A Demonstration of 4D Digital Avatar Infrastructure for Access of Complete Patient Information

Project acronym: MyHealthAvatar

Deliverable No. 2.1
State of the art review related to the MyHealthAvatar environment

Grant agreement no: 600929

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

COVER AND CONTROL PAGE OF DOCUMENT	
Project Acronym:	MyHealthAvatar
Project Full Name:	A Demonstration of 4D Digital Avatar Infrastructure for Access of Complete Patient Information
Deliverable No.:	D2.1
Document name:	State of the art review related to the MyHealthAvatar environment
Nature (R, P, D, O)[1]	R
Dissemination Level (PU, PP, RE, CO)[2]	PU
Version:	1
Actual Submission Date:	29/11/2013
Editor: Institution: E-Mail:	Prof. Dr. Norbert Graf USAAR graf@uks.eu

ABSTRACT:
The main goals of this document are to review existing frameworks, to provide the clinical perspective of the project and to take into account the state of the art, the state of research and the state of practice. We have identified, explored and presented the current infrastructure systems, innovative tools, software and the top eHealth research projects.

KEYWORD LIST:
Review, state of the art, eHealth projects, services, software, repositories, tools, digital patient.

[1] **R**=Report, **P**=Prototype, **D**=Demonstrator, **O**=Other

[2] **PU**=Public, **PP**=Restricted to other programme participants (including the Commission Services), **RE**=Restricted to a group specified by the consortium (including the Commission Services), **CO**=Confidential, only for members of the consortium (including the Commission Services)

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 600929.

The author is solely responsible for its content, it does not represent the opinion of the European Community and the Community is not responsible for any use that might be made of data appearing therein.

MODIFICATION CONTROL			
Version	**Date**	**Status**	**Author**
0.1	30/09/2013	Draft	Ruslan David, USAAR
0.2	31/10/2013	Pre-final version	Ruslan David, USAAR
1.0	18/11/2013	Final version	Norbert Graf, USAAR Ruslan David, USAAR Yvonne Braun, USAAR Holger Stenzhorn, USAAR

List of contributors

- Norbert Graf, USAAR
- Ruslan David, USAAR
- Yvonne Braun, USAAR
- Holger Stenzhorn, USAAR

Contents

1 Executive Summary

The main goals of this document are to review existing frameworks, to provide the clinical perspective of the project and to take into account the state of the art, the state of research and the state of practice. We identified, explored and presented the current infrastructure systems, innovative tools, software and the top research projects.

The first part of this document presents the Digital Patient Roadmap concept and the top eHealth research projects in a clinical perspective to serve as a 'guideline', useful for implementation of the clinical related interfaces and functionalities of the MyHealthAvatar (MHA) platform.

The second part presents the services, software, repositories and the tools useful for successful implementation of the MHA project's activities. The presented and described resources are structured in the following sections:

- Virtual Physiological Human (VPH) Roadmap and eHealth Projects
    - Digital Patient Roadmap
    - eHealth Projects with Clinical Perspective
- Services, Software, Repositories and Tools
    - Personal Health Records
    - 3D Human Anatomy
    - Biomedical Repositories
    - Clinical Trials

2 Virtual Physiological Human (VPH) Roadmap and eHealth Projects

MyHealthAvatar will be built on the latest ICT technology with an aim of engaging public interest to achieve its targeted outcomes. As result, this chapter presents an overview of the top eHealth research projects. This complies with the priority of this document to describe the state-of-the art frameworks and research actions in the eHealth domain, and constitutes a preparatory action aiming at the grand challenge on a "Digital Patient", which is currently the subject of a roadmap in the VPH community.

2.1 Digital Patient Roadmap

DISCIPULUS project[3] is an undertaking established by the European Commission in October 2011 to set up a roadmap for the "digital patient". The Digital Patient term is an envisaged super-sophisticated computer program that will be capable of generating a virtual living version of your(our)self. When this is achieved, it will be possible to run 'simulations' of health and disease processes on the virtual or 'digital' you, and use the results to make predictions about your real health. It will also be possible to determine the best treatment specifically for you. This is termed 'personalised medicine', and is intended to be the future of healthcare.

The DISCIPULUS project has the ambitious task to create a comprehensive roadmap for the realisation of the Digital Patient (DP) initiative, which will enable clinical decisions to be better informed by the predicted outcomes of different treatment options, and allow patients and clinicians to become more pro-active in instituting lifestyle modifications and clinical surveillance for the prevention of diseases.

The Digital Patient Roadmap (**Picture 1**) is one of the top Work Packages (WPs) of the DISCIPULUS project. It will produce the Digital Patient Roadmap, based on both the discourse within the consortium and the consultation process with key stakeholders. It will thereby integrate results from earlier WPs, including identified priority research needs as well as short-, mid- and long-term efforts needed to realise the milestones identified. The Digital Patient Roadmap WP is mainly focused on these objectives:

- Draft an initial, light-weight roadmap for further discussions
- Integrate expert and partner recommendations in the areas of simulation & modelling, visualization, EHR integration, knowledge integration, physiology/pathology knowledge discovery as well as semantic interoperability, trust & quality.
- Validate S&T scenarios in the respective clinical application contexts
- Draft the final roadmap, including recommendations for further research actions at European and global level. Methodologically, the analytical frameworks developed in WPs 2 and 4 will guide this work, allowing us to structure the topical fields to be covered in a consistent manner along the time line identified. The various meetings and conferences planned support this work and facilitate validation of outcomes and priorities with key players and stakeholders.

[3] DISCIPULUS project, http://www.digital-patient.net [September 2013]

The latest draft of the Digital Patient Roadmap[4] outlines the project's vision of the Digital Patient, aiming at the enhancement of medical practice and patient care. This draft roadmap is proposed as an evolving document; it will be further elaborated and updated on a regular basis to reflect ongoing discussions with key stakeholders including the DISCIPULUS Forum on BiomedTown.

Picture 1. DISCIPULUS project's Digital Patient Roadmap

2.2 eHealth Projects with Clinical Perspective

'eHealth projects with clinical perspective' chapter is inspired by the recently published (September 2013) document which offered an overview of the most current (on-going or recently finished) European funded projects in the field of ICT for health and wellbeing (eHealth). [5] The description of projects from the original publication has been updated with CORDIS[6] data.

2.2.1 Neurology

2.2.1.1 ARMOR

CORDIS description: Epilepsy, the propensity for recurrent, unprovoked epileptic seizures, is the most common serious neurological disorder, affecting over 50 million people worldwide. Epileptic seizures manifest with a wide variety of motor, cognitive, affective, and autonomic symptoms and signs and associated changes in the electrical activities of the brain (EEG), heart (ECG), muscles (EMG), skin (GSR), as well as changes in other important measurable biological parameters, such as respiration and blood pressure. Their recognition and full understanding is the basis for their optimal management and treatment, but presently is unsatisfactory in many respects. Epileptic seizures

[4] DISCIPULUS project's Digital Patient Roadmap, http://www.digital-patient.net/files/DP-Roadmap_FINAL_N.pdf [September 2013]

[5] eHealth Projects - Research and Innovation in the Field of ICT for Health and Wellbeing, http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=2852 [October 2013]

[6] CORDIS, EU Research Projects, http://cordis.europa.eu/projects/home_en.html [October 2013]

occur unpredictably and typically outside hospital and are often misdiagnosed as other episodic disturbances such as syncope, psychogenic and sleep disorders, with which they may co-exist, blurring the clinical presentation; on the other hand, costs of hospital evaluation are substantial, frequently without the desirable results, due to suboptimal monitoring capabilities.

Reliable diagnosis requires state of the art monitoring and communication technologies providing real-time, accurate and continuous brain and body multi-parametric data measurements, suited to the patient's medical condition and normal environment and facing issues of patient and data security, integrity and privacy.

In this project we will manage and analyse a large number of already acquired and new multimodal and advanced technology data from brain and body activities of epileptic patients and controls (MEG, multichannel EEG, video, ECG, GSR, EMG, etc) aiming to design ARMOR, a more holistic, personalized, medically efficient and economical monitoring system.

New methods and tools will be developed for multimodal data pre-processing and fusion of information from various sources. Novel approaches for large scale analysis (both real-time and offline) of multi-parametric streaming and archived data will be introduced to discover patterns and associations between external indicators and mental states, detect correlations among parallel observations, and identify vital signs changing significantly. Moreover methods for automatically summarizing results and efficiently managing medical data will be developed. ARMOR will incorporate models derived from data analysis based on already existing communication platform solutions emphasising on security and ethical issues and performing required adaptations to meet specifications. Special effort will be devoted in areas such as data anonymization and provision of required service.

ARMOR will provide flexible monitoring optimized for each patient and will be tested in several case studies and evaluated as a wide use ambulatory monitoring tool for seizures efficient diagnosis and management including possibilities for detecting premonitory signs and feedback to the patient.

Web site: http://armor.tesyd.teimes.gr

Duration: From 2011-11-01 to 2014-10-31

2.2.1.2 CuPiD

CORDIS description: People with Parkinsons disease (PD) suffer from motor and cognitive impairments that severely impact mobility, fall risk, and multiple key aspects of functional independence. Until recently, treatment goals focused almost exclusively on symptom relief, but exciting recent work by CuPiD partners and others has demonstrated that motor learning and rehabilitation principles can be effective even in the presence of PD.

It is critical to make these rehab-like therapies accessible to patients in their home-setting since they need continoues training, as PD is a cronic neurodegenerative disease. Optimal rehabilitation of a neurodegenerative disease like PD requires personalized training paradigms that patients can integrate into their everyday routine in their own homes and use for many years. Ongoing, long-

term treatment in a clinical setting is not feasible, cost effective, or likely something that patients can comply with year after year.

CuPiD is designed to meet this challenge. We will develop an ICT-enabled solution to the rehabilitation of patients with PD in their home setting, tailoring the solution to target mobility, cognitive function and debilitating PD symptoms such as freezing of gait. Key components of the CuPiD solution are: 1) a home-based rehabilitation system (based on unobtrusive wearable sensors, on-board intelligence for real-time biofeedback, virtual reality, and modular, multi-modal restitution interfaces); and 2) an intelligent telemedicine infrastructure for remote monitoring and supervision of the rehabilitation program by a clinician.

The integrated, easy-to-use system will have a huge, beneficial impact on the therapeutic treatment of PD, empowering patients to improve their health-related quality of life in the comforts of their own home. At the same time, we envision that the ultimate costs of treatment will be reduced and the health-care burden dramatically lowered when the unique CuPiD system becomes available.

Web site: http://www.cupid-project.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.1.3 CogWatch

CORDIS description: Neurological patients due to stroke may suffer from disrupted action due to cognitive deficits which prevent them from maintaining independent lives. CogWatch will focus on neurological patients with symptoms of Apraxia and Action Disorganisation Syndrome (AADS) who, while maintaining their motor capabilities, commit cognitive errors during every-day goal-oriented tasks which premorbidly they used to perform automatically. Most common rehabilitation ICT systems are focused on treating physiological symptoms of stroke, such as hemiparesis and are not appropriate for rehabilitation of cognitive impairments. Moreover, they are based on robot and/or virtual environment platforms which are expensive and impractical for home installations. In addition, they are designed as rehabilitation stations which patients have to access and adapt to the way the systems operate. As a consequence, this affects the continuity of the therapy and weakens its impact. A new Personal Healthcare System (PHS) for cognitive rehabitation of action after stroke is proposed which will be be affordable, customisable and capable of delivering continuous cognitive rehabilitation at home, when it is needed. The proposed CogWatch project plans to exploit intelligent tools and objects, portable and wearable devices as well as ambient systems to provide personalised cognitive rehabilitation at home for stroke patients with AADS symptoms.

Web site: http://www.cogwatch.eu

Duration: From 2011-11-01 to 2014-10-31

2.2.1.4 CONTRAST

CORDIS description: Millions of people live with the consequences of stroke, which often include cognitive impairments. A wide gap exists between clinical rehabilitation and care, monitoring and support of patients at home to maximize independent, socially integrated living. CONTRAST will

bridge this gap by developing easy-to-use auto-adaptive human-machine interfaces (HCI) which can be used in the sub-acute rehabilitation phase and further at the patients home. Training modules for cognitive enhancement will be tailored to the individual and remote data processing and support systems will allow for continuous monitoring of health parameters to evaluate individual progress and for shared patient-expert decision. We will develop, test, and upgrade our brain-neural-computer interface (BNCI) based neurofeedback tools, based on findings that increasing power in specific EEG frequency bands can improve long-term cognitive performance. CONTRAST targets the cognitive function of interest directly in the brain. Thus, CONTRAST will contribute to new medical and practical knowledge for guiding and improving intervention for daily life functioning after stroke. The aims of CONTRAST are the development of (1) a new architecture of HCI that is adaptive and integrates remote processing and shared decision making; (2) an accurate, individually tailored intervention for improvement of cognitive function guided by medical and neuropsychological assessment; (3) a HCI neurofeedback based cognitive enhancement training including automated reward systems to maintain patient motivation; (4) a continuous onsite and remote monitoring of health parameters and evaluation; (5) exploitation and dissemination. While these are ambitious aims, the combination of Universities, Companies, Hospitals, Rehabilitation Centres and User Groups within CONTRAST provides the experience, connections, and infrastructure necessary to have a real impact on disease management, medical knowledge, PHS, and stroke patients.

Web site: http://www.contrast-project.eu

Duration: From 2011-11-01 to 2014-10-31

2.2.1.5 Dem@Care

CORDIS description: The increase in average lifespan across the world has been accompanied by an unprecedented upsurge in the occurrence of dementia with high socio-economic costs. The development of personal health systems provides a means of dealing with such problems in a meaningful and sustainable manner, enabling persons with dementia to maintain independence and inclusion in society, while improving their quality of life and the effectiveness of their caregivers. Multi-parametric monitoring of daily activities, lifestyle, behaviour, in combination with medical data, provides clinicians a comprehensive image of the persons condition and its progression, without their being physically present, allowing remote care of their condition. The objective of Dem@Care is the development of a complete system providing personal health services to people with dementia, as well as medical professionals and caregivers, by using a multitude of sensors, for context-aware, multi-parametric monitoring of lifestyle, ambient environment, and health parameters. Multi-sensor data analysis, combined with intelligent decision making mechanisms, will allow an accurate representation of the person's current status and will provide the appropriate feedback, both to the person and the associated caregivers, enhancing the standard clinical workflow. Many research challenges will arise, ranging from data collection and analysis to integration, interpretation and feedback. Aggregation of information from complementary sources will be a critical aspect of multi-sensor processing that will be addressed, along with the advance of knowledge and data management methodologies, for scalable and meaningful interpretation of the person's condition. The data will be analysed and interpreted in conjunction with established or newly created medical knowledge, for the production of shared patient-doctor decision support

systems. Appropriate user-friendly interfaces will be developed, facilitating the rapid incorporation of the proposed system in the users lives.

Web site: http://www.demcare.eu

Duration: From 2011-11-01 to 2015-10-31

2.2.1.6 EPILEPSIAE

CORDIS description: Epilepsy is the commonest serious brain disorder in every country, and probably the most universal of all medical disorders. In Europe six million people currently have epilepsy and fifteen million will have epilepsy at some time of their lives. Currently nearly 30% of these people cannot be treated by therapeutics based on pharmacological anticonvulsive medication or resective surgery and are completely subjected to the sudden and unforeseen seizures strike that has a strong impact on their everyday life, with temporary impairments of motoricity, perception, speech, memory or conscience.

Epilepsy costs the countries of Europe over 20 billion ECU every year, most of which related to the untreatable patients, an amount that could be significantly reduced with effective action.

The project intends to develop an intelligent alarming system, transportable by the patient, measuring the brain dynamical activity, capable of predicting the seizures, allowing the patient to assess the risk of his actual situation and improving his safety The system is based on multi-signal information (EEG, ECG and others), intelligent data processing and wireless communications.

The project will develop knowledge (in data analysis), algorithms (of seizure prediction) and technologies (of data acquisition and wireless transmission) that integrated into an intelligent system will be an important step forward in economical affordable personal healthcare systems for neurological applications. A distributed European Epilepsy Database will also be built by the project, including all the available information about epileptic patients, allowing semantic mining based on multi-modal, multisignal and multidimensional data.

The EPILEPSIA consortium consists of seven partners from 4 countries: 3 academic, 3 clinics, 1 industrial SME company, covering the whole value chain from theoretical conception to market products and final users.

Web site: http://www.epilepsiae.eu

Duration: From 2008-01-01 to 2011-12-31

2.2.1.7 Help4Mood

CORDIS description: Depression is one of the most common causes of short and long term disability in Europe. It accounts for substantial costs both directly to health services and indirectly through lost productivity and the burden of caring. Most patients with Major Depression (MD) recover with treatment, which may be with antidepressant drugs, psychological therapy or, in severe cases, hospitalisation. However for many, that recovery is either slow or incomplete. Research shows that psychological therapies can be delivered effectively without face to face contact: computerised

cognitive behavioural therapy (CCBT) is suitable for self-guided treatment in the individual's own home. However, its value for patients is limited by the difficulty of staying engaged, and there are professional concerns that important changes in mood may be missed. Help4Mood proposes to significantly advance the state-of-the-art in computerized support for people with MD by monitoring mood, thoughts, physical activity and voice characteristics, prompting adherence to CCBT, 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.

The advances in Help4Mood will provide a closed loop approach to treatment support for MD patients. Outputs include: a validated personal monitoring system; a personal interaction system embodied in a VA and a clinical decision support module. By identifying and supporting patients with delayed recovery, Help4Mood has the potential to target added support for patients most in need and lead to their earlier return to normal health and social and economic activity.

Web site: http://help4mood.info

Duration: From 2011-01-01 to 2013-12-31

2.2.1.8 ICT4DEPRESSION

CORDIS description: Major depression is currently the fourth disorder worldwide in terms of disease burden, and is expected to be the disorder with the highest disease burden in high-income countries by 2030. Estimated costs of depression are annually 177 and 147 million euro per 1 million inhabitants for major and minor depression respectively. Current treatment methods for depressive disorders can reduce the burden of this disease with about one third. The ICT4Depression consortium will develop an ICT-based system for use in primary care that will further improve patient outcomes and increase access to treatment. All technologies to be developed will be beyond state of the art and include 1) devices for monitoring activities and biosignals in a non-intrusive and continuous way, 2) treatments for depression and automatic assessment of the patient using mobile phone and web based communication, 3) computational methods for reasoning about the state of patients, progress of therapies, and the risk of relapse and 4) a flexible system architecture for monitoring and supporting people using continuous observations and feedback via mobile phone and the web.

The ICT4Depression system is flexible and can easily be adapted for treatment of other mental diseases. The project will be carried out by an interdisciplinary consortium with 5 (research) organisations and 2 SME companies at the forefront of Artificial and Ambient Intelligence, wireless biosignal sensors, activity monitoring using cell phones, monitoring patient compliance with drug prescriptions, service oriented application for the health care domain, psychology, psychiatry, and internet-based psychological treatment. The project will boost European leadership in ICT-based treatment of mental illness and will provide ample opportunities for commercial exploitation.

Web site: http://www.ict4depression.eu

Duration: From 2010-01-01 to 2012-12-31

2.2.1.9 INTERACTION

CORDIS description: Continuous daily-life monitoring of the functional activities of stroke survivors in their physical interaction with the environment is essential for optimal guidance of rehabilitation therapy by medical professionals and coaching of the patient. Such performance information cannot be obtained with present monitoring systems.

It is the objective of the INTERACTION project to develop and validate an unobtrusive and modular system for monitoring daily life activities and for training of upper and lower extremity motor function in stroke subjects. The system will be unobtrusively integrated in clothing (e-textile), include fabric-based and distributed inertial sensing, and provide telemonitoring and adaptive on-body feedback capabilities. Telesupervision facilities will enable a clinical expert at a distance to evaluate performance effectively, coach the patient and influence training.

Monitoring will be based on ambulatory sensing of muscle activation (EMG), interaction forces and body movements. The physical interaction with the environment during reaching and grasping will be assessed by relating interaction forces and movements. This provides information about power exchange between the human body and the environment, dynamics of the environment and task performance. Balancing the body will be assessed from ground reaction forces and relative foot placements. EMG provides information about neural control of movements, including abnormal synergies and spasticity. The assessment is made context aware by task identification and estimation of the dynamics of the environment from the sensed quantities.

The system will first be validated in a lab setting, comparing the system against current clinical measures. It will subsequently be demonstrated during the actual daily life of stroke survivors.

Web site: http://www.interaction4stroke.eu

Duration: From 2011-11-01 to 2014-10-31

2.2.1.10 Interstress

CORDIS description: INTERSTRESS aims to design, develop and test an advanced ICT based solution for the assessment and treatment of psychological stress. The system will aim at (1) objective and quantitative assessment of symptoms using biosensors and behavioural analysis; (2) decision support for treatment planning through data fusion and detection algorithms; and (3) provision of warnings and motivating feedback to improve compliance and long-term outcome. To reach its goals the project will use a new concept for e-health - Interreality integrating assessment and treatment within a hybrid, closed-loop empowering experience, bridging physical and virtual worlds: (a) behaviour in the physical world influences the experience in the virtual world; (b) behaviour in the virtual world influences the experience in the real world. This is achieved through: 1) 3D Shared Virtual Worlds immersive (in the health care centre) or non immersive (at home) role-playing experiences in which one or more users interact with one another within a 3D world; 2) Bio and Activity Sensors (From the Real to the Virtual World): to track the emotional/health/activity status of the user and to influence his/her experience in the virtual world (aspect, activity and access); 3)

Mobile Internet Appliances (From the Virtual to the Real World): the social and individual user activity in the virtual world has a direct link with the users life through a mobile phone/PDA. The 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 that patients behavioural and physiological responses with a training or performance criterion. The project will provide a proof of concept of the proposed system with validation in clinical settings guaranteed by the clinical expertise of the coordinator (HC research centre).

Web site: http://interstress.eu

Duration: From 2010-03-01 to 2013-02-28

2.2.1.11 MICHELANGELO

CORDIS description: Q- EEG is used in medical labs to determine the brain connectivity in autistic children but due to the artificial nature of this lab-based approach its validity under a real-life scenario is doubtful.

Also therapeutic interventions are executed typically in a clinical setting and have a limited extension in time while it has been proved the beneficial effect of an intensive intervention.

Moreover, although pointed out by several researchers the need of a personalized treatment for each child, there is a little knowledge about how to identify the most suitable treatment or integration of treatments for a specific child.

The MICHELANGELO project intends to bring the assessment and the therapy of the autism out of the clinical environment and develop a patient-centric home-based intervention requiring a minimal human involvement and therefore extremely cost effective.

The main outcomes of the project will be:

- A camera-based system that triggered by a wearable EEG solution will take snapshots of the scenes according to the eye movement and will allow to identify the stimuli that in a natural environment (the child s home) cause significant responses in the autistic child;
- The same pervasive wearable EEG system that - used in conjunction with a eye-tracking device - measures the brain activity while the patient is presented with the reproduction of the identified stimuli and allows to better characterize them. The system - being pervasive in nature - makes the patient less aware about the artificial nature of the experiment and therefore does not affects the cognitive activity.
- A set of advanced and sophisticated signal processing algorithms enabling accurate characterization of stimulus-specific brainwave anomalies and connectivity between different brain regions and hence giving vivid insight into the process of information integration ability of the brain in a stimulus-specific way.
- The design of a personalized intervention protocol based on a heterogeneous strategy where well consolidated developmental/behavioural therapeutic approaches are combined with neuro-feedback techniques and use also new ICT-based solutions.

- A set of unobtrusive tools for the continuous monitoring of the autistic children during the intervention program allowing its adaptation and personalization.
- Sophisticated algorithms applied to advanced imaging techniques (Diffusion Tensor Imaging and fMRI) which are used by the doctor to check the anatomical and functional connectivity of the brain at different steps during the therapy and assess its effectiveness.

Finally the MICHELANGELO project will set the bases to validate the results of its research work in an exploratory study executed in Italy and in France.

Web site: http://www.michelangelo-project.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.1.12 MONARCA

CORDIS description: 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.

The MONARCA system will consists of 5 components: a sensor enabled mobile phone, a wrist worn activity monitor, a novel sock integrated physiological (GSR, pulse) sensor, a stationary EEG system for periodic measurements, and a home gateway. It will combine GPS location traces, physical motion information, and recognition of complex activities (nutrition habits, household activity, amount and quality of sleep) into a continuously updated behavioural profile.

Physiological information from the GSR sock, the periodic EEG measurements, voice analysis from mobile phone conversations, and motion analysis will provide an assessment of emotional state and mood. Combining this information with patients medical records and established psychiatric knowledge quantitative assessment of patients condition (expressed in Psychiatric Rating Scales like BRAM or HAMD) and prediction of depressive and manic episodes will be implemented.

Closing the loop between the system and the patient an interface for self assessment (on the basis of the above information), provision of warnings and risk profiles and a coaching concept for self treatment will be implemented. For the medical staff, interfaces for interpreting the data, therapy assessment and therapy planning tools (scheduling visits, planning medication) will be developed.

