroke and HIV/AIDS together. On a global scale, the number of life years lost due to TBI is four times that of diabetes-related loss. Recent statistics show a steep increase in the incidence of TBIs, with an increase of 21% over the last five years – threefold greater than the rate of increase in population. Despite this, TBI has been seriously underrepresented in medical R&D efforts compared to many other, less significant health problems.

Due to a vast degree of variation in the injuries of individual patients, the methods currently in use in the treatment of brain injury patients lack strong scientific evidence. The EU-funded project TBIcare provides an objective and evidence-based solution for management of TBI by improving diagnostics and treatment decisions for an individual patient by matching a patient's individual data with the injury's characteristics. In this way it allows each brain injury patient to receive individual treatment that is optimized for his or her needs.

The project develops a tool that will make the day-to-day clinical work of doctors easier and also revolutionize the treatment of TBI. This software tool will enable doctors to match the patient-related variables with the injury-related variables through the combined use of various databases. Using extensive database and system simulation, the software will then form a detailed analysis of the nature of the patient's brain injury, its optimal treatment and predicted outcome. A scenario illustrating the

TBIcare concept is given in the box text.

The project has two scientific objectives; development of
1) a methodology for finding efficient combinations of multi-modal biomarkers in statistical models to objectively diagnose and assess an individual TBI patient, and
2) a simulation model based for objectively predicting outcome of the planned treatment of an individual TBI patient.

The first objective is addressed by using an approach in which a high number of vital signs or biomarkers, relevant to TBIs, are explored from sets of heterogeneous data. These include, for example, structural and functional changes visible in imaging data (computerized tomography, CT; magnetic resonance imaging, MRI; positron emission imaging, PET), changes in electrophysiology (electroencephalography, EEG); changes in bedside multimodality monitoring parameters including systemic cardiac and respiratory physiology, intracranial pressure (ICP), and brain chemistry (monitored by oxygen sensors and microdialysis); and changes in metabolomics visible in the blood. We define sets of biomarkers from several thousand brain injury cases retrospectively, and from several hundred TBI cases and healthy controls prospectively. The goal is to build statistical models allowing standardized and objective interpretation of data from a single patient. The diagnostic rules are derived by comparing the patient data to the most similar cases in a database using statistical inference.

Work towards reaching the second objective uses these statistical models as a basis for the construction of a simulation model. Due to the unique responses to treatments, the simulation model must be individualized. The model is personalized for each patient separately using data only from similar cases. Various approaches can be used for the simulations, such as concepts from system dynamics or Bayesian networks. In the TBIcare concept individual physiological measures and various treatments form the building blocks of the system dynamics model which is used to predict the outcome.

"The EU-funded project TBIcare provides an objective and evidence-based solution for management of TBI by improving diagnostics and treatment decisions for an individual patient by matching a patient's individual data with the injury's characteristics ... it allows each brain injury patient to receive individual treatment that is optimized for his or her needs."

The simulation model provides important information both for scientists and clinical practitioners. It helps a scientist to better understand a human as a system – a viewpoint central to the Virtual Physiological Human. A clinician is able to test the influence of various treatments by first simulating them. As the variability of the individuals and traumas is huge, we do not expect that a simulation model built from hundreds of cases is enough for reliable prediction of the outcome. However, our aim is to develop a strictly evidence-based simulation model for objectively predicting the outcome of treatment and rehabilitation of an individual TBI patient. The model provides objective evidence-based information about the most probable outcome and will be a step towards a scientifically valid approach for treatment planning. This model will be a basis for future development, where an increasing amount of validated clinical data will continuously improve the reliability and usability of the model. In addition, this kind of model may be used to optimize the diagnostic procedure in TBIs, e.g. it may advise the clinician to take some further tests in order to improve the reliability of the model for a certain individual.

These scientific objectives are supplemented by realization of technical objectives: a software solution to be used in daily practice to diagnose and plan treatments; new approaches for extracting information from multi-source and multi-scale physiological databases for management of an extremely heterogeneous disease; and innovative data quantification methods for the clinical TBI environment. Thus, TBIcare transfers the scientific Virtual Physiological Human (VPH) concepts to clinical practice.

TBIcare has impacts for healthcare professionals by improving the healthcare process and increasing medical knowledge; for the patients and their nearest by increased quality adjusted life years; for society it brings reduction in healthcare costs and losses due to working disability, and for the European industry it brings an impetus to increased global competitiveness by providing immediately exploitable innovative methods.

This work is supported by the European Commission under the 7th Framework Programme (FP7-270259-TBIcare). This EU co-funded project has started on 1 February 2011. It is co-ordinated by VTT Technical Research Centre of Finland and the consortium includes GE Healthcare Ltd. (UK), Turku University Central Hospital (Finland), University of Cambridge (UK), Imperial College London (UK), Complexio S.a.r.L. (France), Kaunas University of Technology (Lithuania), and GE Healthcare Finland Oy.

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Healthcare in Free Fall

"... the Internet will continue to permeate into our everyday lives, and it is only a matter of time before healthcare systems change the way they do business and begin to make full use of this incredible communication resource at their disposal."

▸ By Stephen J. Redmond & Nigel H. Lovell

The way that healthcare systems operate is going to change forever. In most cases, primary care is currently delivered by general practitioners (primary care physicians) or community care nurses. In some cases, certain individuals will even attend the emergency department in tertiary hospitals to obtain primary care, without referral. This model of care is inherently reactive in nature and therefore suboptimal in its utilization of valuable healthcare resources; the individual interprets their symptoms and then seeks primary care when they deem appropriate. Even if visits to tertiary care centers are by referral from primary care physicians, often hospital admission may be unavoidable as the patient may not recognize the severity of their condition at an early enough stage to avoid hospitalization.

One acute example of this scenario relates to falls among elderly individuals. Falls and fall-induced injuries among the elderly population are a major cause of morbidity, disability and increased health care utilization. It is estimated that approximately one in three persons over the age of 65 years old fall one or more times each year; this ratio rises to about 50% for persons over the age of 80 years old. In Australia alone, in 2003-2004, the cost of fall-related hospitalization is estimated to have exceeded U.S. $500 million. Through early intervention using physical rehabilitation strategies which are tailored to address the functional deficits of the individual, future falls may be prevented; however, those individuals at risk of falling must first be identified.

Falls-risk assessment is currently a very active research area spurred on by our aging populations in developed nations. Many clinical falls-risk indices have been

Figure 1: Subject wearing a wireless ambulatory monitor attached to a belt placed around the waist. The triaxial accelerometer in this device is used characterize the subject's performance of a number of physical assessments and hence determine their risk of falling in the near future.

developed based on questionnaires regarding previous falls, observations of gait, and balance and postural change maneuvers. Often, these methods require specialized equipment and the presence of a trained assessor which limits their capacity to monitor and screen the general population.

In recent years, through the miniaturization of sensor technologies and the maturation of wireless communication protocols, it has become feasible to address the shortcomings in traditional clinical falls-risk assessments, and bring reliable continuous assessment of falls-risk to the home. Specifically, microelectromechanical sensors (MEMS), which can measure acceleration, rate of rotation and barometric air pressure, are used. All sensors and a wireless transceiver are housed in a single device and worn on the hip, which enables the reliable characterization of human movement.