Web site: http://www.monarca-project.eu

Duration: From 2010-02-01 to 2013-01-31

2.2.1.13 NeuroTREMOR

CORDIS description: Tremor is the most common movement disorder and is strongly increasing in incidence and prevalence with ageing. The most frequent types of tremor are those arising from two neurodegenerative disorders: Parkinsons disease and essential tremor. Although not life threatening, upper limb tremors hamper independent life of 65% of those suffering from them, greatly impacting on their quality of life. Tremor is not effectively managed in 25 % of patients and is one of the most commonly misdiagnosed neurologic disorders.

The main objective of the project is to validate technically, functionally and clinically, a novel system for understanding, giving support to diagnosis, and remotely managing tremors. The system will comprise two platforms:

- The hospital-based platform will provide with detailed recordings of the central and peripheral nervous systems together with kinematic measurements. It will constitute the most advanced system to date for neurophysiological investigation of tremors, and will implement a novel machine tool to support diagnosis of tremors.
- The neuroprosthetic platform will constitute a novel alternative for remote management of upper limb tremors. It will exploit neural and kinematic recordings both to drive a closed loop system to attenuate tremors based on neurostimulation of the afferent pathways, and to evaluate the status and evolution of the disorder. The platform will thus permit the neurologist remotely monitoring and adjusting the therapy.

NeuroTREMOR consortium brings together world-class institutions in their respective fields. Some of the partners collaborated previously in the framework of EU and NIH projects aiming at understanding and managing tremor pathologies, accumulating considerable experience on proposing and validating novel therapies for tremor treatment. The consortium is strongly multidisciplinary with almost no overlapping of expertise among partners.

Web site: http://www.car.upm-csic.es/bioingenieria/neurotremor/

Duration: From 2012-02-01 to 2015-01-31

2.2.1.14 OPTIMI

CORDIS description: Mental health care represents over a third of the cost of health care to all EU nations. However little is being done to develop effective systems for Prevention of the onset of the illnesses or to provide easier Diagnosis with a view to better determine the effects of treatment. OPTIMI will change this by developing tools to perform Prediction through early identification of the onset of an illness by monitoring poor coping behavior. It is based on the hypothesis that the central issue and starting point of longer term mental illness depends on the individual s capacity and ability to cope with stress. OPTIMI will first identify the occurrence of high stress in the individual on a daily basis. Then it will determine the ongoing effect of stress on the individual by studying the behavior pattern over a longer period. Finally it will also make estimates of the base line changes in the person s state of mind using symptomatic measurements that closely link depression with cognitive, motor and verbal behavior.

We will use wearable and domestic appliances and identification will be based on noting when stress occurs, at a fine time resolution using ECG and Cortisol, and daily using the Electronic Diary. The effects on behavior will be identified using EEG, Voice analysis, Physical Activity analysis and the Electronic Diary. Finally specific markers of depression will be checked using EEG, Voice analysis and Physical Activity. The smart sensors will be enhanced with a knowledge based rule system to interpret the data and provide a diagnostic tool for both pharmacological and CBT based preventative and intervening treatments. We will then augment two existing CCBT systems to use these tools in real time to optimize the treatment cycle. We will conduct two phases of trials with volunteers who come from high risk situations (such as mothers caring for a disabled child, recession unemployed and critical final examinations) bOTH phaseS being held in total in 5 countries.

Web site: http://www.optimiproject.eu

Duration: From 2010-01-01 to 2012-12-31

2.2.1.15 PSYCHE

CORDIS description: PSYCHE project will develop a personal, cost-effective, multi-parametric monitoring system based on textile and portable sensing platform for the long and short term acquisition of data. The patient diagnosed with bipolar disorder will be placed at the epicentre of its management, for treatment and prevention of depressive and manic episodes. The system will use wearable and portable devices for acquiring, monitoring and communicating physiological parameters, behavioural and mood correlated indexes (i.e. vital body signs, biochemical markers and voice analysis).The acquired data will be processed and analyzed in the established platform that takes into consideration the Electronic Health Records (EHR) of the patient, the parameters set up in the first stage between bipolar and non-bipolar individuals, as well as medical analysis in order to verify the diagnosis and help in prognosis of the illness.

Finally communication and feedback to the patient will be performed through a direct contact with the patient and device, or by communication between physician and patient. Constant feedback and monitoring will be used to manage illness, to give patients support, to facilitate interaction between patient and physician as well as to alert professionals in case of patients relapse and depressive or manic episodes income. PSYCHE project will focus on the following objectives: i) Implementation of a sensing platform physiological and behavioural monitoring for patients with bipolar disorders ii) Development of novel portable devices for the monitoring of biochemical markers, voice analysis and a behavioural index correlated to mental illness iii) Brain functionality: in order to correlate central measures o with clinical assessment and the parameters measured by Psyche platform iv) Data mining and managing: The ultimate goal is to identify signal trends indicating detection and prediction of critical events v) The system will contain a patient and professional close loop.

Web site: http://www.psyche-project.org

Duration: From 2010-01-01 to 2013-04-30

2.2.1.16 REMPARK

CORDIS description: The specific and ultimate goal of the REMPARK project is to develop a PHS with closed loop detection, response and treatment capabilities for management of Parkinsons Disease (PD) patients at two levels:

At the first level, the project will develop a wearable monitoring system able to identify in real time the motor status of the PD patients, and evaluating ON/OFF/Dyskinesia status, with sensitivity greater than 80% and specificity greater than 80% in operation during ambulatory conditions and will also develop a gait guidance system able to help the patient in real time during their daily activities.

At a second level, the intelligent analysis of data provided by the first level, supported with a disease management system will allow the neurologist in charge to access accurate and reliable information to decide about the treatment that best suits the patient, improving the management of their disease, in particular to adjust so called therapeutic window.

To achieve this global goal, four main objectives need to be achieved:

- Identification of motor status in real time
- Development of a gait guidance system
- Development of a user interface to collect direct feedback from the patient
- Development of a server to allow interaction with the doctor in charge and track the evolution of the patient's condition.

REMPARK system will be tested in 60 real patients from four medical centres. The consortium is formed by medical and technical renowned specialists, and PD patients are represented through the participation of the European Parkinson's Disease Association.

Web site: http://www.rempark.eu

Duration: From 2011-11-01 to 2015-04-30

2.2.1.17 SENSE-PARK

CORDIS description: Parkinsons disease (PD) is the second most common neurodegenerative disease, and prevalence increases with age. This leads, in an aging society, to increasing personal, social and economic burden. To date, basically only symptomatic treatment is available, which application almost always leads to the feeling of dependence and lose of self-control in (a) person(s) with PD (PwPs). A further shortcoming in PD-related treatment is the limited quality of disease state-defining parameters. Recent ICT-associated projects have mainly been focusing on the observation of the user rather than giving feedback to him/her, and they bear little resemblance or application to the reality of living with PD. In addition, obtrusive measurements influenced results in particular in PwPs due to disease-caused neural network changes.

The aim of the SENSE-PARK project is to develop an unobtrusive and empowering information system for use in the home environment, which provides the users with practical, engaging and

motivating tools to monitor patterns in their condition. In more detail, the SENSE-PARK system will inform the users about motor and non-motor functioning in daily life activities (being, data collection via RFID sensors and a wrist-worn data logger), leisure activities (belonging, data collection via gaming console and adapted interface) & scientific environment (becoming, for validation).

The project will include PwPs at central positions to ensure the development of a user-friendly and effective system, and consequent dissemination. In addition, with the SENSE-PARK system, disease course-associated parameters which are provided to the user can also be provided to the doctor, to enable an intense and transparent at-the-point discussion between two specialists of the disease. The system will enable a more continuous, thorough and objective appraisal of changes during disease course with a far wider and more objective perspective, than clinical evaluation can provide.

Web site: http://www.sense-park.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.1.18 StrokeBack

CORDIS description: Stroke is a disease with very high socio-economic impact. In average the healthcare expenditure cost for Strokes across different countries in Europe and USA is 3% of their entire healthcare expenditure. This includes inpatient treatment cost, outpatient hospital visits and long-term rehabilitation and care. Analysis showed that costs of long-term care have increased from 13% to 49% of overall costs in average in recent years. Therefore there is an urgent need for devising an effective long-term care and rehabilitation strategy for Stroke patients, which will involve the patients actively in the process while minimising costly human intervention.

The StrokeBack project intends to develop an automated remote rehabilitation system by blending advances of ICT and practical clinical knowledge that will empower the patients and their immediate carer for effective application of the rehabilitation protocol in home settings.

StrokeBack will combine state-of-the-art monitoring devices forming a wireless Body Area Network that enable simultaneous measurement of multiple vital parameters and currently executed movements that are particularly of interest from a Stroke rehabilitation point of view. The measured parameters will be fused using advanced feature extraction and classification algorithms processed on-body, which will denote the accuracy of the executed exercise. The training parameters along with vital data will be stored in a patient health record to which the responsible clinicians and therapists have access so that they can dynamically update the rehabilitation program. By employing manual intervention only when actually necessary, it will eliminate costly human intervention and thereby significantly reduce the associated costs. The increased rehabilitation speed as well as the fact that the rehabilitation training can be done at home directly improves quality of life of patients. To sum up StrokeBack will increase rehabilitation speed while reducing cost.

Web site: http://www.strokeback.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.1.19 TBIcare

CORDIS description: Traumatic brain injury (TBI) occurs when a sudden trauma causes damage to the brain it is a major health problem and the most common cause of permanent disability in people under the age of 40 years. Yearly cost from TBI in Europe exceeds 100 billion Euros. 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.

TBIcare project provides such an objective and evidence-based solution for management of TBI by improving diagnostics and treatment decisions for an individual patient. A strictly evidence-based approach realises the objectives of developing: 1) a methodology for finding efficient combinations of multi-modal biomarkers used in statistical models to objectively diagnose and assess an individual TBI patient, and 2) a simulation model for objectively predicting outcome of the planned treatment of an individual TBI patient. These objectives are supplemented by realization of: 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.

Web site: http://www.tbicare.eu

Duration: From 2011-02-01 to 2014-01-31

2.2.1.20 THROMBUS

CORDIS description: Rupture risk of intracranial aneurysms (IA) has been studied at length. However, very little is known about the healing mechanism, namely the formation of a clot inside the cavity after insertion of a stent. The multiscale interaction between biological and hemodynamic processes is the central ingredient of this proposal. The core of the project is to develop and validate a biological model of spontaneous or stent-induced thrombosis in IA. From this model we will compute quantitative stent efficiency score by its capability to induce clotting in aneurysms. In medical practice the choice of which stent to deploy is left to the medical doctor and remains intuitive to date. It is common to use one or several full-course stents into each other, in order to induce thrombosis formation. Recent Pipeline stents allowing simple or multiple devices constructs with variable flow disruption will be investigated. Our project will study through numerical simulation the effect of stent configuration in patient specific geometry and will help explain why some stents produce good thrombus while others don't.

The project will develop a multi-scale computational modelling and simulation framework based on the triptych In Vitro - In Vivo - In Silico - rule of three for the thrombosis. The associated technological aim of the project is to deliver software with an interactive end-user interface, providing a virtual simulation of the thrombosis leading to the optimal stent for a specific patient s aneurysm. This goal will be achieved by integrating some of the leading open source software and VPH toolkit software in the area of computational bioengineering. Also a collaborative online system will be adapted allowing partners of THROMBUS to correlate any type of data in case simultaneous multidisciplinary analysis by distant partners is required. This platform will remain operational after the end of the project.

Web site: http://www.thrombus-vph.eu

Duration: From 2011-02-01 to 2014-01-31

2.2.1.21 VERVE

CORDIS description: The project will develop ICT tools to support the treatment of people who are at risk of social exclusion due to fear and/or apathy associated with a disability. These tools will be in the form of personalised Virtual Reality (VR) scenarios and serious games specifically designed for therapeutic targets and made broadly available via a novel integration of interactive 3D environments directly into Web browsers. The project will perform cutting edge research into rendering and simulating personalised and populated VR environments, 3D web graphics, and serious games. These technical efforts will be underpinned by clinical/laboratory and industry partners and in liaison with the stakeholders (i.e., participants, carers/family, and health professionals). They project will test the VERVE interventions in three use-cases, each targeting a different group of participants: Fear of falling, Apathy related to cognitive decline and behavioural disturbances, and other emotional disturbances linked to anxiety.

Web site: http://www.verveconsortium.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.1.22 VPH-DARE@IT

CORDIS description: The DementiA Research Enabled by IT project responds to the European Parliament's 2011 resolution for a European Initiative on Alzheimer's disease and other dementias, and the EU Year of the Brain 2014 Initiative. It delivers the first patient-specific predictive models for early differential diagnosis of dementias and their evolution. Its mechanistic/phenomenological models of the ageing brain account simultaneously for the patient-specific multiscale biochemical, metabolic and biomechanical brain substrate, as well as for genetic, clinical, demographic and lifestyle determinants. It investigates the effect of metabolic syndrome, diabetes, diets, exercise, and pulmonary conditions on the ageing brain, as environmental factors influencing onset and evolution of dementias.

An integrated clinical decision support platform will be validated/ tested by access to a dozen databases of international cross-sectional and longitudinal studies, including exclusive access to a

population study that has tracked brain ageing in more than 10,000 individuals for over 20 years (Rotterdam Study).

Enabling more objective, earlier, predictive and individualised diagnosis and prognosis of dementias will support health systems worldwide to cope with the burden of 36M patients that, due to ageing societies, will increase to 115M by 2050. Worldwide costs are estimated to 450B annually. In 2012, the WHO declared dementia a global health priority.

Our consortium assembles highly recognised engineering, physical, biomedical and clinical scientists, and industrial partners experienced in exploiting VPH technologies in healthcare. Co-operation with infrastructure projects like VPH-Share, related international Physiome efforts, and other dementia research consortia is assured, allowing European researchers from different disciplines to contribute to share resources, methods and generate new knowledge.

Web site: http://www.eibir.org/projects/fp7-projects/vph-dareit/

Duration: From 2013-04-01 to 2017-03-31

2.2.2 Pulmonology

2.2.2.1 AirPROM

CORDIS description: The airways diseases asthma and chronic obstructive pulmonary disease affect over 400 million people world-wide and cause considerable morbidity and mortality. Airways disease costs the European Union in excess of 56 billion per annum. Current therapies are inadequate and we do not have sufficient tools to predict disease progression or response to current or future therapies. Our consortium, Airway Disease PRedicting Outcomes through Patient Specific Computational Modelling (AirPROM), brings together the existing clinical consortia (EvA FP7, U-BIOPRED IMI and BTS Severe Asthma), and expertise in physiology, radiology, image analysis, bioengineering, data harmonization, data security and ethics, computational modelling and systems biology. We shall develop an integrated multi-scale model building upon existing models.

This airway model will be comprised of an integrated micro-scale and macro-scale airway model informed and validated by omic data and ex vivo models at the genome-transcriptome-cell-tissue scale and by CT and functional MRI imaging coupled to detailed physiology at the tissue-organ scale utilising Europe's largest airway disease cohort. Validation will be undertaken cross-sectionally, following interventions and after longitudinal follow-up to incorporate both spatial and temporal dimensions.

AirPROM has a comprehensive data management platform and a well-developed ethico-legal framework. Critically, AirPROM has an extensive exploitation plan, involving at its inception and throughout its evolution those that will develop and use the technologies emerging from this project. AirPROM therefore will bridge the critical gaps in our clinical management of airways disease, by providing validated models to predict disease progression and response to treatment and the platform to translate these patient-specific tools, so as to pave the way to improved, personalised management of airways disease.

Web site: http://www.europeanlung.org/en/projects-and-research/projects/airprom/home

Duration: From 2011-03-01 to 2016-02-29

2.2.2.2 CHRONIOUS

CORDIS description: Chronic diseases are the leading causes of death and disability for a large amount of people in most industrialized nations. Chronic diseases have also a deep impact on today's society costs. Adopting healthy behaviours can prevent or control the devastating effects of these diseases.

CHRONIOUS implements a system architecture that offers continuous monitoring easily adaptable to any chronic disease management programme.

The project goals will be achieved by developing a modular and flexible system design that integrates state of the art sensors and services in order to cover both patients and healthcare professional's needs.

Data will be collected by using monitoring sensors, mostly wearable, that control continuously vital signals, dietary habits and plans, drug intake, environmental parameters, biochemical parameters, activity and social context.

Every abnormal health condition will be noticed and reported by the system. In particular the CHRONIOUS system will report deviations and all conditions differing from those that are expected.

Healthcare professionals on the other hand will be provided with supporting decision support and data analysis tools.

CHRONIOUS, in its very final form, will be a universal solution to healthcare facilities and professionals for managing all different kind of chronic diseases increasing the quality of patients' life and reducing health assistance costs.

Web site: http://www.chronious.eu

Duration: From 2008-02-01 to 2012-01-31

2.2.2.1 Synergy-COPD

CORDIS description: Synergy will develop a simulation environment and a decision-support system aiming at enabling deployment of systems medicine. The three core elements are a knowledge base (KB), an inference engine (IE), and a graphical visualisation environment (GVE). The project focuses on patients with chronic obstructive pulmonary disease (COPD).

The KB will include five well established physiological models addressing: 1) Central and peripheral O2 transport and utilization, 2) Pulmonary gas exchange, 3) Regional-lung heterogeneities in ventilation and perfusion, 4) Skeletal muscle bioenergetics, and 5) Mitochondrial reactive oxygen species (ROS) generation. These models will be written in systems biology mark-up language (SBML) and vertically integrated. Ontologies will be used as the default knowledge-representation system.

The KB will include multi-level data from experimental studies (BioBridge), data from a multicentre longitudinal study on COPD phenotyping (PAC-COPD) and public datasets.

The IE will enable to explore associations over the KB, perform transversal multi-scale model integration and related simulations including interactions among O2-availability/O2-utilization, ROS generation, systemic inflammation and abnormal tissue re-modelling.

The Web-based GVE will facilitate relevant simulations in a more intuitive way with respect to the state of the art, addressing two main user profiles: bio-researchers and clinicians.

The focus will be on underlying mechanisms of COPD phenotypes associated with poor prognosis. Disease model validation and refinement will be done using a well-established, large dataset (ECLIPSE) together with experimental studies designed to test 'in silico' generated hypotheses. Besides the use of the simulation environment by bio-researchers for optimal experimental design, the Synergy platform will be a relevant decision-support tool for integrated healthcare strategies aiming at modulating the evolution of COPDs.

Web site: http://www.synergy-copd.eu

Duration: From 2011-02-01 to 2014-01-31

2.2.3 Urology

2.2.3.1 NEPHRON+

CORDIS description: NEPHRON+ will provide a major leap forward in Renal Care. It aims at a next generation, integrated solution for personalized treatment and management of chronic diseased, end-stage renal patients. It offers an ideal solution for continuous dialysis outside the hospital offering better blood clearance, while patients can stay mobile and active in social and economic life. It relies on an ICT-enabled wearable artificial kidney for on-body blood purification. This blood treatment can be adjusted to personal parameters and can be remotely controlled by clinical specialists. The system allows for real-time, continuous, multiparametric (tele) monitoring of both the patient and the device via innovative sensors. The continuous data collection allows for early detection of anomalies and trend analysis on the health status of the patient, offering learning curves for improved treatment. Hereby, NEPHRON+ guarantees accuracy of measurements and treatment, personalized feedback and advice and provides a basis for education of patients.
The patients benefit from lower costs, higher clearance levels, and more comfort which will result in: a) Improvement of their health condition, b) longer life expectancy and c) improved economical and social living conditions. The potential applications of NEPHRON+ solution can be exploited further beyond Renal Care patients, such as those with acute blood poisoning, liver disease, cancer and chemotherapy patients suffering from heart rhythm variations, weight loss and in need of controlled chemotherapy medicine release based on body parameter and fluid measurements.

Web site: http://www.nephronplus.eu

Duration: From 2010-04-01 to 2014-03-31

2.2.3.2 PAEON

CORDIS description: Infertility affects 12% to 15% of reproductive age couples in Europe, costs approximately 1 billion Euros per year, and experts agree that these figures will double in a decade. In about 50% of such couples, infertility is caused by female health problems, more than 40% of which are related to endocrinological diseases impairing women's health independently from fertility. Such considerations motivate our three-pillar project focusing on quantitative models for Infertility Related Endocrinological Diseases (IREDs).

Our first pillar (modelling) will develop patient-specific computer-based models for IRED. Such models will account for the physiological and pathophysiological mechanisms regulating the menstrual cycle and how this is influenced by external (e.g., drugs) as well as environmental (e.g., obesity) factors. Our model will enable a quantitative understanding of the mechanisms behind endocrine disorders such as Polycystic Ovarian Syndrome (PCOS), hyperprolactinemia or endometriosis.

Our second pillar (computation) will develop general purpose methods and tools to support effective exploitation of patient-specific models to reliably predict the outcome of a treatment on a specific patient and to support individualisation of a treatment for a specific patient.

Our third pillar (clinical trial) will gather data (e.g. hormonal secretion patterns in different physiological and pathophysiological settings) to enable validation of the models and tools developed in our project and will carry out such a validation thereby providing feedback to the previous pillars. Such a feedback loop will drive the iterative refinement approach foreseen in our project.

Our multidisciplinary consortium consists of highly qualified research institutions (HSLU, URM1, ZIB), and hospitals (MHH, UZH). The resulting synergies will enable successful completion all project objectives as well as wide dissemination and effective exploitation of the project results.

Web site: http://paeon.di.uniroma1.it

Duration: From 2013-02-01 to 2016-01-31

2.2.4 Cardiology

2.2.4.1 ARTreat

CORDIS description: ARTreat targets at providing a patient-specific computational model of the cardiovascular system, used to improve the quality of prediction for the atherosclerosis progression and propagation into life-threatening events that need to be treated accordingly.

ARTreat will provide a three-level patient model describing the 3d arterial tree anatomy, the patient-specific blood flow and blood particle dynamics and the biological processes that lead to the creation and progression of atherosclerotic plaques.

ARTreat will apply the developed patient-specific model on two main applications: the clinical decision support and the training. ARTreat will produce two decision support tools to assist clinical

cardiologists into providing personalized treatment selection and real-time, on- the-fly advice during invasive interventions, such stent positioning. The aim is to minimize future therapy costs, by providing higher than even possible personalized treatment support. The same patient-specific model will also be used to develop a real-case simulator training, which will support realistic hands-on skill development training to clinical cardiologists.

Finally, ARTreat is coupled with advanced clinical support tools for plaque characterization, and the discovery of new knowledge; associations among heterogeneous data, that can improve the predictive power of the patient-model. It thus supports the medical expert into programming the accumulated knowledge into the existing model and generating an adaptive patient-specific computational tool. Key market players AGFA and SORIN will exploit the ARTreat applications to provide new sophisticated solutions to their product range, while all academic and IT company partners will accumulate significant experience on the new generation patient-specific healthcare services.

Web site: http://www.artreat.org

Duration: From 2008-09-01 to 2011-08-31

2.2.4.2 Bravehealth

CORDIS description: BRAVEHEALTH proposes a patient-centric vision to CVD management and treatment, providing people already diagnosed as subjects at risk with a sound solution for continuous and remote monitoring and real time prevention of malignant events. The solution proposed will be made up of the following sub-systems: 1)WEARABLE UNIT: it is an innovative concept of miniaturised multi-parameter sensor, able to continuously monitoring the most critical parameters needed to perform a thorough diagnosis by means of specific diagnostic and prognostic algorithms running on it. It will be possible both to perform scheduled analysis of critical parameters and to remotely trigger the screening of specific vital signs. 2)REMOTE MANAGEMENT UNIT: it represents the main interface between physicians and the system, providing both automated support, in the form of text messages with information or suggestions to the patient directly generated by the system, and doctor managed supervision, allowing direct communication with the patients with voice/text/chat messages. The most important added value of the this unit is the possibility to be interfaced with existing National Health Records and Physiological Data Banks in order to generating and verifying risk prediction models using advanced data mining approaches. 3)LIFE! GATEWAY: Data acquired by the wearable unit will be relayed to a gateway which represents the means by which the information flow from the user to the Central Supervision Unit. This unit will provide the user with the following functionalities: a)Real time communications: in case of anomalies, or simply to suggest specific drugs to be taken, or to advice some particular activity to be performed; 2)Location aware information, exploiting the positioning capabilities of GPS. 3)Mobile virtual community for education and support.

Web site: http://cordis.europa.eu/projects/rcn/102204_en.html

Duration: From 2010-03-01 to 2014-02-28

2.2.4.3 euHeart

CORDIS description: Cardiovascular disease (CVD) has a significant impact on the European society in terms of mortality, morbidity and allied healthcare costs. The opportunity of multi-scale modelling spanning, sub-cellular level up to whole heart is to improve CVD outcomes by providing a consistent, biophysically-based framework for the integration of the huge amount of fragmented and inhomogeneous data currently available. However, multi-scale models have not yet been translated into clinical environments mainly due to the difficulty of personalising biophysical models. The challenge of the euHeart project is to directly address this need by combining novel ICT technologies with integrative multi-scale computational models of the heart in clinical environments to improve diagnosis, treatment planning and interventions for CVD.

To meet this challenge we will bring together leading European physiological modelling and cardiac groups to develop, integrate and clinically validate patient-specific computational models of the cardiac physiology and disease-related processes. The main outcome of euHeart will be an open source framework for the description and representation of normal and pathological multi-scale and multi-physics cardiovascular models, using the international encoding standards. In addition, a library of innovative tools for the execution of the biophysical simulations, the personalisation of the models and the automated analysis of multi-modal images are developed.

Evidence of clinical benefit will be collected to quantify potential impact for a number of significant CVD's namely, heart failure, cardiac rhythm disorder, coronary artery disease and valvular and aortic diseases. Each of the selected clinical applications provides a complementary focus for the resulting integrated model of cardiac fluid-electro-mechanical function. The consortium contains a mix of academic leadership, clinical sites, and industrial partners ensuring exploitation of the wealth of models.

Web site: http://www.euheart.eu

Duration: From 2008-06-01 to 2012-11-30

2.2.4.4 HeartCycle

CORDIS description: Each year Cardiovascular Disease (CVD) causes over 1.9 million deaths in the EU, causing direct health costs of -105 billion. Coronary Heart Disease (CHD), half of all CVD deaths, is the single most cause of death in Europe. Heart Failure (HF) - a CHD being the most frequent cause of hospitalisation for people over 65 - has 10 million patients in the EU. Current treatment of HF entails recommendations from clinicians on medication, diet and lifestyle. Patients only receive feedback at doctors visits, or when facing symptoms. Daily monitoring, close follow up, and help on treatment routine is lacking. Non-adherence to the treatment regime is a major cause of suboptimal clinical benefit.

HeartCycle will provide a closed-loop disease management solution to serve both HF and CHD patients, including hypertension, diabetes and arrhythmias as possible co-morbidities. This will be achieved by multi-parametric monitoring of vital signs, analysing the data and providing automated decision support, to derive therapy recommendations.

The system will contain a patient loop interacting directly with the patient to support the daily treatment. It will show the health development, including treatment adherence and effectiveness. Being motivated, compliance will increase, and health will improve. The system will also contain a professional loop involving medical professionals, e.g. alerting to revisit the care plan. The patient loop is connected with hospital information systems, to ensure optimal and personalised care.

Europe¿s health system is undergoing radical changes due to an aging population. It's moving from reactive towards preventative care, and from hospital care to care at home. Tomorrow's patients will become more empowered to take their health into their own hands. New ICT is required to enable this paradigm shift. HeartCycle, coordinated by Philips "leading in electronics and health care", includes experts on textiles, ICT, decision support and user interaction.

Web site: http://www.heartcycle.eu

Duration: From 2008-03-01 to 2012-02-29

2.2.4.5 iCARDEA

CORDIS description: Over the last decade, there has been an exponential growth in the number of cardiac implantable devices, in their electronic and software complexity widening their function and application. However, due to their limited processing capabilities restricted by their size, CIEDs need to be supported with software running on the data centers. Currently, the data center processing is standalone with their custom software and proprietary interfaces.

iCARDEA will expose CIED data through standard interfaces to develop an intelligent platform to semi-automate the follow-up of CIED patients with context-aware, adaptable computer interpretable clinical guideline models. The computer interpretable guideline models to be developed will be designed from re-usable building blocks to facilitate personalization of the patient care and follow-up workflow.

The CIED data will be exposed through standard interfaces based on the HL7, ISO/IEEE 11073 standards and the IHE IDCO Profile. EHR interoperability will be achieved by exposing legacy EHR systems through standard HL7 CDA interfaces so that information about patients medical history such as the non-cardiac conditions denoting contraindications to the proposed therapies can be obtained from the patient EHR data and used in the clinical follow-up workflow.

The clinical guidelines will automate the risk assessment and hence support medical professionals by automatically assessing the situations and generating alarms. iCARDEA will introduce outcome indicators with the related steps of the clinical guidelines to measure the success of the care process so that it can be combined with expert feedback to achieve a closed-loop system.

The patients will be empowered with Personal Health Records (PHR) to enable informed and responsible participation in the process and for their education. iCARDEA platform will provide comprehensive security and privacy mechanisms and will be validated in a hospital in Austria with CIEDs from two major vendors.

Web site: http://www.srdc.com.tr/projects/icardea/

Duration: From 2010-02-01 to 2013-01-31

2.2.4.6 RT3S

CORDIS description: Vascular stenting is an invasive procedure for the treatment of occlusive vascular diseases; a small wire mesh tube called a stent is permanently placed in the artery or vein to help it remain open. The procedure is called angioplasty. Originally developed to treat sever occlusions of coronary arteries, thanks to its good results, stenting found an expanding indication also for the treatment of occlusions in peripheral arteries. Around 20% of the population over 60 years old have peripheral arterial disease, and in a fifth of them symptoms can become severe and progressive, causing major lifestyle limitation; in many of these cases a stent can solve the problem effectively and with moderate risk for the patient. As common for many other implantable devices, the expansion of the indication is also producing new complications. In particular, the risk of stent rupture, which in coronaries is near to zero, is becoming an increasing source of concerns for devices placed in peripheral arteries.

The variability of the incidence of this complication, that in some recent clinical studies affect 30% of the patients, suggest that problem is not only due to the design of the device, but also to factors related to the patient functional anatomy and lifestyle, and to the surgical procedure. The RT3S project aim to develop and validate a sophisticated patient-specific, probabilistic model of the fatigue-fracture of a stent, integrated in a computer-aided surgery planning application, implemented to run in real-time during the surgical planning, so as to provide advice of the risk of stent rupture while the surgeon is planning the operation. The real time software library, easy embeddable in any existing application, will make possible to include the assessment of risk for stent fracture in all software solutions for computer-aided planning, training and intervention of peripheral vascular angioplasty procedures.

Web site: http://www.rt3s.eu

Duration: From 2011-01-01 to 2013-12-31

2.2.4.7 SCATh

CORDIS description: Modern medicine is irreversibly shifting towards less invasive surgical procedures. Conventional open surgery approaches are systematically being replaced by interventions that reduce access trauma and thereby minimise pain and hospitalisation periods for patients. The downside of this approach is that it is highly demanding for the interventionalist, entailing unacceptable risks for the patient. In the perspective of patient safety, SCATh aims at minimizing these drawbacks specifically for a series of new and promising catheterization procedures. These procedures have the common denominator of dealing with cardiovascular disease, the main cause of death in the EU. SCATh will provide the interventionalist with visual and haptic tools for robust and accurate catheter guidance, which will be developed through novel approaches, by fusing preoperative patient-specific anatomical and mechanical models and intra-operative data streams from in situ sensors. By complementing and augmenting the skills of the interventionalist, patient safety will drastically increase and at the same time, potentially life-threatening complications which result from poor or damaging (x-ray, use of contrast agents)

visualisation or poor surgical technique can be avoided. The new concept for tracking, sensing, modelling and manipulation of the surgical environment will be integrated with existing technological state-of-the-art in close cooperation with clinical experts and industrial partners, both in the design and in the evaluation phases. The common efforts delivered during this project will result in a demonstrator applied to a carefully selected set of catheter procedures. Moreover, many of the technological advancements created during SCATh touch upon minimally invasive surgical procedures in general.

Web site: http://www.scath.net

Duration: From 2010-02-01 to 2013-01-31

2.2.4.8 SensorART

CORDIS description: Heart failure (HF) is the most increasing cause of death in Western Countries. For that reason, together with the difficulty of having a sufficient number of donor organs, it is recognized that the device-based therapeutic approaches will assume an increasingly important role in treating the growing number of patients with advanced heart failure, not only as bridge to transplant, but also as destination therapy, by considering also the ageing population. SensorART will provide: innovative telemedicine services supporting patients with chronic heart failure and healthcare professionals, allowing patients to be treated at home without renouncing to accessing high medical expertise; innovative tele-control services allowing the patient and the healthcare professional to keep under control the performance of cardiovascular implanted assist devices (VAD); demonstration of effectiveness and cost effectiveness of specialized telemedicine services and the positive impact on the healthcare system reducing hospitalisation time, by considering also the higher degree of device acceptability at home by a training of the patient and his empowerment.

The psychological support, evaluation and counselling before and after implantation will be strongly considered, by taking into consideration the importance of brain-heart and brain-homeostasis recover relations; circulatory modelling and simulation of cardiac and circulatory dynamics will be adapted to reconstruct the patient's status and analyse separately the effects of heart and circulatory conditions along with the assistance conduction, through this application, novices will have the possibility to make himself familiar with VADs, while gaining in-silico experience in treating acute heart failure; analysis and exploitation of the medical device market by the development of an open, standardized interoperable system able to easily interact with the existing products.

Web site: http://www.sensorart.eu

Duration: From 2010-03-01 to 2014-02-28

2.2.5 Endocrinology

2.2.5.1 AP@home

CORDIS description: The objective of AP@home is to build and evaluate an artificial pancreas (AP) with automated closed loop glycaemic control for insulin treated patients with diabetes. AP systems require algorithms using blood glucose levels obtained via glucose monitoring for controlling subcutaneous insulin administration. First, well established subcutaneous continuous glucose

sensors and insulin pumps will be combined to improve and verify the functionality of enhanced closed-loop algorithms. We will advance algorithm quality, improve sensors by bringing their accuracy below the desired 5% error level and add a remote hypoglycaemia alarm. Second, in parallel, two AP systems will be developed by combining an insulin pump and a sensor into a single device, using only one access point through the skin (single-port). Thereby the need to puncture the skin twice, once for the glucose sensor and once for the insulin infusion, can be avoided (two-port). If proven successful in computer simulations we will evaluate the best selected single-port system under clinical conditions.

Deliverables include:

- Description of more precise glucose sensing methods
- Description of system integration of the two-port and both single-port AP systems
- Validation of prototypes in the clinic and at home.

In a multinational controlled trial AP performance will be compared with standard intensive insulin therapy in daily life. Impact of the project includes strengthened competitiveness of European industry across a complete value chain involving large, mid-sized and small companies, enabling Europe to lead progress in AP systems. Also, the project will put European research and clinical organizations in leading positions with an increased number of high-skilled jobs in the medical device industry. Finally, diabetes care will be simplified, quality of life of patients with diabetes will be improved and diabetes related complications and health costs will diminish in the long run.

Web site: http://www.apathome.eu

Duration: From 2010-02-01 to 2014-01-31

2.2.5.2 Commodity12

CORDIS description: In COMMODITY12 we will build a multi-layered multi-parametric infrastructure for continuous monitoring of diabetes type 1 and 2. The COMMODITY12 system will exploit multi-parametric data to provide healthcare workers and patients, with clinical indicators for the treatment of diabetes type 1 and 2. COMMODITY12 will focus on the interaction between diabetes and cardiovascular diseases. To address the 5.1b) Challenge under the FP7 ICT 7th, we propose a four-layered platform structured as follows:

- Body Area Network Layer (BAN): this layer will employ sensors from the BodyTel PHS and additional Bluetooth sensors to monitor the patient physiological signals. This layer will perform multi-parametric aggregation of data for the Smart Hub layer.
- The Smart Hub Layer (SHL): the BodyTel PHS at this layer receives aggregated data from the BAN and applies machine learning to classify the signals and provide indications about abnormalities in the curves. SHL will communicate with DRR over the cell-phone network.
- The Data Representation And Retrieval Layer (DRR): this layer, based on the Portavita PHS to manage EHR, interfaces to the SHL and utilises existing medical data to perform information retrieval and produce structured information for the agents at the AIL.

- The Artificial Intelligence Layer (AIL): this layer uses the DRR layer to retrieve structured background knowledge of the patient for intelligent agents applying diagnostic reasoning to the patient's condition.

The system will be validated with diabetes (type 1 and 2) with a pilot in the form of a trial. The project outcome will aim to curb diabetes hospitalisation costs and to curb the percentage of diabetic patients experiencing cardiovascular complications. The main focus of our platform in Challenge 5.1 b) will be on correlating the multi-parametric data with established biomedical knowledge to derive clinically relevant indicators.

Web site: http://www.commodity12.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.5.3 EMPOWER

CORDIS description: Patient Empowerment involves patients to a greater extent in their own healthcare process and disease management becomes an integrated part of their daily life. The capability of self-management opens the possibility for patients not only to contribute to their own healthcare but also to be more in control of their disease. EMPOWER will develop a modular and standard-based Patient Empowerment Framework which facilitates the self-management of diabetes patients based on PHRs and on context-aware, personalised services. EMPOWER focuses the research and development efforts on a patient-centric perspective that also involves healthcare professionals. EMPOWER provides knowledge-based Self-Management Pathways for diabetes patients and this includes (1) services for the specification and execution of actions to change behaviour according to diabetes-specific health care needs and (2) services for monitoring of vital, physical, mental parameters as well as physical and lifestyle activities based on health standards. EMPOWER semantically integrates multiple information sources (EHR/PHR, diabetes guidelines, patterns of daily living) for a shared knowledge model. The Self-Management Pathways facilitate the specification of recommendations that allow specifying individual goals for the patient. Based on these goals, relevant information and their preferences patients can specify their individual diabetes-specific actions. The Self-Management Pathways are an iterative process where executed actions and reported patterns of daily life can be evaluated. Recommendations, goals and actions can be updated iteratively according to current needs and preferences. Finally, the services in EMPOWER will embrace semantic interoperability based on health standards e.g. HL7 and IHE profiles. A pilot application in Turkey (hosted by the Ministry of Health) and one in Germany (hosted by a network of GPs) will demonstrate that EMPOWER can interoperate with other health applications.

Web site: http://www.empower-fp7.eu

Duration: From 2012-02-01 to 2015-01-31

2.2.5.4 METABO

CORDIS description: The aim of METABO is to set up a comprehensive platform, running both in clinical settings and in every-day life environments, for continuous and multi-parametric monitoring of the metabolic status in patients with, or at risk of, diabetes and associated metabolic disorders.

The type of parameters that will be monitored, in addition to "traditional" clinical and biomedical parameters, will also include subcutaneous glucose concentration, dietary habits, physical activity and energy expenditure, effects of ongoing treatments, and autonomic reactions.

The data produced by METABO will be integrated with the clinical data and the history of the patient and will be used in two major interrelated contexts of care:

1. Setting up a dynamic model of the metabolic behaviour of the individual to predict the influence and relative impact of specific treatments and of single parameters on glucose level.

2. Building personalized care plans integrated in the current clinical processes linking the different actors in primary and secondary care and improving the active role of the Patient.

Web site: http://www.metabo-eu.org

Duration: From 2008-01-01 to 2011-06-30

2.2.5.5 MISSION-T2D

CORDIS description: The MISSION-T2D aims at developing and validating an integrated, multilevel patient-specific model for the simulation and prediction of metabolic and inflammatory processes in the onset and progress of the type 2 diabetes (T2D). The ultimate goal is to provide a diagnostic tool to estimate the risk of developing T2D and to predict its progression in response to possible therapies. In Europe, T2D is one of the most common age-related diseases and a major public health concern. Recent data show that T2D and its complications (heart, kidney, retina, diabetic foot) should be considered a systemic disease sustained by a pervasive, metabolically driven state of inflammation. Accordingly, there is an urgent need to (a) understand the complex mechanisms underpinning the onset of T2D and (b) to identify early diagnostic parameters and related inflammatory indicators, by following a personalized medicine approach. This mission will be accomplished by setting up a multi-scale model to study the systemic interactions of the involved biological mechanisms (immunological/inflammatory processes, energy intake/expenditure ratio and cell cycle rate) in response to a variety of nutritional and metabolic stimuli/stressors.

The overall architecture will exploit an already established immune system simulator as well as several discrete and continuous mathematical methods for the modelling of the processes critically involved in the onset and progression of T2D. The crucial validation work will compare simulation predictions with actual biological and clinical data. MISSION-T2D aims at paving the way for translating validated multilevel immune-metabolic models into the clinical setting of T2D. Indeed, this approach will eventually generate predictive biomarkers from the integration of metabolic, nutritional, immune/inflammatory, genetic and gut microbiota profiles, as well as of clinical data, suitable to be translated into cost-effective mobile-based diagnostic tools.

Web site: http://cordis.europa.eu/projects/rcn/108366_en.html

Duration: From 2013-03-01 to 2016-02-29

2.2.5.6 MOSAIC

CORDIS description: MOSAIC will address two very specific aspects linked to the prediction of risk of developing diabetes (type 2 and gestational) and complications associated to diabetes. These objectives respond to a widely recognized problem related to diabetes management and have the potential to have a major impact in the way diabetes is currently diagnosed and followed in Europe.

The MOSAIC consortium counts with the expertise of four modelling partners who have worked over 25 years in the development of models of the human metabolic response in diabetes that will be enhanced in the project with the incorporation of elements that provide information related to environmental and clinical factors that prove to be relevant for the objectives defined such as socio-economic aspects, geographic localization, cultural background, nutrition, etc.

Multiple data bases cutting across geographic boundaries are available to the MOSAIC consortium as a result of the activities of previous studies and projects of the members, such as (a) METABO 7FP EU project; (b) from the transversal study "Healthy Breakfast" enriched with Medtronic's CareLink© reports for continuous glucose monitoring systems; (c) two large longitudinal epidemiological studies over 10 years long (VIVA study, BOTNIA prospective study); (d) outpatient data treated by FSM, Athens Hospital, Health Department 'Valencia-La Fe', ASL Pavia program over more than 10 years and (e) other data bases generated in ongoing 7FP EU studies like ePREDICE.

MOSAIC will integrate these models into an already existing platform for diabetes management and remote monitoring, NOMHAD Chronic, to facilitate the interpretation and visualization of the data and to enable a comprehensive understanding of the information by the health care professionals. At the same time this platform will be used during the validation phase of the project to acquire data during the prospective study to feed the models under test.

Web site: http://www.mosaicproject.eu

Duration: From 2013-01-01 to 2016-04-30

2.2.5.7 REACTION

CORDIS description: The REACTION project will develop an integrated approach to improved long term management of diabetes; continuous blood glucose monitoring, clinical monitoring and intervention strategies, monitoring and predicting related disease indicators, complemented by education on life style factors such as obesity and exercise and, ultimately, automated closed-loop delivery of insulin.

The REACTION platform will feature an interoperable peer-to-peer communication platform based on a (SoA) service oriented architecture all functionalities, including devices, are represented as services and applications consisting of a series of services orchestrated to perform a desired workflow. The REACTION platform also features a Model Drive Application Development environment based on extensive use of dynamic ontologies and advanced Data Management capabilities with algorithms for clinical assessment and rule-based data processing.

The intelligent, interoperable platform developed by REACTION will provide integrated, professional, management and therapy services to diabetes patients in different healthcare regimes across Europe, including 1) professional decision support for in-hospital environments, 2) safety monitoring for dosage and compliance, 3) long term management of outpatients in clinical schemes, 4) care of acute diabetic conditions and 5) support for self management and life-style changes for diabetic patients.

A range of REACTION services will be developed targeted to insulin-dependent type 1 diabetic patients. The services aim to improve continuous blood glucose monitoring (CGM) and insulin therapy, by both basal dose adjustment and contextualised glycaemic control based on patient activity, nutrition, stress level, etc. Decision support will assist healthcare professionals, patients and informal carers to better manage diabetes therapy and make correct choices about e.g. good blood glucose control, nutrition and exercise.

Web site: http://www.reaction-project.eu

Duration: From 2010-03-01 to 2014-02-28

2.2.6 Cancer

2.2.6.1 CHIC

CORDIS description: Developing robust, reproducible, interoperable and collaborative hyper-models of diseases and normal physiology is a sine qua non necessity if rational, coherent and comprehensive exploitation of the invaluable information hidden within human multiscale biological data is envisaged. Responding to this imperative in the context of both the broad Virtual Physiological Human (VPH) initiative and the paradigmatic cancer domain, CHIC proposes the development of a suite of tools, services and secure infrastructure that will support accessibility and reusability of VPH mathematical and computational hypermodels. These will include a hypermodelling infrastructure consisting primarily of a hypermodelling editor and a hypermodelling execution environment, an infrastructure for semantic metadata management, a hypermodel repository, a hypermodel-driven clinical data repository, a distributed metadata repository and an in silico trial repository for the storage of executed simulation scenarios. Multiscale models and data will be semantically annotated using the ontological and annotating tools to be developed. An image processing and visualization toolkit, and cloud and virtualization services will also be developed. The CHIC tools, services, infrastructure and repositories will provide the community with a collaborative interface for exchanging knowledge and sharing work in an effective and standardized way. A number of open source features and tools will enhance usability and accessibility. In order to ensure clinical relevance and foster clinical acceptance of hypermodelling in the future, the whole endeavour will be driven by the clinical partners of the consortium. Cancer hypermodels to be collaboratively developed by the consortium cancer modellers will provide the framework and the testbed for the development of the CHIC technologies. Clinical adaptation and partial clinical validation of hypermodels and hypermodel oncosimulators will be undertaken.

Web site: http://chic-vph.eu

Duration: From 2013-04-01 to 2017-03-31

2.2.6.2 DR THERAPAT

CORDIS description: The past decade has seen a revolution in radiation therapy technology, offering exceptional flexibility in dose delivery. Image guidance during treatment ensures a reliable targeting of the dose to the tumour. This has created the possibility to irradiate the tumour with a high dose with minimal exposure of surrounding tissue. Thus an improvement in tumour control is no longer invariably associated with an increase in radiation-induced toxicity.

Now, the capacity exists to create treatment plans that are tailored to the specific characteristics of the patient. Thus, the success of radiotherapy depends on proper personalized therapy planning and outcome prediction. However, an individualized representational model that informs on radiation therapy planning and outcome prediction is still lacking.

There are several modelling approaches available that have the potential to fill this gap, among them empirical, but established radiobiological models and more sophisticated multi-scale models.

DR THERAPATs aim is to create the Digital Radiation Therapy Patient, integrating the available knowledge on tumour imaging, image analysis and interpretation, radiobiological models and radiation therapy planning into a reusable, multi-scale digital representation. DR THERAPAT will enable 1) Broad access to dose painting 2) Individualized planning resulting in more effective and safer treatment 3) Accurate prediction of tumour Control Probability and Normal Tissue Complication Probability, 4) improve outcome, 5) provide a platform demonstrating the integration of modelling into the clinical workflow, and 6) provide a platform for the validation of the models.

A demonstrator of this platform will be made for prostate cancer. With a second demonstrator for cervical cancer, we will show that the model can be translated to other forms of cancer. DR THERAPAT will adapt and integrate today's available tools into a digital representation of the patients health status and clinical workflow.

Web site: http://drtherapat.eu

Duration: From 2013-02-01 to 2016-01-31

2.2.6.3 FUSIMO

CORDIS description: In recent years, High-Intensity Focused Ultrasound and Focused Ultrasound (FUS) have become frequent tools for non-invasive benign tumour therapy. Applications in the treatment of fibroadenoma of uterus has become commercial and passed FDA clearance in 2004 and sonication of bone metastasis has obtained a CE mark. Other tumours are under preclinical (prostate, kidney) and clinical (breast, brain and liver) evaluation. However, treating tumours with focused ultrasound is still challenging in terms of reliable therapy planning, monitoring and outcome prediction especially in moving organs with a complex blood supply. It is important to understand that the processes involved in FUS therapy are multi-level ranging from organ morphology, perfusion and motion, down to microscopic and cellular level. The relation within and between these levels is not well understood. FUSIMO will develop, implement and validate a multi-level model for moving

abdominal organs for use with FUS and Magnetic resonance-guided focused ultrasound surgery. The overall model will consist of several sub-models, which interact and describe aspects in a hierarchical manner. The integrated model will consist of; - Abdominal organ model to simulate motion and the influence on ultrasound application - Target organ/tumour model to capture organ/tumour physiology, and organ/tumour reaction to therapy - Microscopic tissue model to simulate direct heat ablation, model energy distribution, tissue heating and cooling - Model to evaluate first steps to simulate drug delivery, microbubble distribution and dynamics The FUSIMO developments in the field of hardware and software will be combined into an integrated system, which will allow both abdominal FUS application to moving organs, and also other treatment modalities such as radio frequency, laser or cryotherapy or other types of interventions based on particles or fields in radiation therapy.

Web site: http://www.fusimo.eu

Duration: From 2011-01-01 to 2013-12-31

2.2.6.4 GoSmart

CORDIS description: The Go-Smart project will build a generic open-source software simulation environment for planning of image guided percutaneous Minimally Invasive Cancer Treatment (MICT). MICT includes radiofrequency ablation (RFA), cryoablation, microwave ablation (MW), transarterial chemoembolisation (TACE), brachytherapy (BT), and prospectively, irreversible electroporation (IRE). Beside of TACE each type of MICT uses needles that are inserted into the tumour tissue and the tissue is destroyed through heating, cooling, and application of an electric field or radiation. These treatments are often combined with TACE. The commonalities between the different procedures allow for the development of a generic, reusable, robust simulation environment with the relevant physics and physiology needed to correctly predict the result of MICT in terms of lesion size and shape. The environment will incorporate patient data and appropriate physiological models to simulate tissue response to heat, cooling, hypoxia, radiation, or electrical pulses. The models will account for multi-scale physiological dependencies between a full organ, its anatomical structures and tissue properties down to the cellular level.

The software environment will be open-ended with extendable interfaces to allow clinicians to add further patient data collected before, during and after MICTs. This data will be used by the research community to refine the existing physiological tissue models thus transforming the environment into a user-driven growing info-structure. The Go-Smart environment will allow the Interventional Radiologists (IR) to select an optimal type of MICT by simulating the personalised result of the different treatments and medical protocols in patient specific conditions. Bringing different MICTs into a unified simulation environment is a unique approach and will promote their systematic comparison and establish much needed common standards and protocols for MICT in Europe.