Our group at the University of New South Wales has developed a directed routine which includes a short battery of commonly used physical assessment tasks. These tasks are performed unsupervised in the home and can be characterized using a single triaxial accelerometer device (designed at our laboratories), clipped onto a belt around the subject's waist (see Fig. 1). Explicitly, the direct routine consists of three physical assessments – rise from a chair, walk three meters and return to the chair; place the left foot on a small step, then back to the floor, then the same with the right foot, and repeat four times; and stand up and sit down five times. The resulting accelerometry signals are analyzed to extract information relating to speed, strength and balance, and are employed in a model which estimates the subject's risk of falling. Results from testing on 68 elderly subjects show that the falls-risk estimates generated by the model correlate extremely well (99%) with a commonly used clinical falls-risk assessment test – the Physiological Profile Assessment.

To provide some background in regards to how such monitoring technologies might find their way into the home environment, we need to examine the current state of fall detection devices. Fall detection technologies, which are different in that they identify the occurrence of a fall after the event, are beginning to mature, although high false positive alarm rates still pose a challenge which needs to be overcome. The marketplace for such technologies is competitive and already crowded, with monitoring devices available from: Tunstall (Tunstall Group, UK); iFall (Android mobile phone 'App'); Verhaert Zenio (Verhaert, Kruibeke, Belgium); Wellcore Personal Emergency Response System (Wellcore, San Jose, CA, USA); myHalo Fall Detection Device (myHalo, Novi, MI, USA); and, Philips Lifeline with AutoAlert (Philips, Amsterdam, the Netherlands). It is becoming apparent that fall detection devices, in whatever final form they assume, will become an established technology for monitoring the elderly at home. Therefore, it can be envisaged that future fall detection technologies in the home will eventually include some type of falls prevention strategy, similar to the method described earlier.

"It is becoming apparent that fall detection devices, in whatever final form they assume, will become an established technology for monitoring the elderly at home. Therefore, it can be envisaged that future fall detection technologies in the home will eventually include some type of falls prevention strategy, similar to the method described earlier."

The key factor in the success of all of these technologies is the Internet. The ability to unobtrusively retrieve patient health information from their home, act on this information, and issue health management recommendations from a distance will open up a world of possibilities for healthcare. While the transition will be painful, change is coming. As the Australian government currently ponders the pros and cons of spending up to U.S. $43 billion on a proposed initiative to install fiber optic cable, carrying broadband speeds of approximately 100 Mbits/s, to every home in the country, the migration of primary healthcare to the home is proving to be one of the critical issues driving the debate. Irrespective of the successes of Australia's National Broadband Network, the Internet will continue to permeate into our everyday lives, and it is only a matter of time before healthcare systems change the way they do business and begin to make full use of this incredible communication resource at their disposal.

We plan to trial our falls-risk assessment technology on a larger scale, and in a completely unsupervised setting, over the next year. We are currently redesigning the unit so it will not only record acceleration, but will contain gyroscopes (to measure angular velocity) and a barometric air pressure sensor (to detect changes in the device altitude), improving how well human movement may be characterized. A speaker will also be added so that a voice recording may guide the user through the directed routine assessment, since they will be otherwise unsupervised. It is our hope that in the coming years, this form of monitoring technology will significantly improve the quality of life of an aging population by reducing their incidence of falls.

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Brain Machine Interfaces for Personalized Neurological Diagnostics and Therapy

"The overarching theme of BMIs is the restoration/repair of damaged sensory, cognitive and motor functions such as hearing, sight, memory and movement via direct interactions between the nervous system and these artificial devices. It may even go beyond simple restoration to conceivably augment these functions, previously imagined only in the realm of science fiction."

By Karim Oweiss

Brain Machine Interfaces (BMIs), a technology that is only about 10 years old, promises to revolutionize the way we diagnose and treat a wide variety of neurological diseases and disorders. Broadly defined, a BMI system provides a direct communication pathway between the brain and a man-made device. The latter can be a an active circuit on a silicon chip, an artificial limb, or even a network of computers. The overarching theme of BMIs is the restoration/repair of damaged sensory, cognitive and motor functions such as hearing, sight, memory and movement via direct interactions between the nervous system and these artificial devices. It may even go beyond simple restoration to conceivably augment these functions, previously imagined only in the realm of science fiction.

Some striking advances in microfabrication technology and systems engineering, coupled with substantial progress in invasive brain surgery, have fueled the brisk evolution of BMIs. It is now feasible to implant arrays of microelectrodes in select brain areas for sufficiently long periods of time to monitor signals from small populations of brain cells. These signals can now be decoded and used to control external devices, such as robotic limbs, or even be used to stimulate the subject's natural arms. The interface technology, however, is not restricted to invasive techniques and now encompasses the use of noninvasive recordings (e.g. EEG), albeit at the expense of much lower temporal and spatial resolution, to monitor global brain states during a variety of experimental conditions.

Reliable and sustained brain recordings in patients interacting naturally with their surroundings is key for clinically viable BMIs. This is in part because many complex brain mechanisms during the normal

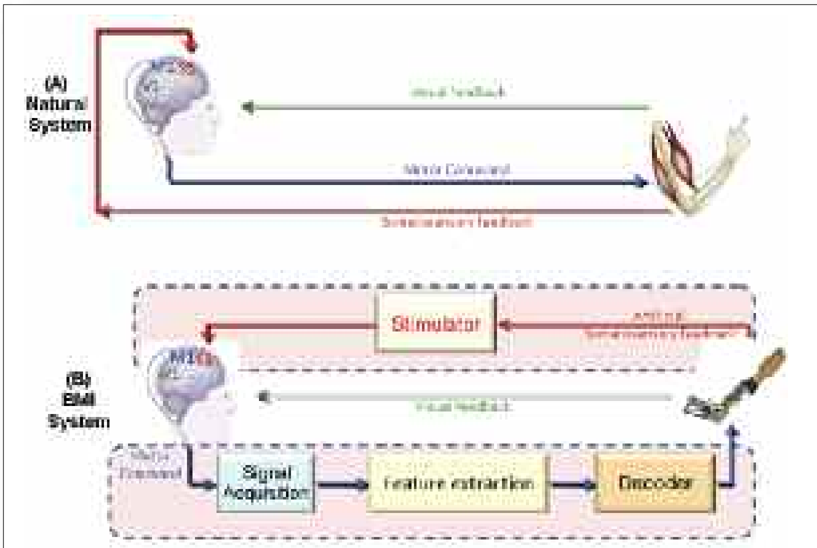

Figure 1: Brain Machine Interfaces may replace natural sensorimotor transformation in subjects with severe motor deficits. (M1 = Primary Motor Cortex, S1= Primary Somatosensory Cortex, V1 = Primary Visual Cortex).

and pathological states can only be monitored over prolonged periods of time, such as detecting epileptic seizure onset. Wireless BMIs constitute one major focus of the community to allow continuous monitoring of brain states in patients at home by telemetering neural data continuously to promptly alert the caregiver. The opportunity for immediate intervention also exists by stimulating or modulating brain activity through BMIs to combat potential symptoms of abnormal brain activity.

The pace of research in this area is rapid to the extent that new techniques continue to swiftly emerge. The paradigm shift being witnessed now in understanding brain function as a result of advances in BMIs is already paving the way for the technology to become a building block in a myriad of emerging clinical applications.

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Wearable Systems for Brain-body Reading and Mind Healing

"Ubiquitous monitoring of physiological and behavioral correlates of complex mental states might prove instrumental in providing insight in dealing with mental disorders."