Web site: http://www.gosmart-project.eu

Duration: From 2013-04-01 to 2016-03-31

2.2.6.5 INTEGRATE

CORDIS description: There is a strong need in biomedical research, especially in the case of complex heterogeneous diseases such as cancer, to achieve an all-comprising harmonization of efforts: To integrate the available data and knowledge in comprehensive models supported by interoperable infrastructures and tools, to standardize methodologies, and to achieve wide-scale data sharing and reuse, and multidisciplinary collaboration.

INTEGRATE aims to build solutions that support a large and multidisciplinary biomedical community ranging from basic, translational and clinical researchers to the pharmaceutical industry to collaborate, share data and knowledge, and build and share predictive models for response to therapies, with the end goal of improving patient outcome. Moving away from empirical medicine, towards evidence-based personalized care has the potential to both dramatically improve patient outcome and to reduce costs. INTEGRATE will deliver reconfigurable infrastructure components; tools for sharing and collaboration; standards-based data models; and repositories of data, models and knowledge.

The INTEGRATE environment will enable: Collection, preservation, management and reuse of data collected within multi-centric clinical trials. These unique comprehensive datasets will be made available through uniform interfaces to support information sharing and collaborative knowledge generation. Multi-disciplinary collaboration, providing an environment and tools that support researchers across domains, institutions and industries to jointly contribute to research objectives, develop common methodologies and complex analyses, and efficiently make use of each other's expertise and results. Collaborative definition and development of relevant clinical questions and more efficient validation of potential biomarker results and predictive models in clinical trials.

Collaborative development, preservation and sharing of multi-scale realistic and validated predictive models of response to novel therapies and anti-cancer drugs. We will propose methodologies for model development, a modelling framework, and predictive multi-scale models in the context of breast cancer. INTEGRATE will also provide standards-based interoperability to existing research and clinical infrastructures to support efficient information reuse and integration.

Web site: http://www.fp7-integrate.eu

Duration: From 2011-02-01 to 2014-01-31

2.2.6.6 PICTURE

CORDIS description: Breast cancer is the most common cancer to affect women in Europe and has a lifetime risk of 1 in 9. It is an increasingly treatable disease, however, and 10-year survival now exceeds 80%. Thus many women will live for many years with the potentially disfiguring aesthetic consequences of their treatment. When a woman faces a breast cancer diagnosis, and surgery is proposed, two options are available: breast-conserving surgery or mastectomy. The decision as to which type of surgery to offer patients is totally subjective and based almost exclusively on the judgment and experience of the clinician. In breast-conserving surgery, approximately 30% of women receive a suboptimal or poor aesthetic outcome, however there is currently no standardised method of identifying these women.

The PICTURE project aims to address this issue by providing objective tools to predict the aesthetic outcome of breast conserving surgery. Using a combination of 3D photography, together with routinely acquired radiological images (i.e. mammography, ultrasound and MRI, when available), we will develop techniques to biomechanically model the anatomy of the breast and the effect of surgical removal of cancerous tissue. These predictive tools will enable alternative surgical strategies to be explored and the consequences of the available options, with respect to the appearance of the breast, to be visualised. This will aid communication of the type of breast surgery recommended by the surgeon, to the patient, and will empower patients to take an active role in a shared decision making process. These tools will also enable the patient's aesthetic appearance after treatment to be objectively evaluated.

Web site: http://www.vph-picture.eu

Duration: From 2013-02-01 to 2016-01-31

2.2.6.7 TUMOR

CORDIS description: The project aims at developing a European clinically oriented semantic-layered cancer digital model repository from existing EU projects that will be interoperable with the US grid enabled semantic-layered digital model repository platform at CViT.org (Center for the Development of a Virtual Tumor, Massachusetts General Hospital (MGH), Boston, USA) which is NIH/NCI-caGRID compatible.

This interoperable, CViT interfaced, environment will offer a range of services to international cancer modelers, bio-researchers and eventually clinicians aimed at supporting both basic cancer quantitative research and individualized optimization of cancer treatment.

This Transatlantic project will therefore be the starting point for an international validation environment which will support joint applications, verification and validation of the clinical relevance of cancer models. To ensure the clinical relevance of this joint effort, the development of the project will be based upon specific clinical scenarios that will be implemented within an integrated EU-US workflow environment prototype for predictive, In Silico Oncology-guided clinical studies that will be deployed towards the end of the project. As an end result, a specific, clinically relevant workflow involving both EU and CViT models will be demonstrated, which will clearly highlight the need for and added value of interoperability.

To achieve these goals, multiscale models/tools developed and data collected within the framework of three ongoing EC funded research projects namely ACGT [Advancing Clinicogenomic Trials on Cancer], ContraCancrum [Clinically Oriented Cancer Multilevel Modeling] and the VPH NoE [Virtual Physiological Human Network of Excellence], in conjunction with models and data from the NIH supported ICBP Program CViT.org will drive the development, optimization and validation of the integrated system. Thus, a new module of the VPH environment will emerge.

Web site: http://tumor-project.eu

Duration: From 2010-04-01 to 2013-03-31

2.2.6.8 VPH-PRISM

CORDIS description: Breast cancer is frequent and life threatening, but curable if detected early. Early detection and comprehensive characterisation of findings require optimized imaging and image understanding to maximise detection of significant disease while preventing overdiagnosis. Personalised predictive modelling of breast cancer allows treatment stratification, preventing unnecessary and unsuccessful treatments. VPH-PRISM addresses these key topics with integrated multidisciplinary, multi-scale ICT modelling of breast tissue microstructure in the context of environmental, genetic, and clinical factors.

Key challenges include establishment of combined biomarkers from the automated analysis and spatial correlation of digital pathology and advanced breast imaging. Tissue characterisation includes the peritumoural stroma, a key in tumour progression and therapy response. Comprehensive clinical breast cancer phenotypes are extracted from prospectively collected multidisciplinary data. Interactions of environmental and genetic factors with specific breast tissue patterns are analysed in three large ongoing population-based imaging cohorts. A standard breast model enables efficient, combined statistical modelling of sparsely sampled and heterogeneous, large-scale data across disciplines, scales, structures, time and patients.

Using the developed tools and models, and the data collected, we will:

- improve estimates of tumour spread to aid surgery and assess chemo- and radiotherapeutic response
- optimise multi-modal imaging methods through biophysical forward modelling of image formation for more efficient phenotyping and imaging biomarkers
- predict personal risks for cancer progression and select optimal treatment strategies

VPH-PRISM will provide a proof of concept for multidisciplinary model based discovery of environment-tissue interactions, quantitative drug efficacy assessment, surgery planning, and treatment outcome prediction at early and advanced stages of breast cancer.

Web site: http://www.vph-prism.eu

Duration: From 2013-03-01 to 2016-02-29

2.2.7 Paediatrics

2.2.7.1 Caretoy

CORDIS description: Stroke and other neurological conditions affect the population of infants in percentages that cannot be considered marginal. Preterm infants are the highest infants at risk for neurological damage. Currently, infants have rehabilitation sessions few times a week in rehabilitation centres but according to basic neuroscience it would be necessary to provide them

with an early, intensive and multiaxial intervention. One option to reduce the cost of the entire European Healthcare System while increasing the practice of rehabilitation is to devise therapies and technologies that can be administered at home by caregivers and telemonitored by rehabilitation staff. The aim of this proposal is to promote early intervention in the first year of life and to reinforce therapy by "CareToy": a portable low cost smart system telemonitored thus augmenting the clinical effectiveness of the therapy while reducing the cost.

The smart system is based on a common baby gym, composed of different modules: a) an instrumented baby gym with mechatronic hanging toys, so that the infants' actions on the gym can be measured and stimulated, b) a vision module, for measuring and promoting infants' attention and gaze movements and c) a sensorized mat for measuring and promoting postural control. Each module will also incorporate built-in signal processor, memory and wireless communication. A fourth telerehabilitation module completes the system that allows the system to remotely communicate with the rehabilitation staff for monitoring and assessing the rehabilitation techniques. CareToy and the effectiveness of home rehabilitation based on this system will be validated by clinical trials on 100 preterm infants with different brain lesions. The result of this project could have a large impact. CareToy may become a commercial product, manufactured on a large scale and distributed not only in rehabilitation centres but also at homes, sold or rented by the Health Care System to families as a therapeutic tool for care intensity.

Web site: http://www.caretoy.eu

Duration: From 2011-11-01 to 2014-10-31

2.2.7.2 MD Paedigree

CORDIS description: MD-Paedigree is a clinically-led VPH project that addresses both the first and the second actions of part B of Objective ICT-2011.5.2:

1. it enhances existing disease models stemming from former EC-funded research (Health-e-Child and Sim-e-Child) and from industry and academia, by developing robust and reusable multi-scale models for more predictive, individualised, effective and safer healthcare in several disease areas;

2. it builds on the eHealth platform already developed for Health-e-Child and Sim-e-Child to establish a worldwide advanced paediatric digital repository.

Integrating the point of care through state-of-the-art and fast response interfaces, MD-Paedigree services a broad range of off-the-shelf models and simulations to support physicians and clinical researchers in their daily work. MD-Paedigree vertically integrates data, information and knowledge of incoming patients, in participating hospitals from across Europe and the USA, and provides innovative tools to define new workflows of models towards personalised predictive medicine. Conceived of as a part of the "VPH Infostructure" described in the ARGOS, MD-Paedigree encompasses a set of services for storage, sharing, similarity search, outcome analysis, risk stratification, and personalised decision support in paediatrics within its innovative model-driven data and workflow-based digital repository. As a specific implementation of the VPH-Share project, MD-Paedigree fully interoperates with it. It has the ambition to be the dominant tool within its

purview. MD-Paedigree integrates methodological approaches from the targeted specialties and consequently analyses biomedical data derived from a multiplicity of heterogeneous sources (from clinical, genetic and metagenomic analysis, to MRI and US image analytics, to haemodynamics, to real-time processing of musculoskeletal parameters and fibres biomechanical data, and others), as well as specialised biomechanical and imaging VPH simulation models.

Web site: http://www.md-paedigree.eu

Duration: From 2013-03-01 to 2017-02-28

2.2.7.3 Sim-e-Child

CORDIS description: There is a high demand for patient specific cardiovascular disease therapeutics. Paediatric cardiology, in particular, faces difficult challenges due to the evolving nature of a child s. The Sim-e-Child project proposes to develop a grid-enabled platform for large scale simulations in paediatric cardiology, providing a collaborative environment for constructing and validating multi-scale and personalized models of a growing heart and vessels.

The project will establish an international cooperation, by linking the EC funded Health-e-Child project with leading institutions such as the American College of Cardiology, Johns Hopkins University, Technical University of Munich, and Siemens Corporate Research. Sim-e-Child is an extension of the Health-e-Child platform that: Interconnects the Health-e-Child database with new data from two prospective US multicenter studies Enhances and expands the Health-e-Child heart with existing models of the aorta, aortic valve and mitral valve, and with computational fluid dynamics Integrates the Health-e-Child Gateway and Case Reasoner with versatile tools for simulation workflow composition (iKDD) and sharing of scientific experiments (SciPort)

The objective of the Sim-e-Child is to strengthen the impact of the Health-e-Child project by creating an international simulation and validation environment for paediatric cardiology, supported by integrated data repositories. The project will advance the state-of-the-art by providing comprehensive and patient specific models for the dynamic and longitudinal interactions occurring in the left heart, with a focus on the congenital aortic arch disease and repair.

Web site: http://www.sim-e-child.org

Duration: From 2010-01-01 to 2012-06-30

2.2.8 Rehabilitation

2.2.8.1 REWIRE

CORDIS description: REWIRE develops, integrates and field tests an innovative virtual reality based rehabilitation platform, which allows patients, discharged from the hospital, to continue intensive rehabilitation at home under remote monitoring by the hospital itself. The main idea is to assemble off the shelf components in a robust and reliable way to get a platform system that can be to be deployed massively at the patients homes. The platform is constituted of three hierarchical components: a patient station (PS), deployed installed at home, a hospital station (HS) and a networking station (NS) at a the health provider site. The PS is based on video-based tracking

(through a mix of 2D and 3D cameras) and virtual reality. The patient sees on the display himself or an avatar moving and interacting in real-time with a virtual game with his movements tracked in real-time. Game variety of scenarios, balanced scoring system, quantitative exercise evaluation, audio-visual feed-back aims at maximum patients motivation. A robust and reliable auto-calibration and spatial synchronization with the graphics is developed. Patients daily activity is monitored by a Body Sensor Networks and his activity is profiled through eigenbehaviours. Environmental, physiological and motion data are combined to tune the rehabilitation exercise level, to assess potential risks and advice clinicians on the therapy. The HS main role is the definition and monitoring of the treatment. Data mining in the NS discovers common features and trends of rehabilitation treatment among hospitals and regions. A virtual community is setup to educate and motivate patients. A pilot is designed both for the clinical evaluation of effectiveness and suitability of REWIRE, and the study of the most appropriate model to seamlessly connect long-term at home rehabilitation to that at hospital, appropriate service settings and adequate business modells. Using advanced DTI imaging it is tested whether REWIRE meets the rationale of rehabilitation, that it triggers brain adaptations that mediate recovery.

Web site: http://www.rewire-project.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.8.2 SCRIPT

CORDIS description: Recent development in robot-mediated rehabilitation has shown the potential of robotic devices for delivering repetitive training thus allowing for a large number of repetitions to be delivered during acute and chronic phases of stroke rehabilitation. While there is growing evidence that such technologies are beneficial to patients recovery of functional and motor outcome, our goals are:

- To use such technologies at patients home, enabling better management of chronic stroke as it allows to administer larger repetitions and frequent exercise which can in turn increase the recovery gains. Moreover, it allows objective database of performance for tailoring treatment and follow-up.
- To focus on hand and wrist exercise that present the least researched area with the most functional relevance, and potential for contribution to personal independence.
- To look at differences between passive and active actuated devices. Inherent safe nature of these devices make them an ideal choice for home use.
- To provide an educational, motivational and engaging interaction, which makes a therapy session more enjoyable while having the capabilities to provide feedback to patients and health professional. The provided feedback will be based on heterogeneous data collected during interaction as well as comparisons with modells such as minimum jerk model as a performance indicator.
- To focus on remote management and support of the patient. It creates a communication platform that will support the remote management allowing to adjust the therapy program remotely thus reducing hospital or home visits frequency. This is facilitated by incorporating the clinical workflows into user interfaces used by patients and clinicians while maintaining a customisable and easy to operate front-end for users. The two-fold objective here enables

us to look at aspects of acceptability and compliance as well as data security and confidentiality.

- To infer from summative evaluation in this project, impact on health and recovery and its potential cost implications.

Web site: http://scriptproject.eu

Duration: From 2011-11-01 to 2014-10-31

2.2.9 Orthopedy

2.2.9.1 MXL

CORDIS description: Osteoarthritis (OA) is a disabling disease, affecting the joints of 40% or more of the population over 60, resulting in a socioeconomic burden of 7b. per year in Germany alone. Joint surgery attempts to address the various disease stages, to either minimize the risk of early degeneration of the native joint, or to replace a fully degenerated joint, with well over 1,000,000 surgeries performed annually in the EU. Adequate joint function and longevity are the most important factors that define success, yet at least 10% of reconstructions fail within 10 years of surgery, and a large fraction of native joints progresses to early OA. The ensuing revision surgery is not only painful and stressful for the patient but also costly for the health care providers. Joint failure is a consequence of inadequate competence of the patient s musculoskeletal system, joint overload and instability, or their combination.

Currently, surgeons rely on 2D static radiographs and their experience to plan the procedure. To prevent failures and improve outcome, key facts on the mechanical conditions of the joint need to be available to the surgeon. By implementing refined image reconstruction, biomechanical modeling and analysis tools, MXL will make the dynamic joint loading and stability accessible for the planning of joint surgery in every case. Based on this technology, MXL safeguards the patient by supporting the surgeon to decide when to operate, which procedure to use, and which key aspects to address to reduce the failure rate and improve the functional outcome of joint surgery. Therefore, we will develop an ICT based planning environment that provides the surgeon with quantitative information on the patient s anatomy, the competence of the soft and hard tissues, and integrates them within biomechanical models to arrive at an optimal strategy for joint surgery. This will result in a breakthrough with tremendous effects on patient safety and the return of function and joint longevity.

Web site: http://www.m-x-l.eu

Duration: From 2010-01-01 to 2012-12-31

2.2.9.2 MySpine

CORDIS description: Treatment and prognosis of spinal disc degeneration are still based on trial and error clinical decisions from the surgeon leading to numerous post treatment complications and eventual morbidity. A rational engineering approach based on advanced ICT and patient-specific

predictive systems to treat various spinal pathologies needs to be developed to guide clinicians and improve long-term clinical outcomes. In silico virtual assessment of the evolution of treatments for patient-specific lumbar spine geometries, tissue properties, and loading histories is the cornerstone of such predictive system. Focus must be made on functional patient-specific models that have mechanobiological predictive capabilities.

The objective of My SPINE is to adapt and integrate existing generic finite element (FE) models and use them as ICT tools in a clinical setting. The predictive system will consist in a set of specialized computing platforms. A geometrical and mechanical patient-specific model will be built, involving specialized processes such as image segmentation and analysis, mesh morphing, FE simulations, and optimizations. Based on the analysis of each integrated biomechanical and mechanobiological model, results will be evaluated in a probabilistic way, helping clinician to safely assess the risks and benefits of each simulated treatment.

The main outputs of the project are the creation of a prototype computing platform with a graphical user interface for clinical settings and a patient-specific database of the lumbar spine. This interface will give clinicians the ability to virtually explore patient-specific treatment outcomes of disc degeneration, from short-term biomechanical ending to long-term mechanobiological tissue evolution. The project will impact ehealth by bringing new engineering rationale in the clinical decision-process. Impact is thus directly linked to ICT companies for clinical software development and hospital for the development of new clinical protocols.

Web site: http://www.myspineproject.eu

Duration: From 2011-03-01 to 2014-02-28

2.2.9.3 NMS Physiome

CORDIS description: The musculoskeletal apparatus is probably the organ system where the need for the integrative approach advocated by the Virtual Physiological Human (VPH) initiative is most pronounced. The neuromotor control involves the entire body, whereas the processes involved in muscle twitching, bones and muscle adaptation, musculoskeletal aging, and in most musculoskeletal diseases take place at the molecular level. The traditional reductionist approach is reaching dead ends in a number of relevant questions in musculoskeletal research, such as those related to osteoporotic fractures, the pathophysiology of growth in cerebral palsy children, the pathogenesis of rheumatoid arthritis and osteoarthritis, etc.

It is becoming more and more evident that the way out is the development of new Information and Communication Technology (ICT) that makes personalised, predictive, and integrative musculoskeletal medicine possible. Worldwide, the two largest research projects focused on this are the Osteoporotic Virtual Physiological Human (VPHOP) integrated project funded by the European Commission, and the Center for Physics-based Simulation of Biological Structures (SIMBIOS) funded by the USA National Institute of Health. Both projects are targeting the same strategic objective, but each project breaks it into research goals that are overlapping in a few cases and complementary in all the others.

This unique condition creates an extremely interesting opportunity for international collaboration, which drastically increases the international impact of the work being done by the VPHOP project, and produces the conditions for global cooperation on this grand challenge of biomedical research. With the Neuro Musculo Skeletal Physiome (NMS Physiome) project, the SIMBIOS and VPHOP consortia intend to establish a more organic cooperation, structured around three objectives: integrate the project communities, integrate the projects tools, and work collaboratively on grand challenges.

Web site: http://www.nmsphysiome.eu

Duration: From 2010-01-01 to 2012-12-31

2.2.9.4 TLEMsafe

CORDIS description: The burden of Musculo-skeletal (M-S) diseases and prosthetic revision operations is huge and increasing rapidly with the aging population. For patients that require a major surgical intervention, procedures are unsafe, uncertain in outcome and have a high complication rate. The goal of TLEMsafe is to create an ICT-based patient-specific surgical navigation system that helps the surgeon safely reaching the optimal functional result for the patient and is a user friendly training facility for the surgeons. TLEMsafe is developed by generating automated 3-D image-analyzing tools to parameterize the M-S system. The patient-specific parameters are fed into a recently developed M-S model with which the patient-specific functional outcome can be predicted. This consists of a direct effect (e.g. due to the removal of a muscle in a tumour patient), but has also a secondary effect in the sense that the patient will generate adaptive behaviour to the altered M-S system. Implementation of the adaptive capacity will be a unique (but essential) feature which allows valid predictions of the functional effects of surgical interventions. The next step is that the surgeon can virtually operate on the patient-specific model after which the model predicts the functional effects. Once the optimal plan is selected, this is fed into a system that allows the surgeon to reproduce the selected surgical plan during the actual surgery TLEMsafe is a navigation system based on innovative ICT tools for training and pre-operative planning. Extensive, innovative validation techniques including quantitative indicators to improve safety (of surgical operation) and quality (highly predictable effects of complex surgery) are included. The emphasis on the M-S pathologies and the adaptive capabilities of the human M-S system creates a unique system. Co-developing the software of the visual and interactive (surgical) parts with clinicians and companies eases the successful introduction to (future) surgeons.

Web site: https://www.tlemsafe.eu

Duration: From 2010-03-01 to 2014-02-28

2.2.10 Gastroenterology

2.2.10.1 d-LIVER

CORDIS description: D-LIVER applies scenario-driven development methodologies to address an unmet need for bio-artificial liver support via continuous detoxification as remote transient therapy at the Point-of-Need. The liver is a complex organ with various vital functions in synthesis,

detoxification and regulation; its failure is life-threatening and the only curative treatment is transplantation. Whilst awaiting transplantation, or after liver resection, patients need to be supported with detoxification systems which, currently mainly based on filtration, do not support metabolic liver function. This can only be provided by living cells. Thus, development of ICT-enabled bio-artificial liver support systems with associated remote monitoring to assist in the treatment and management of liver patients in care settings extending from the hospital to the home is essential.

D-LIVER targets sensor-based monitoring of patient health status at home, concentrating on continuous monitoring of physiological parameters and discrete measurement of a defined set of biochemical species. D-LIVER also targets remote monitoring and control of the bio-artificial liver and communication with patient sensor networks and hospital information systems. Systems will be capable of remote, secure communication of the status of both the patient and the bio-artificial liver to central clinical services such that they can schedule swift and beneficial treatment and remedial actions. In this way D-LIVER will provide fundamental advances in liver support by reducing hospitalisation costs while enhancing quality of care and, at the same time, reinforcing European leadership in Personal Health systems.

In a parallel, high-risk, activity the production of human hepatocytes from pancreatic progenitor cells will be investigated. These would be ideal for use in D-LIVER systems since they may provide an unlimited supply of hepatocytes, which would overcome drawbacks associated with both primary hepatocytes and stem cells.

Web site: http://www.d-liver.eu

Duration: From 2011-10-01 to 2015-09-30

2.2.10.2 CD-MEDICS

CORDIS description: The overall concept of the CD-MEDICS IP is to develop a technology platform for point-of-care diagnostics, capable of simultaneous genomic and proteomic detection, with embedded communication abilities for direct interfacing with hospital information systems. This will be achieved by exploiting breakthroughs at the confluences of bio-, micro- and nano- technologies to create a low-cost non-invasive intelligent diagnosis system.

This platform will be developed in a modular format, which will allow each module to be developed and exploited individually. The modules will subsequently be integrated to facilitate the desired application. Advances in data communications, molecular biology and biosensor technology, with the integration of nanostructured functional components in macro and microsystems, will facilitate the realisation of a minimally invasive generic platform, which is capable of multi-parametric monitoring and will be interoperable with electronic medical records.

The advantages of integrated biosensor systems include their ease of use, their sensitivity, their inherent selectivity (preventing problems due to interfering substances), their versatility (allowing `in-field¿ use) and their cost effectiveness. Addressing the future health care requirement of an individualised theranostic approach, the specific application that will be demonstrated in this IP will be for the management, monitoring and diagnosis of coeliac disease, with the proposed technology

contributing to significant advances in sensitivity and specificity of diagnosis. The technology platform developed, however, could be applied to a variety of clinical screening applications, such as cancer. The radical innovation proposed in this IP will result in a concrete prime deliverable of a technology platform of wide application and unquestionable socio-economic benefit, increasing European competitiveness whilst contributing considerably to the quality of life well being of the population.

Web site: http://www.etseq.urv.es/cdmedics/

Duration: From 2008-02-01 to 2012-07-31

2.2.10.3 VIGOR++

CORDIS description: Inflammatory Bowel diseases (IBDs) constitute on of the largest healthcare problems in the Western World, affecting over 1 million European citizens alone, 700,000 of whom suffer from Crohn s disease. Grading of Crohn s disease severity is important to determine treatment strategy and to quantify the response to treatment. Colonoscopy in combination with the assessment of biopsy samples is considered the reference standard for diagnosis of all IBD. However, the procedure is invasive and requires extensive bowel preparation, which is considered very burdensome by most patients. Moreover, it only gives information on superficial abnormalities. The VIGOR++ project aims to create a multiscale, personalised GI tract model, which facilitates improved detection of Crohn s disease and drives an accurate index of Crohn s disease severity.