▸ By Alessandro Tognetti et al.

People express their mental states through gesture, posture, facial expression, eye gaze, prosody and vocal tones. Hidden physiological parameters such as Heart Rate (HR), Heart Rate Variability (HRV), Respiration Rate (RR), and electrodermal response (EDR) are somehow correlated to emotions and thoughts. Ubiquitous monitoring of physiological and behavioral correlates of complex mental states might prove instrumental in providing insight in dealing with mental disorders.

Our group is involved in the development of fully wearable interfaces for unobtrusive monitoring of physiological signs, activity and movement, eye gaze and facial expression to explore their potentialities in the management of mental disorders.

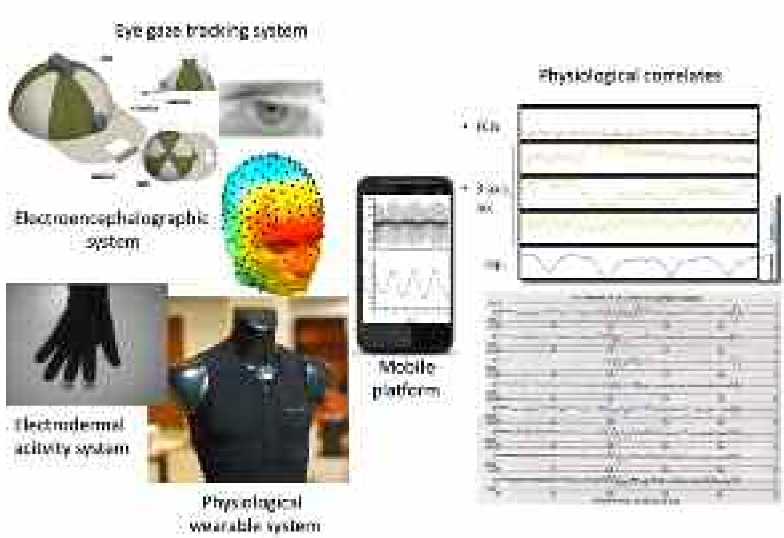

Figure 1: Wearable bio-monitoring systems.

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Figure 2: Textile based motion sensing interfaces.

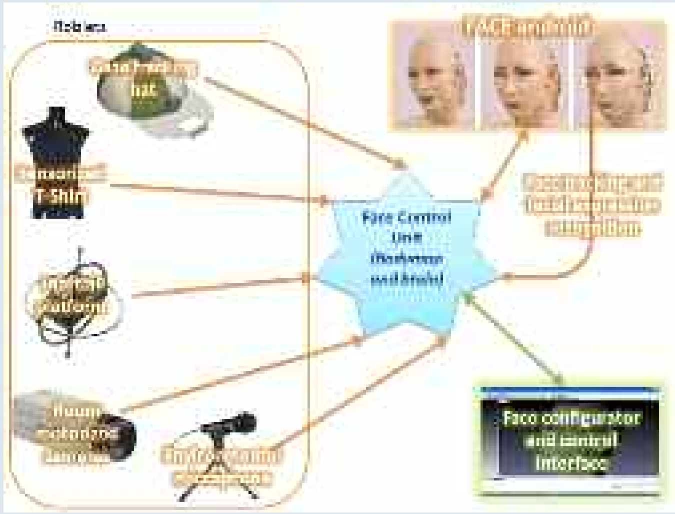

Figure 3 (right): Framework for the treatment of ASD disorders through facial expression mimicking.

Our bio-monitoring research is mainly focused on evaluating human Psycho-Physiological State (PPS) by processing peripheral and central signals acquired by non-invasive monitoring systems (Fig. 1). The aim is to identify differences between healthy and pathological subjects as well as healthy (pathological) subjects in different psycho-physiological states. Several domains are covered ranging from biomedical signal processing, sensors, embedded electronics, advanced analysis and computational intelligence. Most of the physiological signals are acquired by means of textile-based systems, Electrocardiogram (ECG) and breathing activity through sensing T-shirts and EDR through sensing gloves. Concerning Central Nervous System (CNS), standard instrumentation such as clinical and high resolution Electroencephalogram (EEG) are used as a gold standard for cognitive investigation. Moreover, a compact head mounted eye-gaze tracker has been developed in order to investigate the functional connectivity between pupil size variation or gaze-point set and PPS.

Wearable interfaces for full body monitoring (Fig. 2) have been developed through the textile integration of elastic sensors based on conductive elastomer (CE) materials. CE materials show piezo-resistive properties – a fabric deformation can be related to a sensor electrical resistance variation. CE materials can be integrated into elastic fabrics without changing the substrate mechanical properties, thus maintaining user comfort during the monitoring phase. These innovative sensing garments allow the monitoring of body posture and gesture in rehabilitation and human machine interaction for disabled people. Furthermore, these systems were successfully employed in behavioral studies with functional MRI during specific motor tasks. The main advantages of the described technologies are the overall system lightness, flexibility and unobtrusiveness, and the low costs of the textile process. Current research is oriented towards the combined use of inertial and textile sensors in a data fusion approach in order to address the limitations of the systems that are currently available.

A new paradigm for the treatment of Autistic Spectrum Disorders (ASD) has been conceived and implemented in our lab by means of the FACE android which is used as an interactive, physical display of emotional facial expressions; a room in which the human-android interaction takes place is equipped with motorized cameras, directional microphones, smart wearable sensors for physiological signals acquisition, and other acquisition and user interaction systems as shown in Fig. 3. The physiological and gestural wearable interfaces are being used in several research projects focused on basic investigation, assessment, and treatment of psychological related aspects.

In the EU-funded PSYCHE project, the described wearable bio-monitoring systems are used for the study and treatment of bipolar patients.

Within the EU-funded INTERSTRESS project, whose aim is the physiological stress treatment through virtual reality experiences and continuous patient monitoring, a mobile personal bio-monitoring system is under development. This system will unobtrusively perform a continuous tracking of patients' physiological (HR, HRV, RR) and behavioral status. Behavioral assessment is not intended for stress identification but for the definition of physiological measurements context.

Recent studies within the EU-funded CEEDS project, are oriented towards the capture and classification of explicit and implicit navigation through mental states to investigate the process of discovering hidden data in huge multi-dimensional datasets.

Alessandro Tognetti, Ph.D.
Enzo Pasquale Scilingo, Assistant Professor, Ph.D.
Gaetano Anania, M.Eng
Nicola Carbonaro, Ph.D.
Antonio Lanatà, Ph.D.
Federico Lorussi, Ph.D.
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7TH ANNUAL GAMES FOR HEALTH CONFERENCE

PART OF GAMES BEYOND ENTERTAINMENT WEEK

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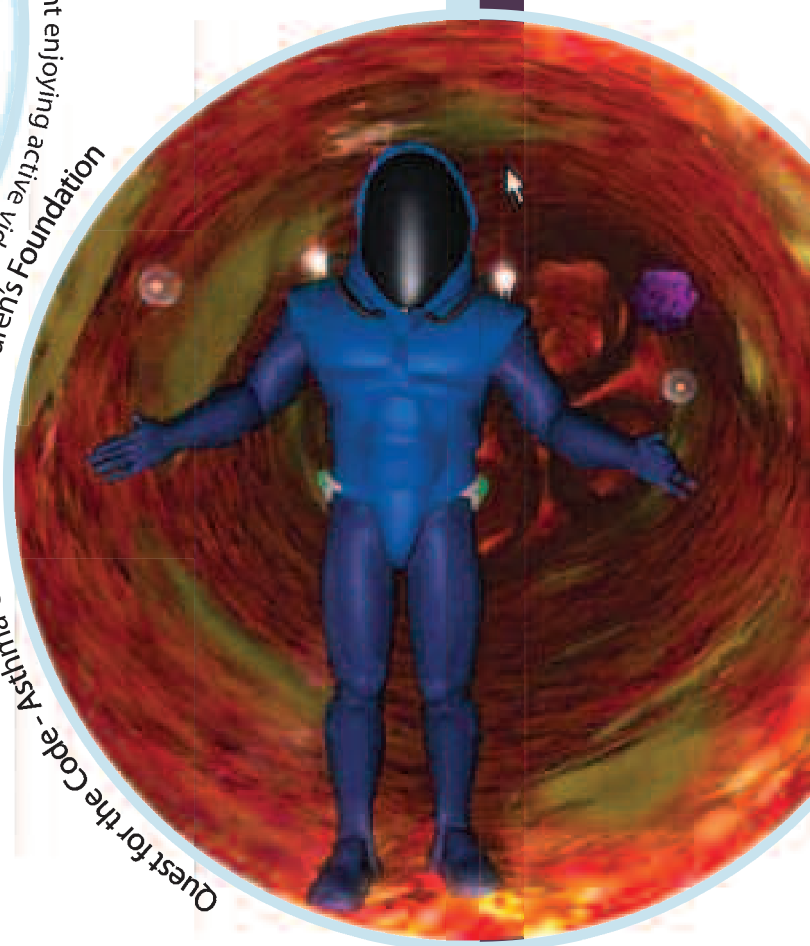
THREE DAYS TO EXPLORE THE ROLE OF VIDEOGAMES IN HEALTH & HEALTHCARE


John Hopkins Hospital patient enjoying active videogame play


Quest for the Code - Asthma Game, Starlight Children's Foundation

pioneer

Robert Wood Johnson Foundation

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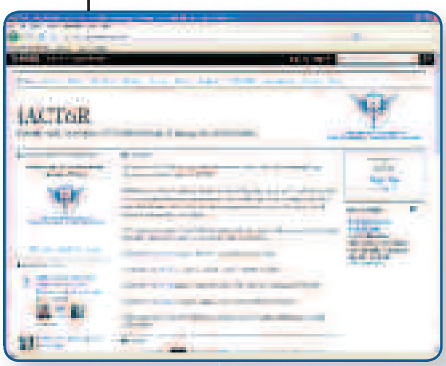
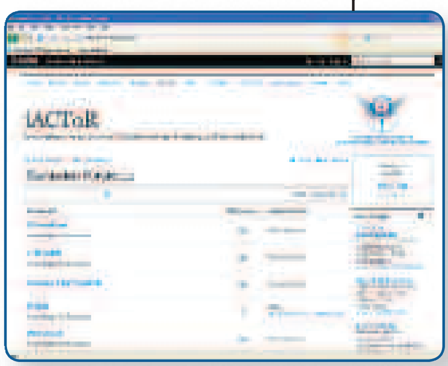
10% discount: enter **bost11** during registration



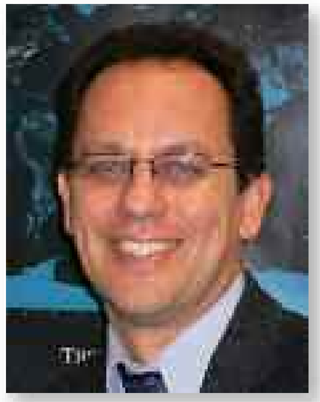


Ask the Expert:

Q&A Ilias Iakovidas

Head of Unit of the ICT for Health General Directorate Information Society

"In the near future, we could see people accessing their records online, booking appointments, requesting repeat prescription and volunteering for research trials. You give the right tools to the patients and you get them to have a 'response-ability' to cope with their condition."



Brenda Wiederhold: Today I am in Brussels, interviewing Dr. Ilias Iakovidis from the European Commission. Dr. Iakovidis, I would like to start by asking what your current position is at the Commission?

Ilias Iakovidis: I am currently acting as Head of Unit of the ICT for Health, General Directorate Information Society.

B.W.: Can you tell me what the significance is of healthcare events that you help to organize?

I.I.: We try to present past projects to politicians, industry members, users, stakeholders, and health care professionals in order to involve them in the large-scale innovation and deployment process. In 2010 we held a spring event targeting policy and politicians, and the fall event focusing on market forces.

B.W.: And how did you become interested in technology and health care?

I.I.: I had an accidental interaction with cardiologists at my university when I was a PhD student in the US, which ultimately led to my thesis. After finishing my PhD, I was called by the Biomedical Engineering Department in Canada to prove my PhD work. I applied my theory into practice as a post-doc and later, as a research associate at the Montreal Heart Institute. I applied for a research officer position at the European Commission while working in Canada, and that came to fruition in 1993. Now here I am – a "Eurocrat" managing R&D and policy in the domain of health informatics, now known as eHealth.

B.W.: Can you tell me about the European Commission's role in health care and technology?

I.I.: The European Commission has huge framework programs to facilitate research and innovation, but it has a very weak mandate in healthcare, which is left to the Member States. Through the window of a single market for eHealth systems and services, the Commission has been one of the first international funding organizations to focus on interdisciplinary projects and research in eHealth since the end of the '80s. We invested early, and gradually increased. So from $10 million a year at the end of the '80s, we are now at $100 million a year. In the late '90s we started working with Member States, policy, industry, users, stakeholders, and associations. We then created European associations of eHealth stakeholders like EUROREC, EHTEL, and began policy work and deployment, based on solid research ground.

B.W.: It seems you have also been very involved in EU-US cooperation, is that correct?

I.I.: Yes. We are involved in policy and research with the US, supporting global interoperability. Last December Vice-President of the European Commission Neelie Kroes and United States Secretary of Health and Human Services Kathleen Sebelius signed a Memorandum of Understanding with the common aim to create new markets and growth opportunities for industry in the eHealth sector in both the EU and the US.[1] As well the ARGOS eHealth Pilot Project expands the impact of eHealth Week across the Atlantic: it develops and promotes common methods for responding to global eHealth challenges in the EU and the US.

B.W.: Are American universities involved in the European research initiatives?

I.I.: Certainly. We had a special call inviting US organizations to join our Virtual Physiological Human (VPH) initiative [2] projects. We are in close contact with several US funding agencies working on VPH, mainly multi-scale modeling and simulation.

B.W.: What would you consider the ICT for Health's main achievements for the past two years?

I.I.: I think the biggest achievement was getting EU Member States to agree to form a high-level eHealth governance initiative.

B.W.: And what do you see some of the main initiatives being – moving forward for the remainder of 2011 and beyond?

I.I.: We are working to break the legal barriers on patient identification and professional authentication, to increase awareness of benefits by health professionals and patients, and to get the health care professionals and patients personally involved with eHealth.

B.W.: People talk a lot about how technology can improve healthcare, but what do you think are some of the main impacts that it will have on the individual's healthcare?