VIGOR++ will acquire laboratory, MRI, colonoscopy and microscopy (histopathology) data in order to develop the targeted ICT tools. A novel integration of existing models is employed to predict features on the molecular to cellular scale (microscopy/colonoscopy) from descriptive properties at the organ to patient scales (MRI/laboratory). Effectively, this would render the standard methods (colonoscopy/biopsy) superfluous. The tools sustain early diagnosis, improved therapy planning and a better quality of life for patients. The clinical benefit is demonstrated by an assessment of the tools performance to predict Crohn s disease status. Moreover, a preliminary study will be performed in which the effect of therapy is evaluated using the VIGOR++ tools. The consortium harbours leading groups in abdominal radiology, medical image analysis, modelling, scientific visualization, gastroenterology and commercial diffusion. Importantly, it has solid plans for the commercialisation of the generated innovations. Notably, the ICT tools are developed in a clinically used environment, 3Dnet Suite, so that they can be readily commercialized.

Web site: http://www.vigorpp.eu

Duration: From 2011-02-01 to 2014-01-31

2.2.11 Biomedical informatics

2.2.11.1 GRANATUM

CORDIS description: The vision of the proposed GRANATUM project is to bridge the information, knowledge and collaboration gap among biomedical researchers in Europe (at least) ensuring that the biomedical scientific community has homogenized, integrated access to the globally available

information and data resources needed to perform complex cancer chemoprevention experiments and conduct studies on large-scale datasets.

In this way, the GRANATUM initiative will facilitate the social sharing and collective analysis of biomedical experts knowledge and experience, as well as the joint conceptualization and design of scalable chemoprevention models and simulators, towards the enablement of collaborative biomedical research activities beyond geographical.

- the innovative GRANATUM Framework, Architecture and Platform for socially interconnecting and semantically linking the cancer chemoprevention biomedical researchers, data, resources and services;
- the GRANATUM Semantic Model that constitutes a common ontological reference model for the semantic annotation, sharing and interconnection of globally available biomedical resources, such as EHR databases, digital libraries and archives, online communities and discussions;
- a set of GRANATUM Research Collaboration Showcases and Experiments in Cancer Chemoprevention that will validate and prove the concepts and tools of the proposed GRANATUM initiative;
- the GRANATUM Methodology that constitutes a step-by-step cookbook with methodological adoption guidelines for leveraging the quality of the integrative biomedical research in cancer chemoprevention;
- Wide-scale dissemination and exploitation of the project results to the European academic, scientific and industrial stakeholders in the enlarged Europe and beyond. Led by Fraunhofer FIT, the GRANATUM consortium consists of eight (8) partners, from five (5) EU member states, i.e. Ireland, Italy, Germany, Cyprus and Greece.

Web site: http://www.granatum.org

Duration: From 2011-02-01 to 2013-07-31

2.2.11.2 INBIOMEDvision

CORDIS description: Biomedical Informatics deals with the integrative management and synergic exploitation of the wide ranging and inter-related scope of information that is generated and needed in healthcare settings, biomedical research institutions and health-related industry.

Some key present challenges of Biomedical Informatics are:

- The effective and synergic integration between computational methods and technologies supporting life sciences research (Bioinformatics) and the informatics supporting healthcare and medical research (Health or Medical Informatics).
- The development of effective translational knowledge management approaches facilitating the application of knowledge arising from basic biomedical research into clinical practice.
- The integration and joint exploitation of heterogeneous information stored in widespread repositories and diverse formats.
- The development of innovative methods for the modelling and simulation of complex biological phenomena, as well as the corresponding computational applications.

- The intersection between neuroscience and informatics (neuroinformatics). In this context, INBIOMEDvision aims to become a European-wide initiative intended to monitor the evolution of the Biomedical Informatics field and address its scientific challenges by means of collaborative efforts performed by a broad group of experts with complementary perspectives on the field.

These efforts will certainly contribute to the strength and expansion of the Biomedical Informatics scientific community, particularly in Europe.

INBIOMEDvision will develop a series of services and activities to serve the aforementioned purposes (inventory of resources and initiatives, state of the art reviews, prospective analyses, community building actions and dissemination and training activities).

Web site: http://www.inbiomedvision.eu

Duration: From 2011-02-01 to 2013-01-31

2.2.11.3 MSV

CORDIS description: In recent years, various terms the Virtual Physiological Human (VPH), Integrative Biology, Physiome Research have been used to describe the trend in biomedical research towards the consideration of systemic processes. These phenomena are commonly observed in living organisms but cannot be explained within a single sub-system but reflect, rather, systemic outcomes that result from the interaction of multiple sub-systems. Traditionally, when confronted by the complexity exhibited in biomedical problems, researchers have been forced to focus purely on individual sub-systems; the most common boundary separating these has been spatiotemporal scale.

The current interest in VPH is demanding greater concentration on the study and simulation of biological systems at multiple scales, and multiscale data collection and multiscale modelling have recently become synonymous with integrative research. The many VPH projects that will start to demand multiscale visualisation in the coming years suggests that this area should receive urgent attention. The Multiscale Spatiotemporal Visualisation (MSV) project aims, by international cooperation between the European @neurIST and VPHOP integrated projects, the US National Alliance for Medical Imaging Computing (NA-MIC), and the New Zealand-based IUPS Physiome initiative:

- to define an interactive visualisation paradigm for biomedical multiscale data
- to validate it on the large collections produced by the VPH projects
- to develop a concrete implementation as an open-source extension to the Visualisation Took Kit (VTK), ready to be incorporated by virtually any biomedical modelling software project.

Web site: http://www.msv-project.eu

Duration: From 2010-01-01 to 2012-12-31

2.2.12 Drugs and patient safety

2.2.12.1 ALERT

CORDIS description: Serious adverse effects resulting from the treatment with thalidomide prompted modern drug legislation more than 40 years ago. Post-marketing spontaneous reporting systems for suspected adverse drug reactions (ADRs) have been a cornerstone to detect safety signals in pharmacovigilance. It has become evident that adverse effects of drugs may be detected too late, when millions of persons have already been exposed.

In this project, an alternative approach for the detection of ADR signals will be developed. Rather than relying on the physician's capability and willingness to recognize and report suspected ADRs, the system will systematically calculate the occurrence of disease (potentially ADRs) during specific drug use based on data available in electronic patient records. In this project, electronic health records (EHRs) of over 30 million patients from several European countries will be available. In an environment where rapid signal detection is feasible, rapid signal assessment is equally important. To rapidly assess signals, a number of resources will be used to substantiate the signals: causal reasoning based on information in the EHRs, semantic mining of the biomedical literature, and computational analysis of biological and chemical information (drugs, targets, anti-targets, SNPs, pathways, etc.).

The overall objective of this project is the design, development and validation of a computerized system that exploits data from electronic healthcare records and biomedical databases for the early detection of adverse drug reactions. The ALERT system will generate signals using data and text mining, epidemiological and other computational techniques, and subsequently substantiate these signals in the light of current knowledge of biological mechanisms and in silico prediction capabilities. The system should be able to detect signals better and faster than spontaneous reporting systems and should allow for identification of subpopulations at higher risk for ADRs.

Web site: http://www.eu-adr-project.com

Duration: From 2008-02-01 to 2011-07-31

2.2.12.2 preDICT

CORDIS description: Many drugs fail to reach the market because of side effects on the heart. The principal objective of this proposal is to create an advanced computational technology for in silico assessment of the efficacy and safety of specific drugs [ICT-2007.5.3(c) (3)], i.e. an open environment comprising validated computational models, tools and numerical methods that will enable simulations of drug actions on the electrophysiology of the human heart.

Such simulations will involve modelling of drug interactions at the molecular and cellular level, will extend current technology to enable prediction of the effects of those interactions on the dynamics of the whole heart, and will lead to an understanding of how genetic factors can be used to assess patient-specific risk profiles. This requires a multi-level systems approach, based on multi-scale, multi-physics methods, including computations on adaptive spatial grids and multi-grid time integration. Computations on realistic models at appropriate spatial and temporal scales are

currently not feasible, so we will investigate new algorithms and their implementation on high-performance platforms, including a new generation of petaflop computers, to achieve 'faster than real-time' simulation.

These tools form part of the infrastructure required to simulate the physiology of major organ systems, thereby contributing to the goal of creating the Virtual Physiological Human (VPH) [ICT-2007.5.3]. The balanced team in this project, including founders of the Human Physiome Project, has decades of experience in the experimental study and modelling of the electrophysiology and mechanics of the heart, while pharmaceutical industry partners bring deep understanding of the mechanisms of drug actions. The results will demonstrate the value of the VPH initiative to fundamental scientific understanding of the heart, with major economic and clinical impacts through accelerated drug development, approval and use.

Web site: http://www.vph-predict.eu

Duration: From 2008-06-01 to 2011-05-31

2.2.12.3 SAFROS

CORDIS description: This proposal addresses the development of technologies for patient safety in robotic surgery. We define patient safety metrics for surgical procedures and then develop methods that abide by safety requirements, formulated in terms of our metrics. We aim at demonstrating that a properly controlled robotic surgery carried out in accordance to our safety criteria can improve the level of patient safety currently achievable by traditional surgery.

The main innovative aspects of this project are: 1- Research driven by patient-safety requirements 2- Emphasis on methodological rigor: development of a methodology founded in evidence-based medicine 3- Scope: the entire surgical workflow is considered for development and validation. SAFROS focuses on innovative development of methods for the following technologies: Soft organ modeling and calibration, considering patient pathologies and anatomical variants Simulation planning in deformable environments Intra-operative registration and workflow monitoring Robot modeling and performance monitoring Surgeon training Operator interface with integrated stereovision and haptics New methods are integrated and validated on two distinct surgical robots (MIRO and RAMS), with respect to two inherently different contexts (pancreatic and vascular surgery). We quantitatively validate the adherence of our methods to the safety criteria, using surgical phantoms and animals.

By comparing across robots and surgical contexts we draw conclusions about the generality of our approach. The SAFROS consortium comprises: Hospitals with worldwide reputation, which provide medical knowledge and can validate our approach Europe s leading research groups in tele-robotics and surgical robotics Innovative companies, to develop new technologies for surgical simulators World Health Organization, with global expertise in patient safety surgical safety guidelines Renowned educational organizations, to innovate surgeon training

Web site: http://www.safros.eu

Duration: From 2010-04-01 to 2013-03-31

2.2.12.4 TRANSFoRm

CORDIS description: TRANSFoRm will develop rigorous, generic methods for the integration of Primary Care clinical and research activities, to support patient safety and clinical research via:

1. Rich capture of clinical data, including symptoms and signs rather than just a single diagnosis. A generic, dynamic interface, integrated with electronic health records (eHR), will facilitate both diagnostic decision support and identification of patients eligible for research, thus enhancing patient safety.

2. Distributed interoperability of eHR data and other data sources that maintain provenance, confidentiality and security. This will enable large-scale phenotype-genotype association studies and follow up of trials.

3. Software tools and services to enable use of controlled vocabulary and standardized data elements in clinical research.

This will enable integration and reuse of clinical data. Why this is important? Whilst diagnostic error is the commonest cause of litigation in Primary Care, eHR systems do not provide for easy collection of the data required for decision support. At the same time, clinical research is becoming uneconomic due to the costs of recruiting and following study participants, tasks that could be supported by the use of data from eHRs. Who will conduct the work? A multi-disciplinary consortium of ICT and clinical researchers from across Europe. These include experts in ontology, integration, distributed systems, security, data mining, user-facing design, evaluation and clinical research domains. Clinical participants include The European Clinical Research Infrastructures Network (where the systems will be deployed), The European General Practice Research Network, and a major Contract Research Organization. What is the anticipated impact? Improved patient safety by speeding translational research, quicker and more economic recruitment and follow up of RCTs, and enhanced uptake of eHR systems that offer support for clinical care and research.

Web site: http://www.transformproject.eu

Duration: From 2010-03-01 to 2015-02-28

2.2.13 Personal health systems, preventive healthcare and chronic illnesses

2.2.13.1 eHealthMonitor

CORDIS description: The eHealthMonitor project provides a platform that generates a Personal eHealth Knowledge Space (PeKS) as an aggregation of all knowledge sources (e.g., EHR and PHR) relevant for the provision of individualized personal eHealth services. This is realised by integrating service-oriented architecture, knowledge engineering, multiagent systems, and wearable/portable devices technologies. Innovations in eHealthMonitor are: (1) an adaptive, sustainable platform architecture for individualized personal electronic healthcare services; (2) reasoning, model evolution, and model summarization methods based on semantic models with different degrees of granularity, specificity, and different types of heterogeneity (syntactic, lexical, semantic); (3) distributed, adaptive knowledge sharing coordination methods which consider privacy protection requirements; and (4) personal eHealth services that support cooperation and decision making of

the involved participants (patients, clinicians, social services): medical decision support services, personal information services, environmental and lifestyle risk factor monitoring services, and physiological and bio-chemical data monitoring services. The eHealthMonitor platform and health services are evaluated in three case studies: Deployment of the platform in two hospital scenarios built around two of the most relevant issues in the current EU eHealth environment (1) dementia and (2) cardiovascular diseases involving patients and medical professionals. (3) Deployment of the eHealthMonitor platform as part of prevention strategies where an insurance company provides its clients (patients and non-patients) access to the eHealthMonitor services in order to lower the risk of potential diseases. The impact is ensured through an active open source (OS) strategy which bases all basic software components on existing OS software and releases developed eHealth reference processes and guidelines as open models through Open Model Initiative.

Web site: http://www.ehealthmonitor.eu

Duration: From 2011-12-01 to 2014-11-30

2.2.13.2 Mobiguide

CORDIS description: MobiGuide (MG) will develop a patient guidance system that integrates hospital and monitoring data into a Personal Health Record (PHR) accessible by patients and care providers and provide personalized secure clinical-guideline-based guidance also outside clinical environments. MG's ubiquity will be achieved by having a Decision Support System (DSS) at the back end, and on the front end by utilizing Body Area Network (BAN) technology and developing a coordinated light-weight DSS that can operate independently. Personalization will be achieved by considering patient preferences and context. Retrospective data analysis will be used to assess compliance and to indicate care pathways shown to be beneficial for certain patient context.
MG will be validated on pre-selected clinical domains with intensive vs. sparse monitoring to demonstrate the generality of the design and assess functionality, feasibility, and impact.
MG addresses EU priorities: increasing patient safety, ubiquitous secure access to health care, patient empowerment, developing a common platform for healthcare services, and competitiveness of Europe.

The time is right for MG in view of Europe's vast interest in national PHRs and patient empowerment. MG will leverage this momentum to create a solution that goes beyond local proprietary and stand-alone EMR, DSS, and BAN.

Our team includes complementary partners with diverse experience in: patient guideline-based DSS, focusing on reasoning with patient guideline intentions and temporal patterns, decision-theoretic models, knowledge-data integration, and information visualization Health BAN, telemedicine data analysis for diabetes, telemedicine applications for cardiology and expertise in large system integration to create the secure PHR.

Web site: http://www.mobiguide-project.eu

Duration: From 2011-11-01 to 2015-10-31

2.2.14 General VPH projects

2.2.14.1 RICORDO

CORDIS description: The Virtual Physiological Human network represents an active and diverse community of biomedical scientists that studies human biology by computational means. This diversity is the basis for an impressive breadth of scientific approaches, and emergent technologies, as well as potentially shareable resources such as data and models. Although in principle, the resources generated are re-usable, in practice, few can currently be shared. A key reason for this disparity stems from the lack of consistent cataloguing, annotation and accessibility of VPH data and models (VPHDMs). The creation of a communal annotation strategy that supports the interoperability of VPHDMs across different biological scales (known as vertical integration), in such a way that is clinically relevant, is a fundamental goal for the VPH community. For this objective to be achieved, a community standard for the representation of multiscale biological entities represented across VPHDMs must be studied and tested carefully. To this end, this project will take a key step in prototyping a multiscale anatomy standard, and demonstrate its effectiveness in connecting patient specific radiological images to mathematical models of physiology, as well as to related genomic and molecular data. VPH data and model resources vary in type, complexity and accessibility. Therefore, the technical infrastructure that complements such an annotation strategy, and supports the interoperability of distributed VPH resources, will also be prototyped in this project.The outcome of this work will contribute a resource interoperability plan to the VPH's Toolkit Development Plan.

Web site: http://www.ricordo.eu

Duration: From 2010-02-01 to 2012-09-30

2.2.14.2 VPH NoE

CORDIS description: The Virtual Physiological Human Network of Excellence (VPH NoE) proposal has been designed with 'service to the community' of VPH researchers as its primary purpose. Its aims range from the development of a VPH ToolKit and associated infrastructural resources, through integration of models and data across the various relevant levels of physiological structure and functional organisation, to VPH community building and support. The VPH NoE aims to foster the development of new and sustainable educational, training and career structures for those involved in VPH related science, technology and medicine, and will lay the foundations for a future Virtual Physiological Human Institute.

The VPH NoE constitutes a leading group of universities, institutes and organisations who will, by integrating their experience and ongoing activities in VPH research, promote the creation of an environment that actively supports and nurtures interdisciplinary research, education, training and strategic development. The VPH NoE will lead the coordination of diverse activities within the VPH initiative to deliver: new environments for predictive, patient-specific, evidence-based, more effective and safer healthcare; improved semantic interoperability of biomedical information and contribution to a common health information infrastructure; facile, on-demand access to distributed European computational infrastructure to support clinical decision making; and increased European multidisciplinary research excellence in biomedical informatics and molecular medicine by fostering

closer cooperation between ICT, medical device, medical imaging, pharmaceutical and biotech companies.

The VPH NoE will connect the diverse VPH projects, including not only those funded as part of the VPH initiative but also those of previous EC frameworks and national funding schemes, together with industry, healthcare providers, and international organisations, thereby ensuring that these impacts will be realised.

Web site: http://www.vph-noe.eu

Duration: From 2008-06-01 to 2012-11-30

2.2.14.3 VPH-Share

CORDIS description: VPH-Share will develop the organisational fabric (the info-structure) and integrate the optimized services to (1) expose and share data and knowledge, (2) jointly develop multiscale models for the composition of new VPH workflows, (3) facilitate collaborations within the VPH community. Four flagship workflows (from @neurIST, euHeart, VPHOP, Virolab) provide existing data, tools and models, engage with the services developed by VPH-Share to drive the development of the info-structure, and pilot its applications. Data sources are usually clinical data from individual patients - medical images and/or biomedical signals - sometimes with population information. The operations range from secure access and storage through annotation, data inference and assimilation, to complex image processing and physics-based mathematical modelling, to data reduction and representation.

The project focuses on a key bottleneck: the interface with the wealth of data from medical research infrastructures and from clinical processes. VPH-Share will provide the essential services, as well as the computational infrastructure, for the sharing of clinical and research data and tools, facilitating the construction and operation of new VPH workflows, and collaborations between the members of the VPH community. Evaluating the effectiveness and fitness-for-purpose of the info-structure and developing a thorough exploitation strategy are key activities, creating confidence in the communities. The consortium, through its optimal mix of medical, mathematical, engineering, software & hardware and industrial knowledge and expertise from the EU and internationally, will make this effort a success, delivering to European citizens clinically useful outcomes that will benefit society. The duration of the project is 4 years, its budget is 14.5M, with an EC contribution of 10.7M.

Web site: http://www.vph-share.eu

Duration: From 2011-03-01 to 2015-02-28

2.2.15 Personalised healthcare

2.2.15.1 p-Medicine

CORDIS description: Medicine is undergoing a revolution that is transforming the nature of healthcare from reactive to preventive. The changes are catalyzed by a new systems approach to disease which focuses on integrated diagnosis, treatment and prevention of disease in individuals. This will replace our current mode of medicine over the coming years with a personalized predictive

treatment. While the goal is clear, the path is fraught with challenges. P-medicine brings together international leaders in their fields to create an infrastructure that will facilitate this translation from current practice to personalized medicine. In achieving this objective p-medicine has formulated a coherent, integrated work plan for the design, development, integration and validation of technologically challenging areas of today. Our emphasis is on formulating an open, modular framework of tools and services, so that p-medicine can be adopted gradually, including efficient secure sharing and handling of large personalized data sets, enabling demanding Virtual Physiological Human (VPH) multi-scale simulations (in silico oncology), building standards-compliant tools and models for VPH research, drawing on the VPH Toolkit and providing tools for large-scale, privacy-preserving data and literature mining, a key component of VPH research. We will ensure that privacy, non-discrimination, and access policies are aligned to maximize protection of and benefit to patients. The p-medicine tools and technologies will be validated within the concrete setting of advanced clinical research. Pilot cancer trials have been selected based on clear research objectives, emphasising the need to integrate multilevel datasets, in the domains of Wilms tumour, breast cancer and leukaemia. To sustain a self-supporting infrastructure realistic use cases will be built that will demonstrate tangible results for clinicians. The project is clinically driven and promotes the principle of open source and open standards.

Web site: http://www.p-medicine.eu

Duration: From 2011-02-01 to 2015-01-31

2.2.15.2 SIFEM

CORDIS description: The clinical evidence indicates that the number of people with all levels of hearing impairment and hearing loss is rising mainly due to a growing global population and longer life expectancies. Hearing loss caused by pathology in the cochlea or the cochlear nerve is classified as sensorineural hearing loss. The study of the normal function and pathology of the inner ear has unique difficulties as it is inaccessible during life and so, conventional techniques of pathologic studies such as biopsy and surgical excision are not feasible.

SIFEM focuses on the development of a Semantic Infostructure interlinking an open source Finite Element Tool with existing data, models and new knowledge for the multi-scale modelling of the inner-ear with regard to the sensorineural hearing loss. The experts will have access to both the data (micro-CT images, histological data) and inner ear models, while the open-source developed tools and the SIFEM Conceptual Model will be contributed to the VPH toolkit enhancing their reusability. These SIFEM open source tools and services enhance and accelerate the delivery of validated and robust multi-scale models by focusing on: (i) Finite Element Models manipulation and development, (ii) cochlea reconstruction and (iii) 3D inner ear models visualization.

The final outcome is the development of a functional, 3D, multi-scale and validated inner-ear model that includes details of the micromechanics, cochlea geometry, supporting structures, surrounding fluid environment and vibration patterns. In the open context that the project addresses the results can be used to better identify the mechanisms that are responsible for the highly sensitive and dynamic properties of hearing loss. These result to the description of alterations that are connected to diverse cochlear disorders and assist the experts to better assess each patient's condition leading

to more efficient treatment and rehabilitation planning and, in long-term, to personalized healthcare.

Web site: http://sifem.ubitech.eu

Duration: From 2013-02-01 to 2016-01-31

2.2.16 Mobile health (mHealth)

2.2.16.1 DECIPHER PCP

CORDIS description: The overarching objective of the DECIPHER Project is to enable secure cross-border mobile access to existing patient healthcare portals which are individually supported by national (governmental) bodies. DECIPHER will deploy Pre-commercial Procurement (PCP) to create step-change innovations in mobile patient ICTs. Using electronic patient records as the key enabling technology, this joint PCP will create technology-led service transformation in cross-border mobile healthcare, delivering significant benefits to patients and healthcare organisations. The Consortium consists of three leading commissioning authorities: FSHS (Finland), ESTAV Centro (Italy), and TicSalut (Spain/Catalonia). A single, joint PCP activity will be issued. Suppliers will be challenged to build on outputs from epSOS, CALLIOPE, and LOD2, and advances in mobile technology. Experts from Greece, France, Finland, UK, Sweden and Ireland will provide support. DECIPHER will generate a portfolio of interoperable applications, deployed on a pan-European platform. This resource will improve existing healthcare services by supporting mobility of patients and healthcare providers. From anywhere in the EU, a patient will be able to use a secure mobile device safely to gain 24/7 access to their prescription data, emergency data, examination results and other health information. To take this opportunity forward, the Consortium has put in place a well-defined Programme Plan. When implemented, the plan will: 1) mobilise the Consortium partners; 2) engage citizens, healthcare professionals, and industry; 3) leverage currently unconnected assets to create new and transformational innovations; 4) deliver step-change improvements to public services; and, 5) contribute to job and wealth creation in Europe. A detailed Dissemination Plan is in place to ensure key stakeholders (e.g. industry, PCP policy and commissioning authorities) are informed and encouraged to engage with DECIPHER.

Web site: http://www.decipherpcp.eu

Duration: From 2012-02-01 to 2015-01-31

2.2.16.2 MovingLife

CORDIS description: The MovingLife project will deliver roadmaps for technological research, implementation practice and policy support with the aim of accelerating the establishment, acceptance and wide use of mobile eHealth solutions with the aim of accelerating the establishment, acceptance and wide use of mobile eHealth solutions that will support lifestyle changes. The MovingLife will take a global perspective on mHealth not only from the developed world, but equally so from the newly developed and developing regions. Evidence and best practice from use of mHealth solutions in the developing world will be taken into account and interviews with experts from newly developed countries such as Brazil and India will be included in the analysis. The

roadmaps will address a broad group of fundamental issues such as: technology options for applications and services; options for new and improved medical guidelines; user empowerment, acceptance, ethics and privacy; socio-economic environments and policy and regulatory frameworks. The project will provide better understanding of the technology options for defining research policies and of the business and regulatory aspects for both private sector-driven and publicly-funded mHealth services. The MovingLife project has defined five objectives to reach the overall goal for the project. These five objectives are: definition and detailed description of state of play and trends, scenario development for mHealth applications, gap analysis and development of roadmaps. The project will also undertake validation and impact assessment in selected areas using Healthcare Technology Assessment methods and simulations of mHealth applications in daily life situations. The expected impact covers improved understanding of the technology options in areas such as network resilience, interoperability, security, etc. as well as improved understanding of the business and regulatory aspects.