I.I.: We focused all of the '90s on connectivity - linking all the departments within a hospital, hospitals with GPs, pharmacies, labs, payers and authorities. Now, we're involving every person as a node of that network, receiving and sending vital information. In the near future, we could see people accessing their records online, booking appointments, requesting repeat prescriptions and volunteering for research trials. You give the right tools to the patients and you get them to have a "response-ability" to cope with their condition.

B.W.: In other words, empowering the patients. Yes?

I.I.: Yes. We try to give the patient some kind of map or GPS to navigate through the road of health, for their own sake.

B.W.: So do you see the individual EU citizen embracing the technology now, or do you think most people are standing back waiting?

I.I.: There are very big variations. That's why health care systems are so different. The way a health care delivery system is organized has to do with the relation between a citizen and the state. If they are very trusting of each other, it works marvelously. You can see Denmark as an example. We're going from a trust between people like me and the doctor, to trust between me and a system. That's huge – for some cultures, it's an inconceivable jump.

B.W.: Several years ago, it seemed like there was not as much in the mental health care arena with technology. But now it seems there is an emphasis on that. Are there more things coming across with mental health care?

I.I.: Yes. Until last year, we consciously kept away from the human mental condition because it was too complex for us to deal with. So for the first time, we entered into the game of mental disease and looking at the bigger picture, but through quantitative measurements if possible.

B.W.: Can you tell me some of the biggest obstacles of incorporating technology into healthcare as we go forward?

I.I.: Organization and skills are the prerequisite for getting benefits out of eHealth, and if you don't have them, IT is just another expense. In addition, there are other challenges such as legal issues, incentives, trust among the stakeholders and finally technology. The technological components exist, but an integrated, user-friendly interface and a relevant kind of semantic interaction is not yet there.

B.W.: What are you most proud of in all these years at the Commission?

I.I.: I am very proud to have taken part in developing a vision of patient-centered care, as in 1994, and then seeing results materialize 10 years later. I also want to mention the renewing of the EU eHealth research agenda twice: introducing personal health systems in 1998 – by forging stronger cooperation with biomedical engineers, and biomedical informatics by forming strong synergies with the system biology community in 2002 that lead to our VPH Initiative in 2005.

B.W.: And now, what are your recommendations to researchers seeking funding from the European Commission?

I.I.: A researcher should really understand what it is that can and has to be done; what can be funded at the European level, and what he can do nationally. Also, he should not present a proposal that he is not fully devoted to, because European money is very competitive and very expensive money. It requires a really big effort and commitment.

B.W.: I think it is nice having different disciplines from different organizations, and different countries and cultures working together to solve a problem. I think that is unique to Europe right now.

I.I.: Yes. Since we began funding projects in '89, we went through a phase of community building. We wanted people to create somewhat of a single market of researchers in Europe. I think we are almost there. Now we need to focus on existing challenges that need to be solved at the EU level.

B.W.: Any predictions on new trends that you see in this area?

I.I.: The one that we're betting on is the stronger engagement of people. Some call it m-health or u-health. People will become more immersed in medical knowledge, so they will be able to form an opinion and give feedback. Another trend is personalized medicine. It's not only about your treatment; it's about your condition as a whole. This is a very difficult challenge to accomplish.

B.W.: Thank you for your time.

[1] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/1744&format=HTML&aged=0&language=EN&guiLanguage=en

[2] en.wikipedia.org/wiki/VPH_NoE

FROM WHERE WE SIT:
What Can Personal Health Systems do for Mental Health? The European Answer

By Giuseppe Riva

Within the healthcare domain, the European Commission focus recently 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.

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 in Fig. 1.

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 centers. 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 center; from medical center that analyzes 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 center (e.g., in the form of personalized feedback and guidance to the patient, adjusted treatment via closed loop therapy, control of therapy devices).

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).

Furthermore, 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.

After a very demanding selection, the Com-

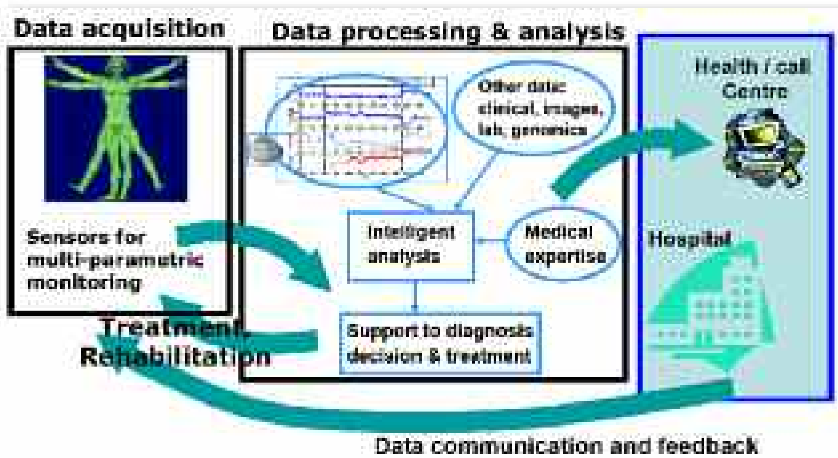


Figure 1: The structure of a Personal Health System.

mission provided financial support to the following six projects – Help4Mood, Ict4Depression, 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. A short description of their contents is in the Table. The expected end outcomes 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 since a lower number of visits will be needed as a result of both preventive monitoring and chronic disease management.

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PHS for Mental Health: The European Projects

Project	Goal
Help4Mood http://www.i2cat.net/en/projecte/help4mood-1	The project Help4Mood proposes to significantly advance the state-of-the-art in computerized support for people with Major Depression by monitoring mood, thoughts, physical activity and voice characteristics, prompting adherence and promoting behaviours in response to monitored inputs. These advances will be delivered through a Virtual Agent (VA) which can interact with the patient through a combination of enriched prompts, dialogue, body movements and facial expressions. Monitoring will combine existing (movement sensor, psychological ratings) and novel (voice analysis) technologies, as inputs to a pattern recognition based decision support system for treatment management.
Ict4Depression http://www.ict4depression.eu/	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 the project: developing unnoticeable 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.
Interstress http://www.interstress.eu/	The project aims to design, develop, and test an advanced ICT-based solution for the assessment and treatment of psychological stress based on "interreality".The project's creators define "interreality" as a hybrid, closed-loop, empowering experience bridging both physical and virtual worlds into one seamless reality. In other words, behavior in the physical world will influence the virtual world experience, and behavior in the virtual world will influence the real-world experience. Clinical use of interreality is based on a closed-loop concept that involves the use of technology for assessing, adjusting, and/or moderating the emotional regulation of the individual. This is achieved by increasing the individual's coping skills and appraisal of the environment based upon a comparison of the individual's behavioural and physiologic response with a training or performance criterion. The project will provide a proof of concept of the proposed system with clinical validation.
Monarca http://www.monarca-project.eu/	MONARCA will develop and validate solutions for multi-parametric, long term monitoring of behavioural and physiological information relevant to bipolar disorder. It will combine those solutions with an appropriate platform and a set of services into an innovative system for management, treatment, and self-treatment of the disease. The MONARCA system will be designed to comply with all relevant security, privacy and medical regulations, will pay close attention to interoperability with existing medical information systems, will be integrated into relevant medical workflows, and will be evaluated in a statistically significant manner in clinical trials.
Optimi http://www.optimiproject.eu/	Depression is often associated with poor coping behavior in the face of stress. Some individuals are extremely resilient but others find it difficult to cope. Based on these premises, OPTIMI has set itself two goals: first, the development of new tools to monitor coping behavior in individuals exposed to high levels of stress; second, the development of online interventions to improve this behavior and reduce the incidence of depression. To achieve its first goal, OPTIMI will develop technology-based tools to monitor the physiological state and the cognitive, motor and verbal behavior of high risk individuals over an extended period of time and to detect changes associated with stress, poor coping and depression. To achieve its second goal, OPTIMI will adapt two existing systems, already used to provide online CBT treatment for mental disorders.
Psyche http://www.psyche-project.org	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. The acquired data will be processed and analyzed in the established platform that takes into consideration the Electronic Health Records (EHR) of the patient, a personalized data referee system, as well as medical analysis in order to verify the diagnosis and help in prognosis of the disease.