Web site: http://www.moving-life.eu

Duration: From 2011-09-01 to 2013-02-28

2.2.17 eHealth services

2.2.17.1 HITCH

CORDIS description: e-Health, the beneficial application of ICT-based systems and solutions, has been identified as potentially the key enabler to fundamentally improve patient safety in clinical contexts. However, with ICT becoming a mission critical component of healthcare processes, the interoperability of the multitude of systems that together form the e-Health infrastructure of a hospital, region or nation, is becoming a critical factor for a safe and efficient delivery of care. Vendors, users, patients and authorities need to agree on practical solutions to validate and assert the interoperability of e-Health systems by means of appropriate testing and labeling/certification schemes.

The aim of the HITCH (Healthcare Interoperability Testing and Conformance Harmonization) project is to involve major stakeholders being already at the heart of Interoperability issues for defining and agreeing on a roadmap to establish a foundation for the Interoperability Conformance Testing of information systems in the field of Healthcare. The project will evaluate existing approaches and propose an achievable Interoperability Conformance Testing foundation deployable starting in 2011. Potential gaps in existing initiatives will be identified, as well as evolutions that should be undertaken over the next five years. The roadmap will thereby identify specific needs in terms of process improvements and tools development along with supporting research. The initial elements of this roadmap will be evaluated in a real-world setting with actual healthcare IT applications, with the goal to verify the immediate next steps of the proposed Interoperability Conformance Testing Roadmap and establish a good level of credibility from to the major stakeholders: vendors, users, patients and authorities.

Web site: http://www.hitch-project.eu

Duration: From 2010-01-01 to 2011-06-30

2.2.17.2 Salus

CORDIS description: Pre-approval clinical trials cannot possibly ensure that a drug will not have disastrous side effects once it arrives on the market. Post-approval safety data gathering was put in place to address this problem, but as implemented, it has not proven to be as effective as hoped. This is due to the fact that, current post market safety studies largely depend on the submission of spontaneous case reports where underreporting is a major problem. The need for a proactive approach is apparent, where safety data from multiple sources are actively monitored, linked and analyzed. Effective integration and utilization of electronic health records (EHR) can help to improve post-market safety activities on a proactive basis. There are prototype studies to monitor EHRs for simplifying ADE reporting, and also for signal detection by screening multiple EHRs, however these tools are directly built on top of EHR/EMR systems through proprietary interfaces. It is apparent that the promise of proactive, continuous monitoring of multiple sources cannot be achieved through such proprietary integrations. To facilitate wide scale proactive post market safety studies, there is a need for a new capacity enabling accessing the data locked in multiple different heterogonous EHR systems. In SALUS project, we aim to provide a standard-based interoperability framework that will enable execution of safety studies for mining and analyzing real-time patient data in communication with disparate heterogeneous EHR systems. SALUS will provide:

- Functional interoperability profiles enabling exchange of EHRs
- Semantic interoperability solutions enabling meaningful interpretation of the exchanged EHRs
- Security and Privacy mechanisms ensuring EHRs are shared in an ethical and safe way
- A novel framework for open-ended temporal pattern discovery for safety studies on top of EHR Systems
- Implementation of high potential use cases enabling secondary use of EHRs for post market safety studies

Web site: http://www.salusproject.eu

Duration: From 2012-02-01 to 2015-01-31

2.2.17.3 SemanticHealthNet

CORDIS description: SemanticHealthNet will develop a scalable and sustainable pan-European organisational and governance process for the semantic interoperability of clinical and biomedical knowledge, to help ensure that EHR systems are optimised for patient care, public health and clinical research across healthcare systems and institutions.

Through a clinically-driven workplan, exemplified in cardiovascular medicine, SemanticHealthNet will capture the needs for evidence-based, patient-centred integrated care and for public health, encapsulating existing European consensus in the management of chronic heart failure and cardiovascular prevention. Experts in EHR architectures, clinical data structures, terminologies and

ontology will combine, tailor and pilot their best-of-breed resources in response to the needs articulated by clinicians and public health physicians.

These exemplars will be cross-referenced with other domains and stakeholder perspectives via Clinical and Industrial Advisory Boards and interactions with other projects in Topic 5.3. The project will generalise and formalise the methods and best practices in how to combine and adapt informatics resources to support semantic interoperability, and how these can be developed and supported at scale. Health authorities, clinical professionals, ministries, vendors, purchasers, insurers are involved to ensure the project approach and results are realistically adoptable and viable, building on the SemanticHEALTH and CALLIOPE roadmaps.

A business model to justify strategic investments, including the opportunity costs for key stakeholders such as SDOs, industry, will be defined. This, and links with epSOS II and the eHealth Governance Initiative, will inform the shape of the Virtual Organisation that this Network will establish to sustain semantic interoperability developments and their adoption.

The consortium comprises more than 40 internationally recognised experts, including from USA and Canada, ensuring a global impact.

Web site: http://www.semantichealthnet.eu

Duration: From 2011-12-01 to 2014-11-30

2.2.18 Clinical research

2.2.18.1 EURECA

CORDIS description: EURECA aims to build an advanced, standards-based and scalable semantic integration environment enabling seamless, secure and consistent bi-directional linking of clinical research and clinical care systems to: 1.Support more effective and efficient execution of clinical research by Allowing faster eligible patient identification and enrolment in clinical trials, Providing access to the large amounts of patient data, Enabling long term follow up of patients, Avoid the current need for multiple data entry in the various clinical care. 2.)Allow data mining of longitudinal EHR data for early detection of patient safety issues related to therapies and drugs that would not become manifest in a clinical trial either due to limited sample size or to limited trial duration, 3:)Allow for faster transfer of new research findings and guidelines to the clinical setting (from bench-to-bedside), 4.) Enable healthcare professionals to extract in each patients case the relevant data out of the overwhelmingly large amounts of heterogeneous patient data and treatment information. At the core of the project will be achieving semantic interoperability among EHR and clinical trial systems, consistent with existing standards, while managing the various sources of heterogeneity: technology, medical vocabulary, language, etc. This requires the definition of sound information models describing the EHR and the clinical trial systems, and capturing the semantics of the clinical terms by standard terminology systems. The scalability of the solution will be achieved by modularization, identifying core data subsets covering the chosen clinical domains. We demonstrate and validate concepts developed in EURECA by implementing a set of software services and tools that we deploy in the context of pilot demonstrators. EURECA will develop solutions that fulfill the

data protection and security needs and the legal, ethical and regulatory requirements related to linking research and EHR data.

Web site: http://eurecaproject.eu

Duration: From 2012-02-01 to 2015-07-31

2.2.18.2 Linked2Safety

CORDIS description: The vision of the proposed Linked2Safety project is to advance clinical practice and accelerate medical research, to improve the quality of healthcare, benefiting public health, and to enhance patients safety; by providing pharmaceutical companies, healthcare professionals and patients with an innovative semantic interoperability framework, a sustainable business modell, and a scalable technical infrastructure & platform for the efficient, homogenized access to and the effective, viable utilization of the increasing wealth of medical information contained in the EHRs deployed and maintained at regional and/or national level across Europe, dynamically interconnecting distributed patients data to medical research efforts, respecting patients anonymity, as well as European and national legislation.

The 36-month Linked2Safety project with the developed reference architecture, data protection framework, common EHR schema, lightweight semantic model and integrated platform will facilitate the scalable and standardized semantic interlinking, sharing and reuse of heterogeneous EHR repositories, which will provide healthcare professionals, clinical researchers and pharmaceutical companies experts with a user-friendly, sophisticated, collaborative decision-making environment for:

a. analyzing all the available data including the genetic, environmental and medical history of subjects that exhibit adverse events occurring in the frame of clinical trials, based on the clinical care information existing in the specific patients EHR, leading to the identification of the phenotype and genotype factors that are associated with specific adverse events and thus having direct impact on the patient safety through the early detection of potential patient safety issues.

b. wide identification and selection of patients for clinical trials, though the seamless and standardized linking with heterogeneous EHR repositories, providing advice on the best design of clinical studies.

Web site: http://www.linked2safety-project.eu

Duration: From 2011-10-01 to 2014-09-30

2.2.18.3 Ponte

CORDIS description: Clinical trials are increasingly considered to be not only a means for evaluating the effectiveness of new medicine and pharmaceutical formulas but also for experimenting on existing drugs and their appliance to new diseases and disorders. Pharmaceutical companies tend to prefer launching modified versions of existing drugs, which generate generous profits while carrying little risk of rejection. Translation into clinical therapy has to overcome substantial barriers at the

preclinical and clinical levels. Thus, bridging basic science to clinical practice comprises a new scientific challenge which can result in successful clinical applications with low financial cost.

In the aforementioned context, the results yielding from clinical trials, which are testing the effectiveness of existing drugs and pharmaceutical formulas on diseases other than the ones they are currently treating, are closely dependent on the available data and the patients. The efficacy of such trials requires the pursuit of a number of aspects that need to be addressed ranging from the aggregation of data from various heterogeneous distributed sources (such as electronic health records - EHRs) to the intelligent processing of this data based on the clinical trial-specific requirements for choosing the appropriate patients eligible for recruitment. Within this framework, PONTE aims at providing a platform following a Service Oriented Architecture (SOA) approach that will offer intelligent automatic identification of individuals eligible (concerning their safety and clinical trial efficacy) to participate in clinical trials, as these will be designed and planned through a flexible authoring tool, enabling semantic interoperability of clinical care information systems with clinical research information systems and drug and disease knowledge databases, as well as the appliance of advanced data mining techniques and enhanced learning algorithms.

Web site: http://www.ponte-project.eu

Duration: From 2010-03-01 to 2013-02-28

3 Services, Software, Repositories and Tools

3.1 Personal Health Records

Healthcare services require a prompt access to the patient and clinical related information. It is usually assumed that health information exists primarily for healthcare professionals but well informed patients play as well an important role in the healthcare service processes. A longitudinal health record containing a patient's medical history, usually named Personal Health Record (PHR), holds the potential to transform healthcare by providing a complete set of patient managed information. We present a collection of PHR related tools and services, most of them are accessible on-line and could be further explored, some could serve as a technological background for MHA platform.

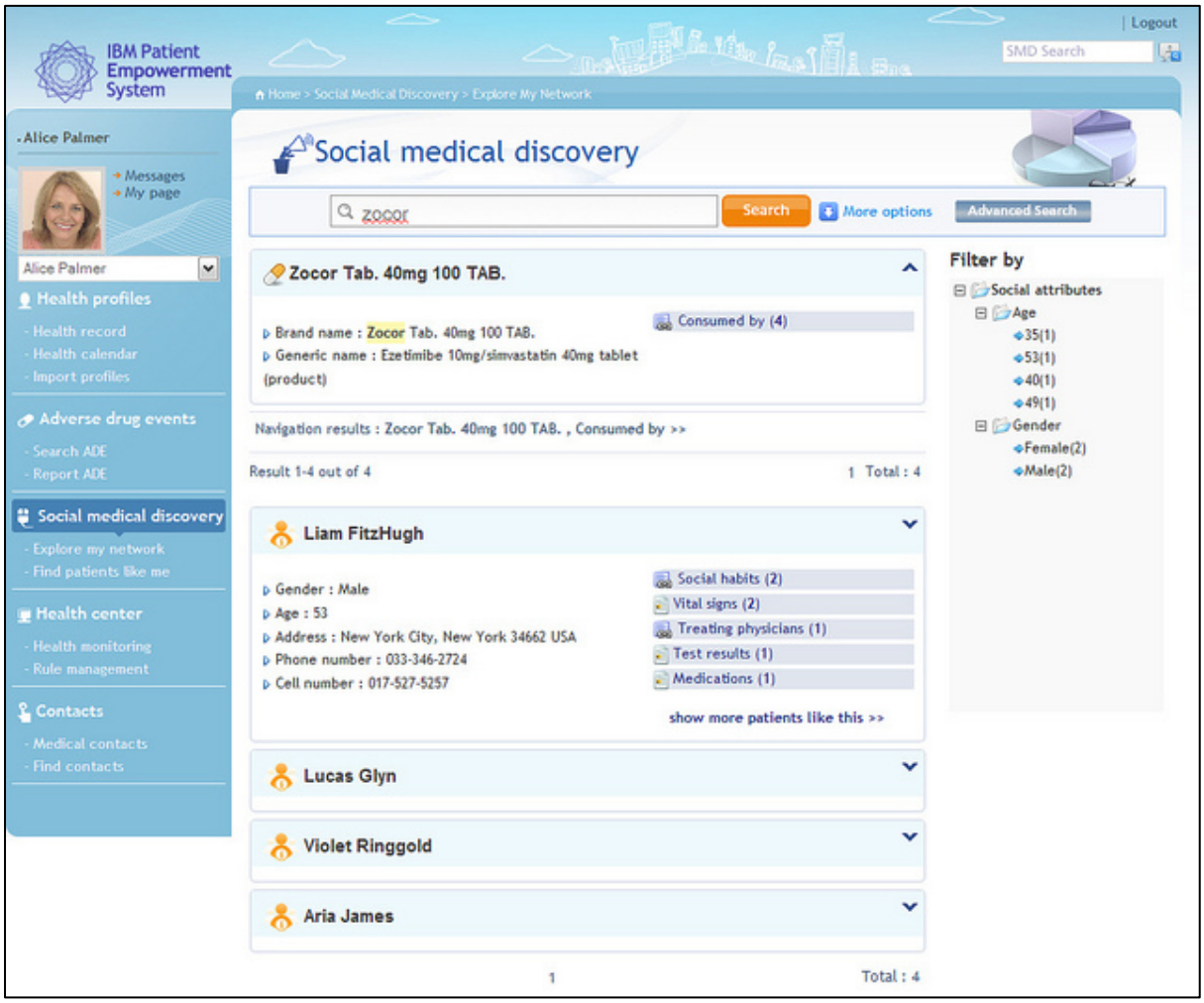
3.1.1 IBM Patient Empowerment System

The IBM Patient Empowerment System (**Picture 2**) goes beyond simply allowing patients to schedule appointments online or access a personal health record. The portal is based on the technology developed by IBM Research in collaboration with physicians and administrators of the Gacheon University Gil Hospital in Korea. Among the largest medical centers in Korea with approximately one million patients, the hospital recently decided to provide physicians and patients with access to the portal as part of a pilot project to increase efficiency and reduce costs.

The IBM Patient Empowerment System is a standards based platform, enabling patients to integrate and manage their healthcare data for all medical needs, receive personalized recommendations or alerts for safer medical treatment, and immediately access data from a vast range of sources including: third-party health portals, hospital electronic medical record systems, sensors, home devices for monitoring health conditions, U.S. Food and Drug Administration (FDA) alerts, medical sites like PubMed, and more. IBM has previewing the system at CeBIT 2011 in Hanover, Germany.

The system is described as the easy-to-use analytical services to reduce costs, increase safety and improve patient satisfaction. By integrating social and medical data from multiple sources, the system allows patients to take an active role in their treatment, bringing the interaction between patients and caregivers to a new level of collaborative teamwork.

The system is also described to protect privacy at various levels of granularity, enabling members to exercise fine-grained control over the level of information in their profile that can be viewed by others and its usage.



Picture 2. IBM Patient Empowerment System (Source: IBM Research)

Although more public sources for medical information are becoming available on the Internet all the time, this onslaught often leaves patients more confused rather than more knowledgeable. Weeding out relevant and accurate information in this sea of data is difficult for the typical patient but the IBM Patient Empowerment System uses expert analytics to take into account a patient's personal medical history and offer decision support information that is appropriate for them.

One example where public knowledge could improve patient safety involves personalized alerts for adverse drug events (ADE) - incidents where different medications could be dangerous when taken together. The Kaiser Family Foundation estimates that there are 7,000 deaths per year due to medication errors alone - about 16 percent more deaths than those attributable to work-related injuries.

ADE contributes greatly to added expenses in hospitalization and insurance costs every year. This service uses the platform's knowledge-bases alongside public repositories for drug-drug, drug-disease, drug-food, and pharmacogenetics interactions; these are then analyzed together with the most current patient clinical and genetic data. The output is an alert that can be given at the point of care to avoid potential harm associated with various drug interactions.

For example, if a patient is already being treated with prescription medicines and wants to take an over-the-counter medication, she would log into the IBM Patient Empowerment System and add the name of the drug to her list of medications. The system immediately crawls through her medical data, performs deep analytics, and then issues a warning message with details about a potentially dangerous interaction between one of the drugs she's already taking and the new one.

Because the system incorporates the patient's genetic profile, it can also issue warnings to the patient and prescribing physician if certain dosages or drug combinations are problematic given her personal genetic variations. Such genetic variations can lead a person to metabolize certain drugs differently than the greater population, raising the risk of dangerous adverse drug reactions. This information might otherwise be unavailable or even unknown to her physician.

Other smart services developed as part of this healthcare portal include socio-medical search and personalized recommendation services. The system maintains a unique dataspace that represents social entities, such as patients and healthcare personnel, and their relationship with medical entities, such as medications, allergies and treatment plans. The IBM Patient Empowerment System also offers search capabilities and recommendations about patients who suffer from similar problems, potential treatment plans, expert physicians, and more. These features are built on IBM's Big Data Analytics platform, which can process structured and unstructured data at scale and speed not possible with traditional data warehouse technologies, allowing the system to discover relations hidden in the data and correlate with external information.

Because the system is designed as a standards-based clinical data warehouse and supports standard interoperability profiles, it can also immediately incorporate any medical information from sensors, home medical devices, monitoring systems, labs, or hospital information systems. Moreover, this interoperability makes it possible to add new data sources or services at any time.

This solution is just one example of how IBM researchers are helping transform the healthcare industry. IBM is also focused on the area of health analytics, which uses sophisticated software to analyze vast amounts of medical data from many different sources at once to quickly help doctors make more informed decisions. For example, IBM's Watson computing system has the ability to analyze the meaning and context of human language to provide physicians with helpful information for diagnosing and treating patients. Helping doctors unlock important knowledge buried within huge volumes of information, technologies like Watson pave the way for a more evidence-based healthcare system that offers more informed diagnosis and treatment for patients - at lower costs for providers, insurers and patients.

The IBM Patient Empowerment System is the result of collaboration among three IBM centers around the world: the IBM Ubiquitous Computing Laboratory in Korea, IBM Research - Haifa and IBM Research - China.

3.1.2 Indivo

The Indivo system[7] is essentially an inversion of the current approach to medical records, in that the record resides with the patients and the patients grant permissions to institutions, clinicians, researchers, and other users of medical information. Indivo is a distributed, web-based, personally controlled electronic medical record system that is ubiquitously accessible to the nomadic user, built to public standards, and available under an open-source license.

3.1.2.1 Architecture Overview

This chapter provides a basic overview of the Indivo X system architecture. This document should be read before continuing on to Indivo Authentication and the Indivo API.

Basic Indivo Concepts:

- Indivo Record: the complete set of medical information stored by Indivo about a single individual.
- Indivo Account: a username/password to log into Indivo. One account may be able to access any number of Indivo Records, and one Indivo Record may be accessible by multiple Indivo Accounts.
- Indivo Document: a piece of medical information stored in an Indivo Record.

Indivo X comprises multiple components, each running as its own web server. Small installations may choose to install multiple components on a single physical server. The Indivo X Server is the core of the system; other components, including the Indivo User Interface, can be easily substituted by custom implementations.

Indivo X Server

For a given Indivo installation, the Indivo X server:

- stores all Indivo account information, as well as the medical records and documents,
- is responsible for authentication and authorization before granting access to Indivo data,
- exposes an API for access by administrative and user applications, and by the Indivo User Interface.

Indivo User Interface / Indivo Chrome

The Indivo User Interface, also known as the "Indivo Chrome", implements the web-based visual interface that an Indivo user will view and use. The branding/colors/details of the user interface are all controlled by the Indivo Chrome. Indivo Chrome connects to Indivo X using the standard Indivo API, including some specific calls accessible only to the Chrome component.

[7] Indivo, http://indivohealth.org [October 2013]

Indivo X will ship with a default implementation of the Indivo Chrome which can be customized while maintaining a clean interface to the Indivo X API. Customizations are encouraged for re-branding or for entirely different devices, e.g. iPhone.

Administrative Application

An Admin Application can connect to Indivo X and

- create new Indivo accounts and records
- reset of passwords
- manage ownership of records, i.e. assigning an account as the owner of a record.

An admin application cannot access medical data, it can only manage a record's metadata. An admin app is thus ideal for a hospital administrator, an Indivo help-desk staffer, a research administrator, etc.

User Application / Personal Health Application

A user application, or Personal Health Application, is an application that Indivo users manually add to their record to provide incremental functionality. Examples of PHA functionality include:

- Diabetes management
- Genomic data display
- Clinical trial matching and messaging

User applications generally provide a web interface to the Indivo user, while connecting to the user's Indivo record directly with the Indivo X Server. Users are fully in control of what data a user application can access. They can, at any time, change those permissions or remove the application entirely. Thus, an Indivo user application connects to Indivo in much the same way that a Facebook application connects to Facebook.

Communication Protocols

All communication between components is over HTTPS, with an API that abides by the REST design philosophy. Authentication is via oAuth.

3.1.3 Microsoft HealthVault

Microsoft HealthVault is a web-based PHR platform able to store, display and transfer health-related data; and store and retrieve medical images. Started in October 2007, the website is accessible at www.healthvault.com and addresses a wide range of end-users:

- Individuals
- Healthcare providers
- Solution providers
- Developers

In June 2010, Microsoft HealthVault was launched in the UK,[5] the website is accessible at www.healthvault.co.uk

For '**Individuals**' HealthVault is presented as *"an online service that lets you gather, store, use and share health information for you and your family, putting you in control of your health information."*

HealthVault includes various features that help consumers collect, exchange, view and use their personal health information more easily. For example:

- Adding data to HealthVault records by:
    - direct user entry
    - online connection with applications (including web, mobile, email, or data package pickup)
    - upload from compatible devices (such as pedometers, blood pressure and glucose meters)
- Enabling data access and exchange with people and applications through various methods (for example record sharing, application authorization, email, and access codes)
- Grouping sets of data that are useful for a particular purpose (such as for an emergency medical profile or weight management efforts)
- Graphing collected data (to show trends such as in blood pressure measurements)
- Sending email notifications about records (such as arrival of new data)
- Printing or exporting collected data (for example, to print information for doctor visits or a wallet card)

For '**Healthcare Providers**' HealthVault "*lets patients store health information from many sources, access a range of health and fitness apps, upload data from health and fitness devices, and share health information with those they trust.*"

HealthVault is promoted as a service which can help healthcare providers:

- Improve patient satisfaction through easier communication
- Manage practice overhead by exchanging information (including medical images) with patients electronically
- Implement Meaningful Use patient engagement objectives of the HITECH Act (applies to US only)

Close to other existing functionalities HealthVault is promoting the functionality to give the patient an electronic CCD. "*Almost every EHR now has the ability to save a "Continuity of Care Document" in electronic format. Your patient can upload the document into HealthVault and use it to populate their personal health record.*"

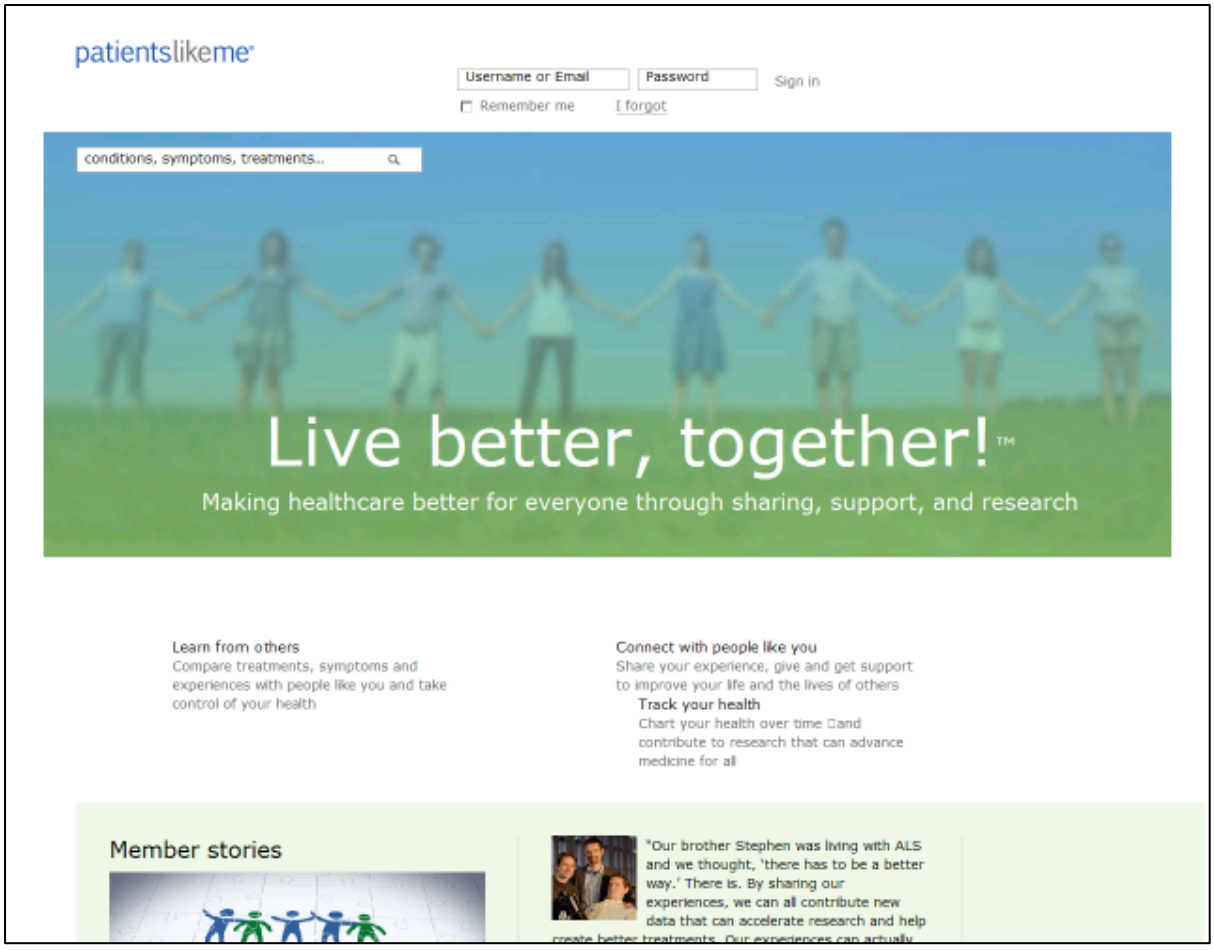
For "**Solution providers**" HealthVault is presented as "*a personal health record technology, HealthVault supports a growing ecosystem of more than 300 connected, user-friendly apps and more than 200 devices. People keep a comprehensive, up-to-date record of their health information in a*

convenient place where they can view and share it with those they trust. HealthVault also has built-in privacy, security, and user controls that put families in control of their health information."

For "**Developers**" HealthVault offers technical description, development basics, SDKs and other services in the frames of the HealthVault Developer Center on MSDN[8]

3.1.4 PatientsLikeMe

According to the available information PatientsLikeMe[9] (**Picture 3**) was co-founded in 2004 by three MIT engineers: Benjamin Heywood , James Heywood and Jeff Cole. Today, PatientsLikeMe is a commercial company which presents itself as an organisation focused on four core values: putting patients first, promoting transparency, fostering openness and creating "wow".



Picture 3. PatientsLikeMe home page [Source: http://www.patientslikeme.com]

PatientsLikeMe platform is following the 'Openness Philosophy' concept. Registered end-users are encouraged to share their medical and life-style data. According to platform's owners it allows *"… the collaboration on a global scale becomes possible. New treatments become possible. Most importantly, change becomes possible. At PatientsLikeMe, we are passionate about bringing people*

[8] HealthVault Developer Center on MSDN, http://msdn.microsoft.com/en-gb/healthvault [October 2013]
[9] PatientsLikeMe, http://www.patientslikeme.com [October 2013]

together for a greater purpose: speeding up the pace of research and fixing a broken healthcare system.

Currently, most healthcare data is inaccessible due to privacy regulations or proprietary tactics. As a result, research is slowed, and the development of breakthrough treatments takes decades. Patients also can't get the information they need to make important treatment decisions. But it doesn't have to be that way. When you and thousands like you share your data, you open up the healthcare system. You learn what's working for others. You improve your dialogue with your doctors. Best of all, you help bring better treatments to market in record time."

The core functionalities of the PatientsLikeMe platform are focused to allow registered members to input real-world data on their conditions, treatment history, side effects, hospitalizations, symptoms, disease-specific functional scores, weight, mood, quality of life and more on an ongoing basis. The result is a detailed longitudinal record - organized into charts and graphs - that allows end-users to gain insight and identify patterns. The data-sharing platform is designed to help patients answer the following question: "Given my status, what is the best outcome I can hope to achieve, and how do I get there?" Answers come in the form of shared longitudinal data from other patients with the same condition(s), thus allowing members to place their experiences in context and see what treatments have helped other patients like them.

Additionally, PatientsLikeMe platform has a detailed Privacy Policy[10] section. It states that some of the information that members provide about themselves may be shared with the PatientsLikeMe community, Partners, and others. Examples of Shared Data that members may submit at the Site, including through their health profile, may include:

- Biographical information, e.g. photograph, biography, gender, age, location (city, state and country), general notes;
- Condition/disease information, e.g. diagnosis date, first symptom, family history;
- Treatment information, e.g. treatment start dates, stop dates, dosages, side effects, treatment evaluations;
- Symptom information, e.g. severity, duration;
- Primary and secondary outcome scores over time, e.g. ALSFRS-R, MSRS, PDRS, FVC, PFRS, Mood Map, Quality of Life, weight, InstantMe;
- Laboratory results, e.g. CD-4 count, viral load, creatinine;
- Genetic information, e.g. information on individual genes and/or entire genetic scans;
- Individual and aggregated survey responses;
- Information shared via free text fields, e.g. the forum, treatment evaluations, surveys, annotations, journals, feeds, adverse event reports; and
- Connections to other people on the Site, e.g. invited care team member, mentors, feeds, subscriptions.

[10] PatientsLikeMe Privacy Policy, http://www.patientslikeme.com/about/privacy [October 2013]

3.1.5 Tolven

Tolven[11] was founded in February 2006, and is focused on the design, development, and delivery of a unique open source solution for the secure storage of healthcare and life science data that embraces industry and technology standards.

Tolven is described to provide professional services that support the adoption, deployment, and customization of its open source solution. Tolven's customer base evidences the scalability of the business model, and includes academic medical centres, independent software vendors, systems integrators, and pharmaceutical companies in the US and overseas.

By delivering open source solutions to the healthcare and life sciences communities, Tolven provides an extensible and affordable platform and series of applications with global applicability that allow healthcare and life science organizations of all sizes to:

- Take advantage of unprecedented development flexibility
- Build on an extensible application footprint
- React to rapidly changing needs
- Adapt to various environments
- Facilitate fast interface development
- Promote the reuse of components, collaborative development, and resource sharing
- Contribute to the rapid spread of innovation
- Enable business models that are innovative, stable, and sustainable
- Facilitate peer review and better quality assurance through open source transparency
- Lower total cost of ownership

3.1.5.1 Architecture Overview

LDAP

This standardized component provides user identity, including password validation. While Tolven includes openLDAP in its distribution, any LDAP component can be substituted. Also, since Tolven uses the JAAS standard for authentication, non-LDAP mechanisms can be substituted.

User

A user is associated with one or more Tolven accounts. This user object is not used for authentication, which is done by the application container using LDAP. Instead, a user object is simply associated with an LDAP UID. What this user object represents is the user's participation in the Tolven database as the author of documents and a participant in one or more Tolven accounts.

[11] Tolven, http://home.tolven.org [October 2013]

When a user logs in, the user selects the desired account, and thus only ever works with one Tolven account at a time.

If the user changes his or her username, such as when changing eMail accounts, a new user record is created. This is because Tolven can't always be certain of the relationship between a set of credentials and a real person. While this creates a bit more database clutter, it also ensures that potential identity ambiguities are accompanied by unique user objects. In particular, it is quite possible for eMail addresses to be reused by different people over time. A user may have access to more than one Tolven account, such as when a physician belongs to two practice groups (two unrelated provider accounts) and has a third, personal account. A person may also have more than one active username such as a personal eMail address and an eMail address at work.

Account

A Tolven account holds health data on behalf of users. One account may have one or more users. For example, a family account might have two adult users and perhaps a teenage user. An account used by a provider might have a number of physicians plus clinical and clerical staff.

A Tolven account provides the primary unit of data ownership. Patient data, rules, schedules and lists are all partitioned into accounts. A user in one account is never allowed to see data in another account. The exchange of data, fundamental to Tolven, is carried out by different mechanisms. The boundaries between accounts are firm. So called shared data is actually copied from the source account and re-encrypted (when applicable) so that the receiving account is able to read the data. At any given moment, all data visible to an account is owned by and is part of that account.

Unless specifically restricted, all users associated with an account will have access to all data held by the account. For example, a clinic (account) will have users that most likely will share access to all patients of that clinic. The users of a family account, say mom and dad, will have access to all patient data, including each other's records and the kids. If this is not desired, a family might establish three accounts: one for each parent and one for the kids. Each parent then is a member of two accounts: one containing their own medical record and the kids account. Thus either of the parents can access the kids medical data but not each others.

Menu/Page

Menu and page displays are controlled by metadata. In general, these are read-only displays. AJAX and other technologies are exploited to provide very fast and efficient displays of these pages. At the same time, which tabs and menus are displayed can vary by account.

Tolven also maintains that page layout, new UI features, and such should be under user or account control, not under control of the base software. Thus, different accounts in the same system may be at different levels of uptake of various features.

List

A list is populated by rules and prepared for high-speed display. Patient lists, disease-based cohort lists, problem lists, new results lists, etc., are all examples of a generalized list mechanism in Tolven

that represents the accumulation of many data elements into a convenient list for viewing. The columns for each list are defined in metadata. List data (and the metadata that defines it) is defined per account. This means two accounts can have completely different list definitions and contents.

Wizard

In Tolven, a wizard is generally responsible for acquiring new or revised data from an end user. The direct target for wizard data is the document repository, described below. From there, the new data will be distributed, as appropriate, by rules. The simplest one-page wizard could be described as a simple data entry form. Nevertheless, Tolven uses the same basic mechanism for simple name changes or complex history and physical entry.

Metadata

Menu metadata defines what will be displayed to the user and in what order. Metadata also defines the columns applicable to lists. In general, metadata does not define low-level page details. Instead, a number of individual templates are defined for things like menu bars and patient summary pages, while the metadata determines which template to use where.

Index Data

Index data (internally called MenuData), is what is most often displayed on lists and in other page templates. Index data is not THE data, but is extracted and derived from document data (see Doc, below). For example, if a lab result arrived, some of that data might be extracted and stored in a new results list (index data). And that index entry will point back to the actual lab result. One new document can result in any number of changes to index data.

Doc

Document data covers a broad range of data types. At the fundamental level (the DocBase class in Java), documents are a string of bytes. Sometimes a document is no more than that, such as a photograph or scanned document (FAX). Other documents are structured, typically as XML, and may be in a recognized form such as CCR or HL7. These higher-level document types can be interpreted by rules to generate index data (described above) or other documents.

Tolven makes no predetermined judgment about the interpretability of documents. Say one rule knows how to recognize an HL7 V3 RIM-based lab result to find the patient and populate a new results list. Another rule might know how to translate an HL7 v2 message into a RIM-based result message. Another rule might know how to recognize a FAX and translate it into an HL7 V2 result message. Therefore, to the extent technology and effort permits, there is no end to the number of usable formats that can be processed as a document.

Rule

When a document is created and becomes active, it is subject to rule evaluation. Rules are defined within an account (many accounts might use the same rule but that is the account's choice). Usually an account will have a number of rules and each document is subject to all of them. Upon evaluation

of the content of a document, a rule can populate index data, or it can create another document, or it can do all of the above, or it can do nothing.

Rules generally have latitude to do almost anything programmatically possible, possible within constraints established by the account. A rule is unable to access data in another account.

What is very common is that a rule can access data both from the document itself and from the corresponding patient. This makes it possible to look for events based on patient data not known (or unreliable) in the document itself. See Rules paper.

UMLS

A rule can use UMLS to evaluate, validate, and categorize coded vocabulary entries in a document. Wizards also use UMLS to prepare value sets for user selection (e.g., list of valid route of administration for a given drug).

MSG

The message component is external to Tolven but is used to describe the mechanism for messages getting into and out of Tolven. Getting a message into Tolven is simply a matter of creating a document. Tolven rules will then take it from there. The mechanism can be a simple web service or Java RIM call to the DocumentBean or through an alternate JMS path. The first approach creates the document synchronously and returns control to the caller while the second approach queues the message to Tolven which then creates the document. The second technique has no real benefit over the first. This is because creating a Tolven document is a very lightweight operation, no heavier than queuing a message. In both cases, the processing of the document is queued. So in the second case, there are simply two queue hops which could negatively affect throughput even though message response time could be less. Nevertheless, in high volume configurations with a lot of memory, the second (JMS) approach may yield better throughput.

3.2 3D Human Anatomy

3D computer graphics (in contrast to 2D computer graphics) are graphics that use a three-dimensional representation of geometric data that is stored in the computer for the purposes of performing calculations and rendering 2D images. Such images may be stored or displayed in real-time.

Human anatomy is the study of the human body in respect to all its parts and their relationships to each other. It can as well be defined as the scientific study of the structural parts of the human body.

The linkage of 3D computer graphics and human anatomy is the main topic of this chapter, where we will present a short overview of the top state-of-the-art products.

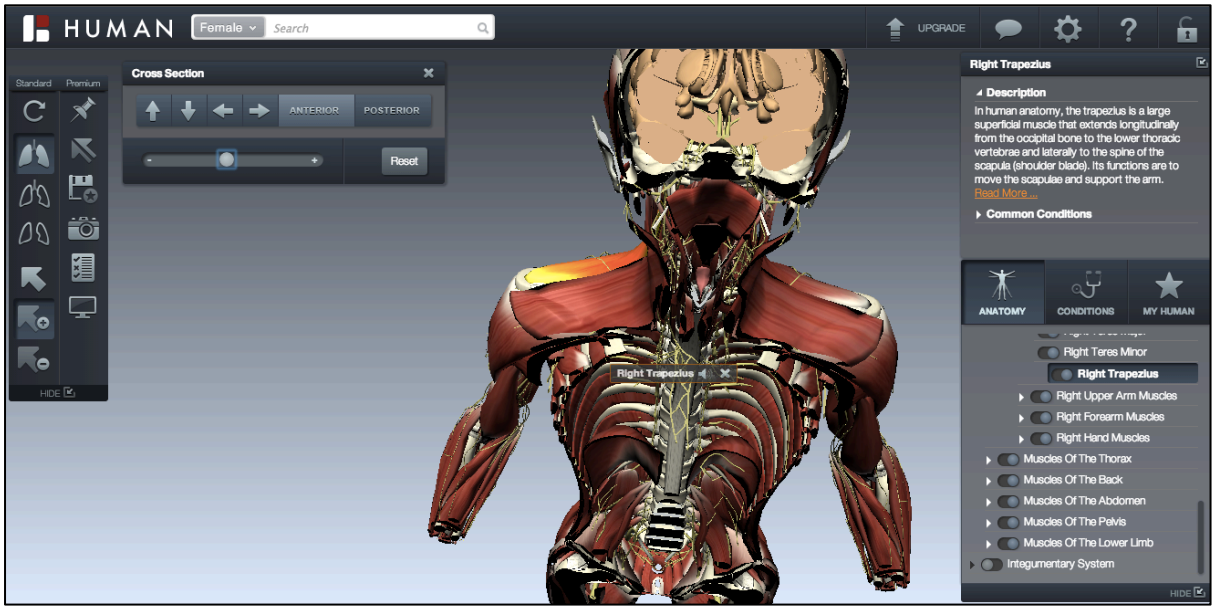
3.2.1 BioDigital Human Platform

According to the information available on the official home page BioDigital[12] was founded in 2002 on the premise that 3D technology could transform the way we understand health and medicine. The founders had witnessed its impact on gaming and Hollywood, and were determined to apply state-

[12] BioDigital Human Platform, http://www.biodigitalhuman.com [October 2013]

of-the-art 3D to healthcare as well. Together they opened BioDigital Systems - a biomedical visualization company - in New York City, and over the years, they have helped make biomedical information more accessible for a diverse list of clients, including hospitals, biotech and medical device companies, pharmaceuticals, non-profit organizations, and academic institutions.

The reactions to BioDigital's 3D storytelling - from patients, physicians, healthcare providers, and educators - were so positive that in 2010, BioDigital decided to expand their technology to empower anyone with Internet access to learn about the human body - in a way that resembles life itself. A year later, the BioDigital Human (**Picture 4**) was born. This interactive, medically accurate virtual body enables users to study anatomy, disease, and treatments. The platform is constantly evolving, as our team of software engineers, 3D animators, physicians, and scientists - all with specialized biology training - continue to add both content and features.



Picture 4. BioDigital interactive 3D [Source: BioDigital web site]

3.2.1 Google Body

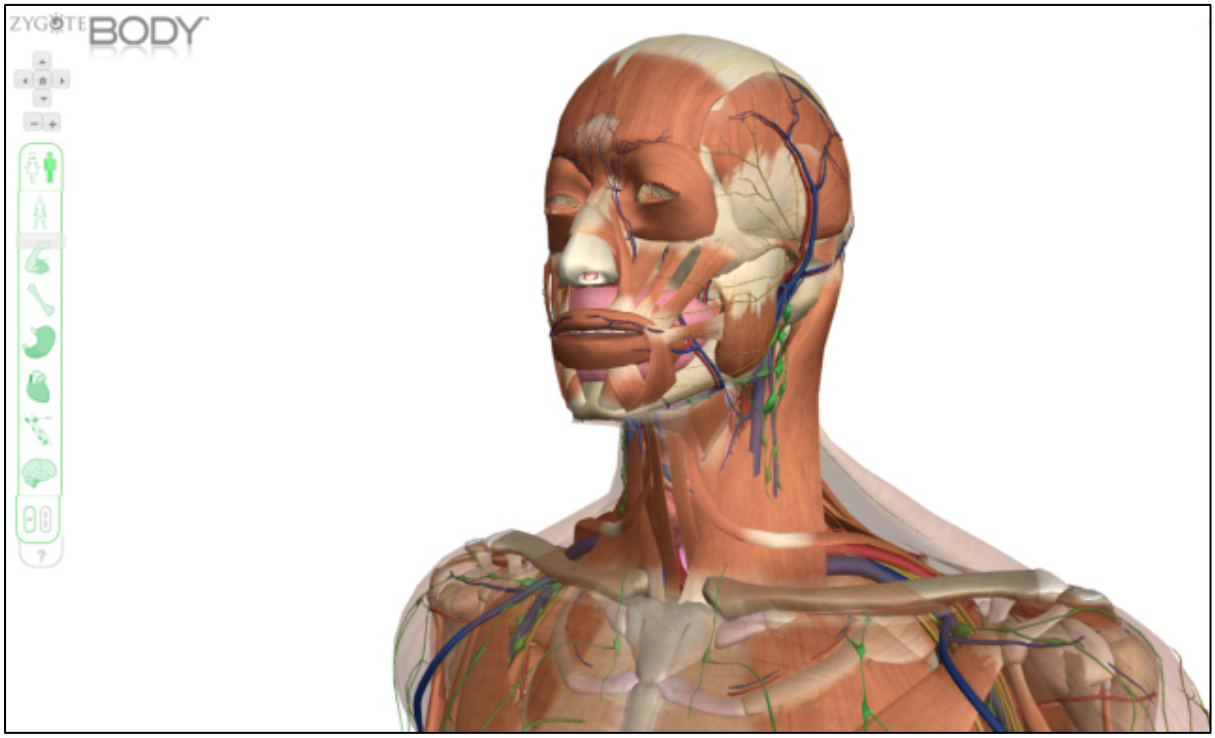
Google Body was built by Google engineers and was retired along with Google Labs, the software underlying Google Body is now open source. Zygote Media Group, Inc.[13] (a 3D human anatomy content and technology company), which provided the imagery for Google Body, has used this open source code to build Zygote Body. Zygote Body offers the same navigation, layering, and instant search as Google Body. Like Google Body, Zygote Body can be used in browsers that support WebGL, like Chrome and Firefox, without needing to install additional software.

To support the release of Zygote Body, the Google Body team built a new open source 3D viewer, now available at https://code.google.com/p/open-3d-viewer/ . This viewer provides a standard way to create and view 3D models in a Web browser, with multiple layers and instant search.

[13] Zygote Media Group, Inc., http://www.zygote.com [October 2013]

3.2.2 ZYGOTE Body

Zygote Body[14] (**Picture 5**), formerly Google Body, is a web application by Zygote Media Group that rendered manipulable 3D anatomical models of the human body. Several layers from muscle tissues down to blood vessels could be made transparent to allow better study of individual body parts. Most of the body parts are labelled and searchable.



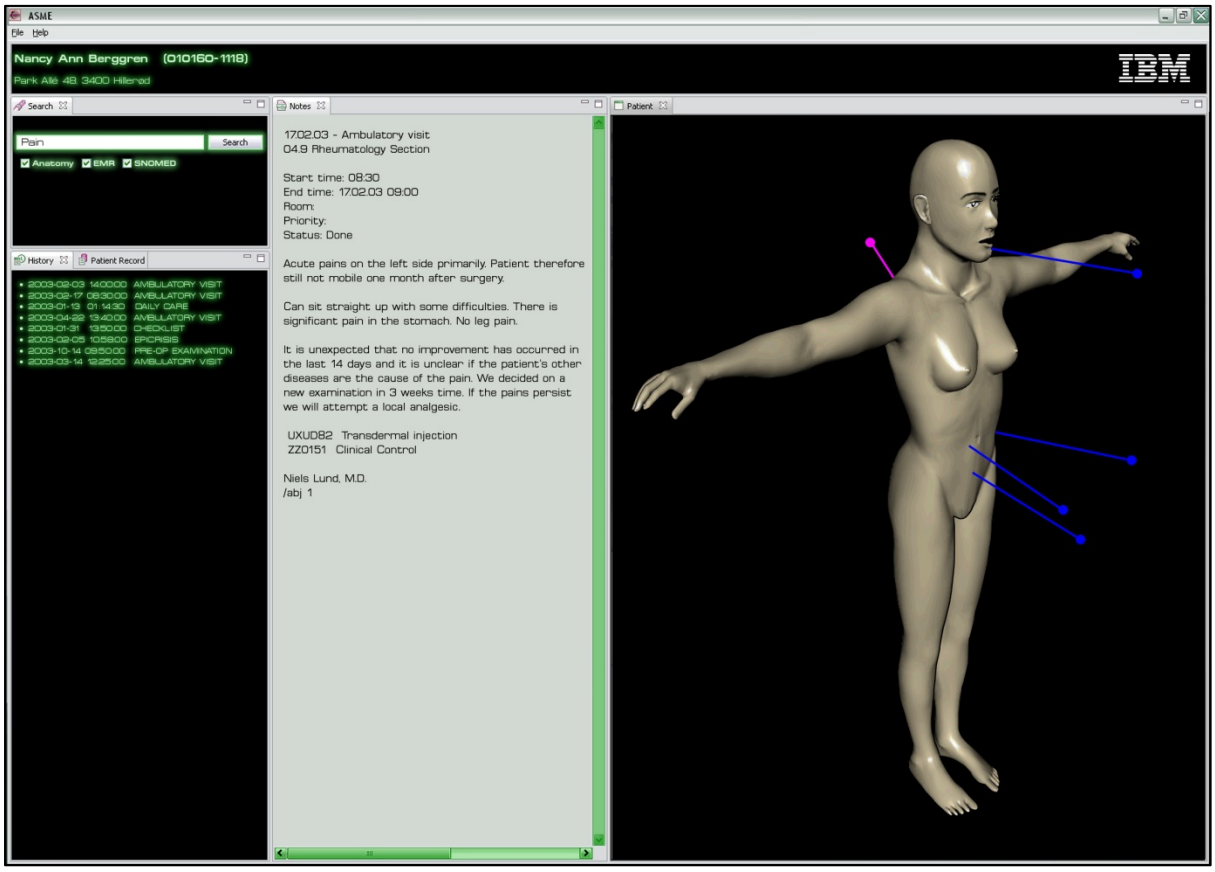
Picture 5. Zygote Body [Source: Zygote Body web site]

3.2.3 IBM Anatomic and Symbolic Mapper Engine (ASME)

IBM researchers unveiled a prototype visualization software that allows doctors to interact with medical data the same way they interact with their patients: by looking at the human body. Created at IBM's Zurich Research Lab, the technology uses an avatar - a 3D representation of the human body - to allow doctors to visualize patient medical records in an entirely new way. Called the Anatomic and Symbolic Mapper Engine (ASME), this innovative visualization method allows a doctor to click with the computer mouse on a particular part of the avatar "body" to trigger a search of medical records to retrieve relevant information.

For example, when a patient visits a doctor's office today and complains of back pain, the doctor will ask the patient about any history the patient can recall, do tests, and visually and physically examine the patient. After that, the doctor will usually sort through stacks of paper records but will most likely not have access to the full patient history and similar complaints.

[14] Zygote Body, http://www.zygotebody.com [October 2013]



Picture 6. IBM Anatomic and Symbolic Mapper Engine (Source: IBM Research)

The ASME system (**Picture 6**) will allow doctors to "click" on different parts of the 3-D avatar of the human body - for example, the spine - and instantly see all the available medical history and information related to that patient's spine, including text entries, lab results and medical images such as radiographs or MRIs. Or the doctor might be interested only in information related to a particular part of the spine; in this case, the practitioner can zoom in, narrowing the search parameters by time or other factors.

Using advanced machine learning and state-of-the-art 3D modeling techniques, the IBM researchers overcame key technical challenges including integrating heterogeneous data sources and complex text-based information - so-called unstructured data - and linking that data to the anatomical model in a meaningful and easy-to-navigate way. ASME also uses SNOMED, the systemized nomenclature of medicine that encompasses approximately 300,000 medical terms, to create a bridge between graphical concepts and text documents.