FURTHER AFIELD:
Personal Healthcare Blossoms in China

By Lingjun Kong

In China, the vast personal healthcare opportunities are currently being stimulated by an increasing demand from a fast-aging population, rising income, and the tremendous growth of biomedical products and services in the domestic biomedical sector market. The growth of this additional demand for medical care and devices has increased in spending that is presenting a major boost to the biomedical sectors. Healthcare spending is expected to reach $600 billion by 2015 according to Medical Device Daily. This recent advancement in medical products has caused a blossoming of personal healthcare in China.

Healthcare reform seems to be a hot topic in the world today. The U.S. is not the only country undergoing a healthcare reform process. Many changes have been implemented that will drastically alter the healthcare landscape of China. For example, two years ago, the State Council in China allocated $125 billion to implement the New Medical Reform Plan to expand China's services to improve universal health care for China's population. Major components of the plan include efforts to expand medical infrastructure such as restructuring existing urban health centers and clinics and improving new ones. These implementations will help reform China's healthcare system to become a source of innovation rather than a base for outsourced and dated biomedical technology. With these renovations, patients will be able to refocus their spending on disease prevention and health improvement. Because of the high demand for health screening within the middle class, one area of tremendous growth is the In Vitro Diagnostic (IVD) market. Hospitals have adopted advanced technologies in this area, causing more private laboratories to emerge. Another area of noticeable growth is in the Health Information Technology (HIT) sector which is expected to spend $4.1 billion by 2013. Moreover, patients will have a greater awareness of health and wellness, leading to increased demands for high-quality care. As for clinicians and high-tech companies, there has been a surprising increase of interest in patient monitoring devices. For example, numerous domestic 24-hour ECG Holter Monitoring systems surprisingly mushroomed in China International Medical Equipment Fair last year to meet the escalating demands.

The recent advancement for heatlhcare and medical devices has already provided a major lift to the biotechnology sector. China's SFDA introduced nearly one hundred new industrial standards in December 2010, which will become integral parts of the medical device requirements beginning in mid-2012.

"Healthcare reform seems to be a hot topic in the world today. The U.S. is not the only country undergoing healthcare reform process. Many changes have been implemented that will drastically alter the healthcare landscape of China."

Several special regions in China have already rewarded the desired environment for the development of biomedical products: Beijing Zhongguancun Life Science Park is an area dedicated to supporting new discoveries in advanced pharmaceuticals and medicines; Shanghai International Medical Zone specializes in device manufacturing, R&D, medical treatment and education; Taizhou Medical High-Tech Industrial Development Zone, with the support of the central government, focuses on scientific research in the manufacturing of medical equipment.

Among a mass influx of innovative medical products, the IVT Mobile Health Management and Rescue System has gained a lot of attention, and is a distinctly successful device. The system was chosen as one of the Top 10 Technologies at CES 2010. As a complete remote medical monitoring solution that allows medical monitoring from home, this device fully adopted most advanced Bluetooth technologies, reduces the risk of chronic diseases and assists with speedy rescues in the case of emergencies. Patients are able to measure blood pressure, cardiogram, and blood oxygen and glucose levels with the use of the mobile phone, wireless blood pressure meter, oximeter, glucose meter and other devices that come with the system. These signals are displayed on the phone, automatically tracked on the remote server, and sent to third parties through messages for convenient monitoring.

As a foremost global supplier of Bluetooth software, Fixed-Mobile Convergence terminal solutions, and location-based marketing systems, IVT's major product Bluetooth V4.0 High Speed has a user installed base over 100 million in 145 countries. The company applied its advanced Bluetooth technology, integrated various physiology measurement devices, and created a mobile health management and rescue system targeted to treat elderly people who suffer from chronic diseases such as cardiovascular diseases, hypertension and diabetes.

The main device kit includes a S120 mobile phone, a wireless blood pressure meter, a wireless ECG monitor, a wireless oximeter, a wireless glucose meter and a wireless PSTN access point. The S120 is the first mobile phone that utilized Fixed-Mobile Convergence technologies. It can be used as a cordless phone to make it more convenient when making or receiving fixed line

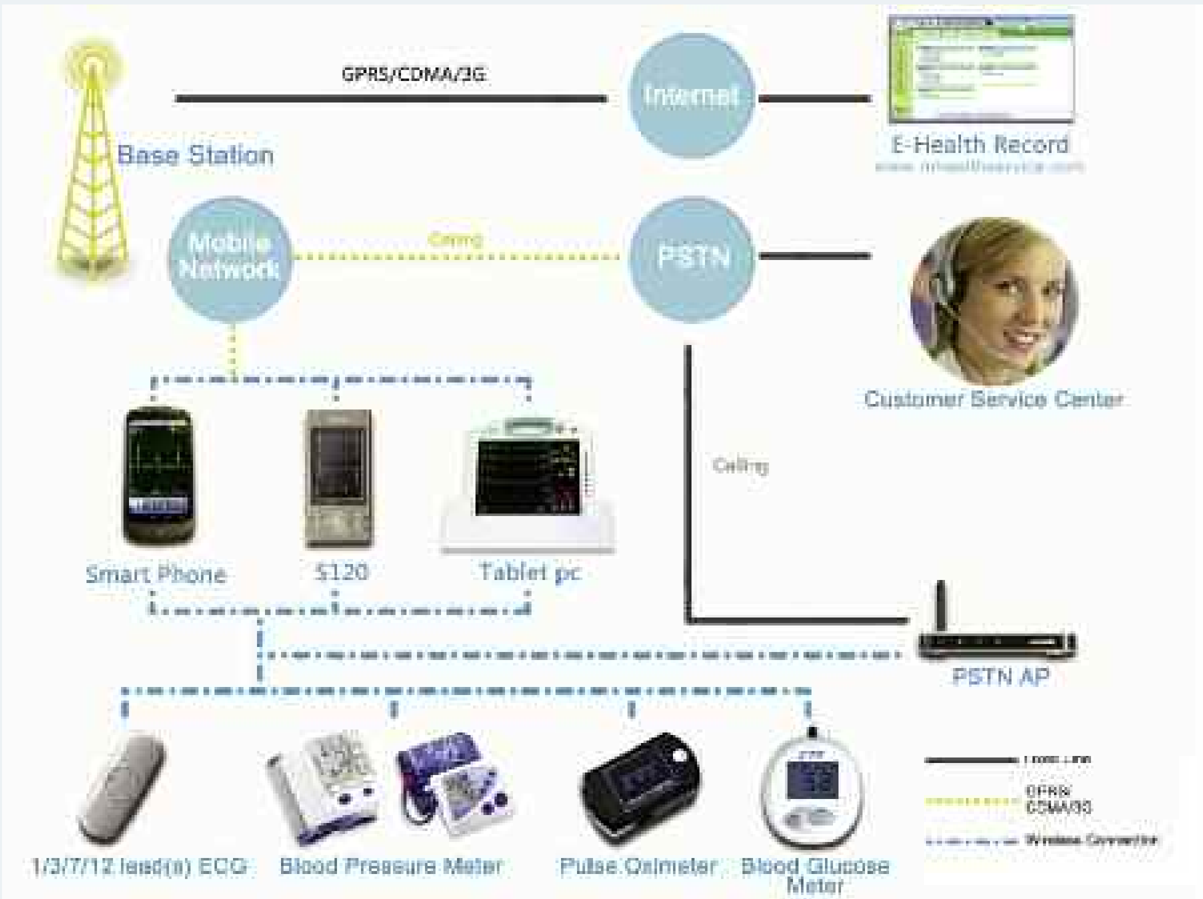

Figure: IVT Mobile Health Management & Rescue System Solution. **Source:** Tim Wei of IVT Corporation

calls. Using this set of fully automated devices, a user can measure their blood pressure, review their cardiac activity, blood glucose level and blood oxygen level. The results, which stand for vital life signs, are displayed on the S120 and sent to the user's Personal E-Health Record on a remote server where the data is saved and analyzed in real time. In addition, the companion mHealth software has also been ported to Windows Mobile, Android and Symbian platforms, so that users will be able use their own smart phones to monitor their health condition.

The Personal E-Health Record is an online network platform of user health information; hospitals, emergency centers, or users can remotely access it. Emergency centers are able to use this record system to provide better rescue plans as all of a user's information can be accessed based on an incoming caller ID from the S120 mobile phone. Similarly, hospitals can access their patients' E-Health Record through this ID, giving doctors a better and more comprehensive understanding of their patients' health history through the touch of a button.

Finally, a national level call center provides 24-hour services with health consultants who can easily process any emergency rescue information and immediate assistance sent by the clients' mobile device. In the case of emergencies, the patient can press a hotkey on the S120 to connect to the emergency center. A short rescue request with the location of the user is sent to all related parties including the IVT call center, emergency center, and relatives.

These diverse devices and software systems offer just a small representation of the emerging technologies. Although there will be harsh competition and a whole different set of new rules and regulations to adhere to for the biomedical sector companies, China will have many novel and innovative technologies in personal healthcare products in the future, even surpassing the success of the IVT Mobile Health Management and Rescue System. New opportunities are continuing to grow with the planned budget allocations and implementation of specialized manufacturing and R&D research zones. With China's already strong and established foundation in healthcare, the time is ripe for these technologies to fully blossom and come to fruition.

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Therapeutic and Educational Use of the Robot KASPAR with Children with Autism

"KASPAR was found to be very attractive to children with autism and may address some of the difficulties that these children face. Interaction with KASPAR is a multi-modal embodied interaction where the complexity of the interaction can be controlled, tailored to the need of the individual child and gradually increased."

By Ben Robins & Kerstin Dautenhahn

Throughout the years, psychologists, therapists and educators have emphasized the important role of play in child development as a crucial vehicle for learning about the physical and social environment, the self, and for developing social cognition and social relationships. For decades the use of computers in education has been an active area of research. In utilizing interactive devices, educators have seen a profound and beneficial effect on how children develop and grow. In recent years, researchers have been exploring the use of mobile and humanoid robots as "toys" in playful interactions for the education and therapy of children with autism.

Studies into the behavior of children with autism suggest that they show a preference for interacting with objects rather than with other people. Often, children with autism are described as socially isolated, ignoring other people near them. People's social behavior can be very subtle and could seem, to those with communication problems and a deficit in mind reading skills, widely unpredictable. This can present itself as a very confusing and possibly stressful experience to children with autism. Different from human beings, interactions with robots can provide a simplified, safe, predictable and reliable environment for these children. Interaction with the robots could be an intermediate phase where robots, with specific programmed behavious and specific play scenarios could then become *social mediators* – encouraging the children to interact with *other people* (peers and adults).

In this article we present case-study examples from our work with our humanoid robot KASPAR in several projects, e.g. AURORA and ROBOSKIN where the research focuses on ways that KASPAR can be used as a social mediator and engage autistic children in various interactive activities such as turn-taking, joint-attention and imitation games, with the aim of encouraging basic communication, tactile and social interaction skills.

KASPAR, a child-sized minimally expressive robot that was developed by the Adaptive Systems Research Group at the University of Hertfordshire, has a novel design particularly suitable for social and health-care robotics applications. It acts as a research platform and as assistive technology for our work with children with autism. It uses mainly bodily expressions (movements of the head, hands, arms), facial expressions, and gestures to interact with a human. Aesthetic consistency and reduction in details of the face are key design issues, as well as the robot's minimally expressive abilities and the recent addition of sensitive skin that are key to engage people in interaction.

Figure 1: KASPAR the robot.

An emphasis on the features used for communication allows the robot to present facial/gestural feedback clearly e.g. by changing orientations of the head, mov-

Figures 3 (above): KASPAR mediates child-child and child-adult interactions in turn-taking and imitation game.

Figure 2 (above): Liroy communicates in a non-verbal way with another child.

ing the eyes and eyelids, moving the arms, and "speaking" in simple, pre-recorded sentences. A reduction in detail de-personalizes the face and allows the interaction partner to project his/her own ideas on it and make it, at least partially, what they want it to be. These are very desirable features for a robot to be used in different social and healthcare applications, e.g when used in assistive technology with children with autism, who generally have great difficulties in recognizing complex facial and gestural expressions.

In recent years we have worked with several special education schools. The children varied widely in their abilities and needs (from very low functioning children with autism to high functioning and those with Asperger syndrome). KASPAR was found to be attractive to all these children regardless of their abilities. During this time play scenarios have been developed taking children's specific strengths and needs into consideration and covering a wide range of objectives in children's development areas (sensory, communicational and interaction, motor, cognitive and social and emotional).

Observation analysis of play sessions of children with autism at schools showed many case study examples of possible implementation of KASPAR for therapeutic or educational objectives as follows:

- promote body awareness and sense of self,
- help to break the isolation for some children,
- mediate child-child or child-adult interaction,
- help children with autism manage collaborative play,
- use by therapists as a tool to teach turn-taking and other basic social skills
- help to encourage or discourage certain tactile behavior during child-robot tactile interaction.

KASPAR Promotes Body Awareness

All the children with autism who met KASPAR for the first time (children of different age groups and of both genders) were drawn to explore him in very physical ways (see Fig. 1). Tactile exploration is important to increase body awareness and sense of self for these children.

KASPAR Helps to Break the Isolation

Several children with severe autism who have very limited or no language at all, and who often are withdrawn into their own world, got excited in their interaction with KASPAR and sought to share this experience and communicate (in a non-verbal way) with other people. One example is Liroy (Fig. 2) who is known at school to not interact at all on his own initiative with other people (not with teachers, nor with other children). After playing with KASPAR for several sessions he sought to share his excitement with his teacher and also started to communicate with another child and with his teachers.

KASPAR Helps Children with Autism to Manage Collaborative Play

The use of a remote control, the simple operation and the minimal expressiveness of KASPAR are all encouraging aspects for the children, not only to play with the robot, but to initiate, control and manage collaborative games with other children and adults (Fig. 3). In this scenario the children no longer merely follow instructions of games given to them by adults (which is often the case in classroom settings) but they have the opportunity, with the use of the remote control, to actually manage the game themselves i.e initiate, follow, take turns and even have the opportunity to give instructions to their peers.

Autism is a spectrum disorder that can occur to different degrees and in a variety of forms. KASPAR was found to be very attractive to children with autism and may address some of the difficulties that these children face. Interaction with KASPAR is a multi-modal embodied interaction where the complexity of the interaction can be controlled, tailored to the need of the individual child and gradually increased. KASPAR may be used in therapy or education to encourage social interaction skills in children with autism, potentially assisting the children in generalizing experiences from interaction with the robot to interaction with people.

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After being forced to completely rebuild their healthcare system while at the same time strengthening the entire country around the middle of the last century, Poland has faced great obstacles to providing its population with reliable mental healthcare. Currently, Poland is giving priority to psychology programs and implementing new technologies to aid treatment.

Since the German occupation of Poland beginning in 1939, Poland has been rebuilding its healthcare system. This occupation proved to be a major setback as the Nazis first targeted psychiatric inpatients in hospitals – a huge number perished during this time – and the existing medical system was dismantled. As the country attempted to rebuild its healthcare system in 1945, psychiatry was not a high priority. In the 1950s it was discovered that there was a large deficit in the number of psychiatric beds in central Poland, resulting in the transfer of patients in need to western Poland where medical treatment could more easily be ensured. This quick-fix solution proved to impose stress on family ties and weaken relationships. Also, a lack in the number of available staff meant that adequate care was not always received and it was difficult to archive related data that would be of interest for long-term studies, including the prevalence of mental disorders. This further compounded the problem of adequately treating chronic mental disorders.

Rebuilding Foundations

In 1952, a special act was introduced by Parliament resulting in the creation of a comprehensive, free general healthcare system including in- and out-patient psychiatric services. To generate a higher number of new specialists in the field of medicine, students were given the option to receive free training to become physicians. Seven universities quickly established medical faculties and this, in turn, helped to develop available psychiatric services.

The introduction of the Mental Health Programme and the Mental Health Act in the mid-1990s acted as momentous catalysts to improve the future of psychiatric practices in Poland. Clinical psychology and psychiatry have been recognized as major specialties in the field of Medicine since 1999, with medical students encouraged to enter available programs. Currently, 18 universities offer psychology programs.

Possible Limitations

The structure fund budget allocates funds in Poland that go towards modernizing and setting up research facilities. Funds are accessible on a national and regional level and contribute towards creating University facilities, Centers of Excellence and Technology Parks based on multi scale domains. Research facilities, therefore, will be positively affected for the upcoming 2-3 years, but researchers voice concern over what it will mean for the development of such facilities and for their staff after the current funds are depleted. An insufficient level of national

Population (Million)	38.2
Life Expectancy (Years)	61%
Fertility Rate	8.5%
Population Median Age (years)	75.7
Percentage of Urban Population	1.3
Unemployment Rate	8.5%
Suicide Rate (per 100,000)	14.9
Psychiatrists (per 100,000)	6
Psychiatric Hospital Beds (per 100,000)	83.2
Extrapolated Prevalence to Schizophrenia (per 100,000) - Inpatient Care	347.8
Extrapolated Prevalence to Schizophrenia (per 100,000) - Outpatient Care	86.6
Extrapolated Prevalence to Anxiety Disorders (per 100,000) - Inpatient Care	889.5
Extrapolated Prevalence to Anxiety Disorders (per 100,000) - Outpatient Care	38.9
Number of Universities Offering Psychology Programs	18

funds for already existing facilities means new growth will be slowed, perhaps offering a chance for self-finance systems or other methods to be explored.

Current Projects

Many opportunities are available for Poland to participate in international collaboration with countries around the world, and in bilateral programs with the U.S. Polish scientific centers have partnered with leading foreign centers to implement join research projects and exchange personnel. For example, The Department of Psychiatry and Combat Stress of the Military Medical Institute in Warsaw (DP&CS MMI) currently collaborates with the Virtual Reality Medical Center in San Diego, as well and the Virtual Reality Medical Institute (VRMI) in Brussels, Belgium to further treatment for stress-related disorders. The organizations have shared software and related hardware, and VRMI representatives have assisted in personnel training to use the systems in Poland. Similarly, the Biological Threats Identification and Countermeasure Centre of the Military Institute of Hygiene and Epidemiology and the Institute of Electro-Optics of the Military Academy of Technology, centers in the Polish Armed Forces, work closely with international labs.

In particular, Universities and large research organizations benefit from these relationships, whether in the form of financing possibilities or furthering business ties. In particular, the 7th FrameWork Programme set up by the European Commission allows Polish partners to fully participate in the European Research Area (ERA) and explore cutting edge technologies and research possibilities with other labs and countries. This program and other types of collaboration allow Polish participants to implement new technologies in their everyday work and further collaboration for learning and development opportunities.

Applied ICT Research in Poland

Advanced technologies are gradually being adopted into current practices. The DP&CS MMI is the first organization to use Virtual Reality (VR) technology in the prevention and treatment of mental disorders. “We have been successfully using this technology in a comprehensive therapy of fear disorders connected with combat stress experienced in military operations in Iraq (Operation Iraqi Freedom – OIF) and Afghanistan (International Security Assistance Force - ISAF),” said Prof. Dr. Stanislaw Ilnicki, a leading researcher in the program.

Information and Communications Technology (ICT) research will assuredly play

a large role in the development of Poland's treatment of mental health problems in upcoming years. A rapidly growing market will include mobile solutions, including telemedicine, to provide easier access to multimedia medical records for medical staff as well as patients. Adam Koprowski, a General Specialist for Telemedicine Development at the Warsaw Military Institute agrees that eHealth is a booming industry including diverse applications such as the implementation of complex Hospital Information Systems, as well as telemonitoring, sensoring and intelligent homes and buildings.

Additionally, the elderly population in Poland, similar to the trend throughout other developed countries, will continue to grow, which will lead to a growth in healthcare facilities and implementing ICT technology as needed. These populations in particular may benefit from tele-rehabilitation to manage chronic diseases through the delivery of specialized services through the Internet, such as an easily accessible software platform to aid in interaction between hospital personnel and at-home patients during the rehabilitation and monitoring processes, Koprowski says.

Spojrzenie Do Przyszłości

As has already been established, the use of ICT in the area of mental health protection in the Polish Armed Forces will be applied in the psycho- and social support network as well as long-term monitoring of veterans' quality of life. The application of VR therapy will undoubtedly see further support and growth and Ilnicki says, "We are going to continue to develop applications of VR in therapy of war-trauma related fear disorders and in stress-resistance training."

Lastly, in 2010 the Military Institute of Medicine in Warsaw (WIM) initiated a permanent tele-medicine communication project with the ISAF's healthcare service which will be used for both psychiatric and psychological consultations.

Poland has suffered largely since the middle of the 20th century, but has determinedly built a strong foundation for a competent and competitive healthcare system. Through international collaboration and the visions of talented Polish researchers and caregivers, healthcare will continue to improve and gain strength, aided largely by advanced technologies.

Sources:

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