ASME is the result of a collaboration between IBM Denmark and IBM Research. By bringing its sales force and its research organization together, IBM has created a unique innovation team with deep understanding of the industry and leading technical expertise.

Advances in technology are driving great breakthroughs in medical treatment and care, but today's health records do not fully take advantage of what is available. Patient records are static and flat-consisting either of unstructured data written on paper or more structured text information stored

in various databases. In either case, the records provide disparate bits and pieces of information on diagnoses and diseases; accessing a comprehensive history proves to be an enormous challenge.

Because the industry is still in the very early stages of achieving a fully functional electronic health records (EHR) system, which would enable the sharing of information among hospitals, clinics and other providers in a way that protects individual patient privacy, most medical professionals prefer to use paper records or their own proprietary system for keeping EHRs. But what if a system could bring together all these flat and static pieces to derive a dynamic and full picture of a patient's health status in real-time? And what if the system were to provide this information in an intuitive and easy-to-use way? With ASME, IBM researchers have now presented such a system - ASME allows navigating through a virtual map of the human body, an intuitive approach for healthcare professionals.

Building on previous IBM healthcare IT milestones, ASME is the medical information hub that semantically integrates information from IBM's Health Information Exchange (HIE) with a virtual model of the human body.

3.3 Biomedical Repositories

The needs for aggregation, standardization or analysis of patient information and molecular data across public data sources are representing one of the major goals of the latest emerging healthcare technologies. Biomedical repositories (data-bases) with advanced data annotation and data integration platforms, flexible user interface and real-time big data analytics will allow researchers and clinicians to tap into the very core of the new knowledge discovery and the advanced decision support tools.

3.3.1 NCBI Resources

The available for download and the top biomedical resources are provided by the National Center for Biotechnology Information (NCBI) from USA. As a national resource for molecular biology information, NCBI's mission is to develop new information technologies to aid in the understanding of fundamental molecular and genetic processes that control health and disease. More specifically, the NCBI has been charged with creating automated systems for storing and analyzing knowledge about molecular biology, biochemistry, and genetics; facilitating the use of such databases and software by the research and medical community; coordinating efforts to gather biotechnology information both nationally and internationally; and performing research into advanced methods of computer-based information processing for analysing the structure and function of biologically important molecules.

The list of all NCBI resources are located here http://www.ncbi.nlm.nih.gov/guide/all/

A small collection of the top resources are presented in the sub-chapters bellow.

3.3.1.1 GenBank

GenBank is the National Institutes of Health (NIH) genetic sequence database, an annotated collection of all publicly available DNA sequences. GenBank is part of the International Nucleotide Sequence Database Collaboration, which comprises the DNA DataBank of Japan (DDBJ), the

European Molecular Biology Laboratory (EMBL), and GenBank at NCBI. These three organizations exchange data on a daily basis. GenBank consists of several divisions, most of which can be accessed through the Nucleotide database. The exceptions are the EST and GSS divisions, which are accessed through the Nucleotide EST and Nucleotide GSS databases, respectively.

Web site: http://www.ncbi.nlm.nih.gov/genbank/

3.3.1.2 Gene

Gene is a searchable database of genes, focusing on genomes that have been completely sequenced and that have an active research community to contribute gene-specific data. Information includes nomenclature, chromosomal localization, gene products and their attributes (e.g., protein interactions), associated markers, phenotypes, interactions, and links to citations, sequences, variation details, maps, expression reports, homologs, protein domain content, and external databases.

Web site: http://www.ncbi.nlm.nih.gov/gene

3.3.1.3 MeSH

MeSH (Medical Subject Headings) is the U.S. National Library of Medicine's controlled vocabulary for indexing articles for MEDLINE/PubMed. MeSH terminology provides a consistent way to retrieve information that may use different terminology for the same concepts.

Web site: http://www.ncbi.nlm.nih.gov/mesh

3.3.1.4 PubChem

PubChem contains unique, validated chemical structures (small molecules) that can be searched using names, synonyms or keywords. The compound records may link to more than one PubChem Substance record if different depositors supplied the same structure. These Compound records reflect validated chemical depiction information provided to describe substances in PubChem Substance. Structures stored within PubChem Compounds are pre-clustered and cross-referenced by identity and similarity groups. Additionally, calculated properties and descriptors are available for searching and filtering of chemical structures.

Web site: http://www.ncbi.nlm.nih.gov/pccompound

3.3.1.5 PubMed

PubMed is a database of citations and abstracts for biomedical literature from MEDLINE and additional life science journals. Links are provided when full text versions of the articles are available via PubMed Central (described below) or other websites.

Web site: http://www.ncbi.nlm.nih.gov/pubmed

3.3.2 Clinical Trials Repositories

3.3.2.1 EU Clinical Trials Register

The EU Clinical Trials Register website contains information on interventional clinical trials on medicines. The information available dates from 1 May 2004 when national medicine regulatory authorities began populating the EudraCT database, the application that is used by national medicine regulatory authorities to enter clinical trial data. The EU Clinical Trials Register website launched on 22 March 2011 enables users to search for information which has been included in the EudraCT database.

Users are able to:

- view the description of a phase II-IV adult clinical trial where the investigator sites are in European Union member states and the European Economic Area;
- view the description of any paediatric clinical trial with investigator sites in the European Union and any trials which form part of a paediatric investigation plan (PIP) including those where the investigator sites are outside the European Union.
- download up to 20 results (per request) in a text file (.txt).

The details in the clinical trial description include:

- the design of the trial;
- the sponsor;
- the investigational medicine (trade name or active substance identification);
- the therapeutic areas;
- the status (authorised, ongoing, complete).

Web site: https://www.clinicaltrialsregister.eu

3.3.2.2 ClinicalTrials.gov

ClinicalTrials.gov is a Web-based resource that provides patients, their family members, health care professionals, researchers, and the public with easy access to information on publicly and privately supported clinical studies on a wide range of diseases and conditions. The Web site is maintained by the National Library of Medicine (NLM) at the National Institutes of Health (NIH). Information on ClinicalTrials.gov is provided and updated by the sponsor or principal investigator of the clinical study. Studies are generally submitted to the Web site (that is, registered) when they begin, and the information on the site is updated throughout the study. In some cases, results of the study are submitted after the study ends. This Web site and database of clinical studies is commonly referred to as a "registry" and "results database."

Web site: http://www.clinicaltrials.gov

3.3.2.3 WHO International Clinical Trials Registry Platform

The mission of the WHO International Clinical Trials Registry Platform is to ensure that a complete view of research is accessible to all those involved in health care decision making. This will improve

research transparency and will ultimately strengthen the validity and value of the scientific evidence base.

Web site: http://www.who.int/ictrp/en/

3.4 Clinical Trials

Clinical trials are used to evaluate potential treatments that have had some effect against disease in the lab, or in animal experiments. The whole point of a clinical trial is to find out if a treatment is effective and safe.

Clinical trials are conducted in a series of steps, called phases:

- Preclinical trials are early experiments performed in the lab, prior to being tested in humans. This early research helps to identify potential treatments that are unsafe or ineffective.
- Phase I trials are the first step in testing a new approach in humans. In these studies, researchers evaluate what dose is safe, how a new agent should be given (by mouth, injected into a vein, or injected into the muscle, for example), and how often.
- Phase II trials study the safety and effectiveness of an agent or intervention, and evaluate how it affects the human body. Phase II studies usually focus on a particular medical condition.
- Phase III trials compare a new agent or intervention (or new use of a standard one) with the current standard therapy. Participants are randomly assigned to the standard group or the new group, usually by computer. This method, called randomization, helps to avoid bias and ensures that human choices or other factors do not affect the study's results. In most cases, studies move into phase III testing only after they have shown promise in phases I and II. Phase III trials may include hundreds of people across the country or globally.
- Phase IV trials are conducted to further evaluate the long-term safety and effectiveness of a treatment. They usually take place after the treatment has been approved for standard use. Several hundred to several thousand people may take part in a phase IV study. These studies are less common than phase I, II, or III trials.

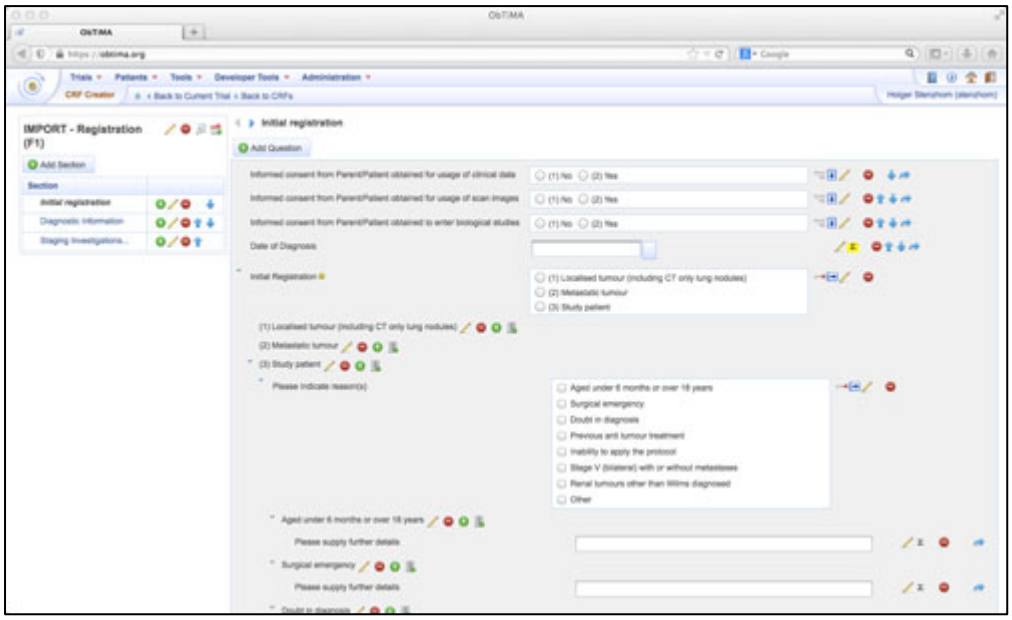
Clinical Trial Management System, also known as CTMS, is a customizable software system used by the clinical research bodies to manage the data involved with the operation of a clinical trial. CTMS maintains and manages the planning, preparation, performance, and reporting of clinical trials, with emphasis on keeping up-to-date contact information for participants and tracking deadlines and milestones such as those for regulatory approval or the issue of progress reports. Often, a clinical trial management system provides data to a business intelligence system, which acts as a digital dashboard for trial managers.

Each clinical trial has different requirements that a CTMS must satisfy. Some usual requirements include: audit trial, patient management, compliance with regulations/standards, and compatibility with other data management systems.

In the chapters bellow we will describe briefly the top open source CTMS which represents a viable alternatives to the more expensive commercial systems to conduct, record and manage clinical studies[15].

3.4.1 ObTiMA

ObTiMA[16] (**Picture 7**) is an ontology-based clinical trial management system intended to support clinicians in both designing and conducting clinical trials. The design phase is facilitated by the Trial Builder in which all aspects of a clinical trial can be specified: A trial chairman can define the outline and metadata of a trial in a master protocol to describe, e.g., trial goals or administrative data. He can further setup treatment plans for guiding clinicians through individual patient treatment where events, e.g., surgery or chemotherapy, can be defined with all necessary information. In addition, the particular treatment order can be freely setup on a timeline and so can treatment stratifications and randomizations to be applied for a patient. A Case Report Form (CRF) can be assigned to each treatment step to collect documentation data.



Picture 7. ObTiMA CRF view (Source: p-medicine project web site)

The ontology-based creation of CRFs in the Trial Builder is one of ObTiMA's major functionalities. A graphical user interface allows defining content, navigation, and layout of CRFs to capture all patient data during a trial, e.g., medical findings or diagnostic data. The resulting descriptions are based on concepts from the Health Data Ontology Trunk (HDOT) for each CRF item along with metadata, e.g., data type and measurement unit, and are used to setup the trial database.

The user interface makes the underlying aspects of the ontological metadata transparent to users and tries to close the gap between clinical practice and the actual logical representation of

[15] Leroux H, McBride S, Gibson S. On selecting a clinical trial management system for large scale, multi-centre, multi-modal clinical research study. Studies in Health Technology and Informatics 168: 89–95. PMID 21893916.
[16] ObTiMA, http://p-medicine.eu/tools/obtima/ [October 2013]

ontological concepts. (Even if natural language descriptions are given for concepts, they rarely reflect the needs of clinical perception of reality. Therefore an application-specific, simplified view of the ontology is given showing only its relevant portions in a clinician-friendly way.) If an item has been created based on a concept, its attributes are determined automatically, e.g., label, data type or answer possibilities, but it can be adopted manually.

Since many trials collect similar or equal data, it is possible to store components of or complete CRFs in a repository as templates. When setting-up a clinical trial, appropriate CRF templates can either be directly reused or can be quickly created by composing them from existing CRF components. This in turn fosters the CRF standardization since CRFs can then readily be compared on the level of single items (through ontological concepts) and also on component level or in their entirety.

The second major functionality is the patient data management system supporting clinicians during a clinical trial. It is automatically setup based on the items defined in the Trial Builder in the design phase. It guides the clinicians through the treatment of the individual patients according to the given treatment plans and provides an easy user interface to fill in the CRFs for a patient (again hiding the actual underlying ontology concepts from the clinician). When the PDMS is set up, the trial database is automatically derived from the ontology-based CRF definitions. Thus, provided that appropriate rights are given, the database can then also be accessed by other trials or applications through using a semantic mediation service based on the ontology.

ObTiMA itself is composed of different modules. In addition to the above described basic components, a DICOM server and DICOM viewer, a SAE and SUSAR reporting tool and a consultation tool are integrated. These tools are optional to handle images used in clinical trials or to simplify the SAE and SUSAR reporting according to GCP criteria. The consultation tool stores all consultations in a standardized way in the trial database. ObTiMA itself fulfils GCP criteria, including an Audit Trail. Data safety and security are guaranteed as pseudonymization of private data is implemented according to roles and rights assigned to users of ObTiMA.

3.4.2 OpenClinica

OpenClinica[17] is powerful, industry leading software for capturing and managing clinical trial data. It allows you to build your own studies, design electronic Case Report Forms (eCRFs), and conduct a range of clinical data capture and clinical data management functions.

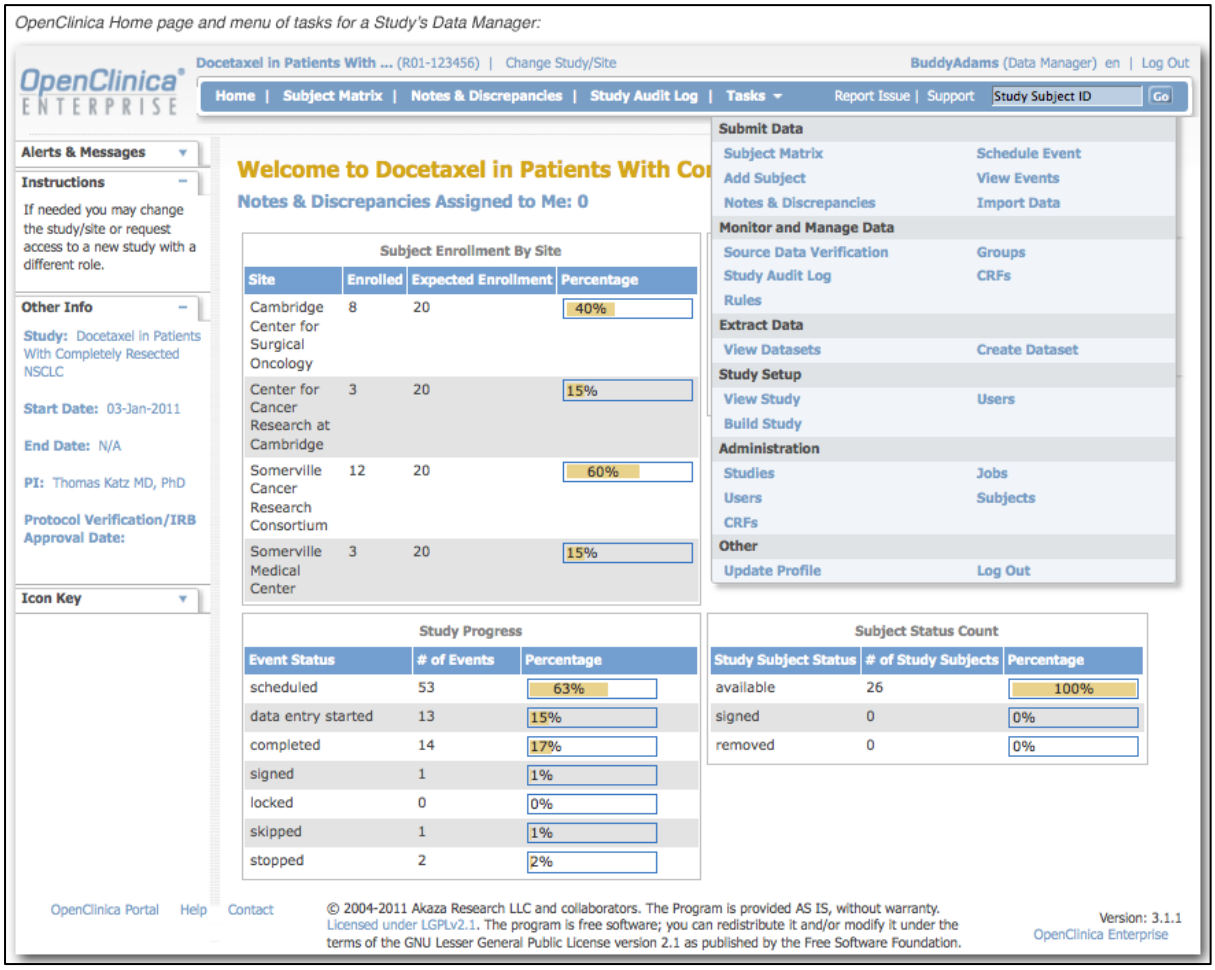
OpenClinica (**Picture 8**) is designed to be used in diverse types of clinical studies. It supports Good Clinical Practice (GCP), regulatory guidelines such as 21 CFR Part 11, and is built on a modern architecture using leading open standards. As web-based software, all your users need is a PC, browser, and internet connection.

OpenClinica's highlights include:

- Submit Data: Intuitive interface for subject enrollment, clinical data capture, validation, and query management.

[17] OpenClinica, http://www.openclinica.com [October 2013]

- Monitor and Manage Data: Tools for data cleaning, clinical data management, and site monitoring.
- Extract Data: Custom define and obtain clinical datasets in real-time, and in a variety of formats.
- Study Build: Design tools for configuring your study protocol: sites, eCRFs, edit checks/rules, users, and study event definitions.
- User Roles: Designate appropriate access for both site-level and study-level users.
- Administration: Tools for overall system oversight, auditing, configuration, and reporting.



Picture 8. OpenClinica main page (Source: OpenClinica web site)

OpenClinica's additional features are:

- Organize your clinical research by study protocol and site, each with its own set of authorized users, subjects, study event definitions, and CRFs. Support for sharing resources across studies in a secure manner.
- Dynamic generation of web-based CRFs for electronic data capture with validation logic defined in reusable templates.

- Management of longitudinal data for complex and recurring patient visits.
- Automated and manual capabilities for import, export, and data interchange data with other systems.
- Rules engine performing advanced validation of study data and define automated actions within the system.
- Enables compliance with Good Clinical Practice (GCP) and regulatory guidelines such as 21 CFR Part 11 via differentiated user roles and privileges, password and user authentication security, electronic signatures, SSL encryption, de-identification of Protected Health Information (PHI), and comprehensive auditing to record and monitor access and data changes. Fully validated software development lifecycle (SDLC).
- A robust and scalable technology infrastructure developed using the Java J2EE framework and powerful PostgreSQL database.
- Modular architecture incorporating web services for extensibility.

3.4.3 REDCap

REDCap[18] (Research Electronic Data Capture is a secure, web-based application designed to support data capture for research studies[19]. Using REDCap's stream-lined process for rapidly developing projects, end-users may create and design projects using 1) the online method from your web browser using the Online Designer; and/or 2) the offline method by constructing a 'data dictionary' template file in Microsoft Excel, which can be later uploaded into REDCap. Both surveys and databases (or a mixture of the two) can be built using these methods. REDCap provides audit trails for tracking data manipulation and user activity, as well as automated export procedures for seamless data downloads to Excel, PDF, and common statistical packages (SPSS, SAS, Stata, R). Also included are a built-in project calendar, a scheduling module, ad hoc reporting tools, and advanced features, such as branching logic, file uploading, and calculated fields. REDCap has a quick and easy software installation process, so that you can get REDCap running and fully functional in a matter of minutes.

3.4.4 Caisis

Caisis[20] is an open source, web based, patient data management system that integrates research with patient care. The system is freely distributed to promote the collection of standard, well structured data suitable for research and multi-institution collaboration.

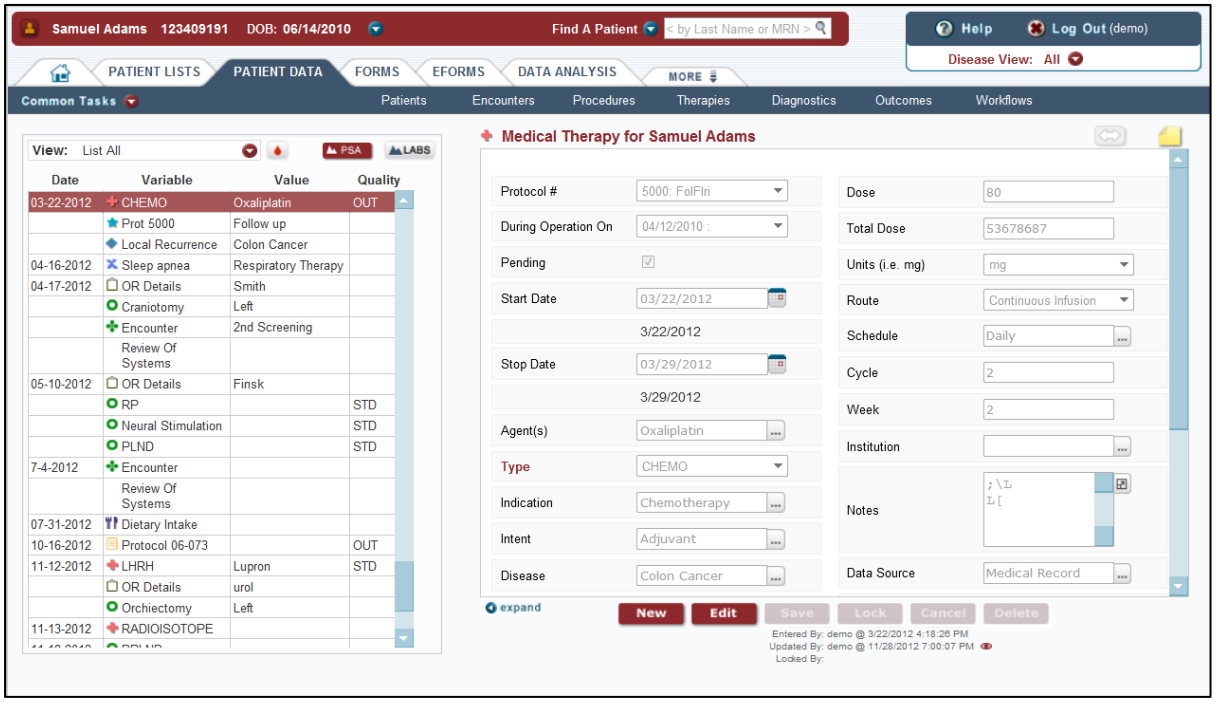
Caisis (**Picture 9**) has been developed to allow the system to evolve and adapt to the evolving landscape of clinical research. As a framework, it is easy for developers to extend Caisis by adding new fields and tables, interfaces, plugins, and new modules with standalone functionality. All new

[18] REDCap, http://www.project-redcap.org [October 2013]

[19] Paul A. Harris, Robert Taylor, Robert Thielke, Jonathon Payne, Nathaniel Gonzalez, Jose G. Conde, Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support, J Biomed Inform. 2009 Apr;42(2):377-81.

[20] Caisis, http://www.caisis.org [October 2013]

functionality supports the primary goal of Caisis: to capture large, clean and standardized datasets while telling the patient's clinical "story".



Picture 9. Caisis patient data view (Source: Caisis web site)

Caisis' highlights include:

- Flexible Forms for Data Collection
  - Highly customizable forms
  - Chronological summary of patient history
  - Auditing of data collection and user activity
  - Views configurable by disease
  - Robust relational data-model for structured data elements
  - Extensive fields for granular research data
  - Standard and configurable vocabulary
- E-forms - Data Entry Workflows
  - Standardized workflows for cancer data entry
  - Vast library of templates
  - Rapid development architecture to ease creation of new eforms
  - Integrated clinic list and approval process
  - Includes templates for prostate, bladder, kidney, breast, liver, pancreas, colorectal, head & neck, etc.

- Data Analysis
  - Rapid report creation using configurable query files
  - Export to common formats such as Excel and Access
  - Full auditing of report views and exports
  - Support for robust charting
  - Integration of R statistic library for advanced functions
- Protocol Manager
  - Patient study calendar that integrates the patient schedule and data entry
  - Serious adverse event reporting
  - Outcomes management for Biomarker, Soft Tissue, and Bone response
  - Data entry customization by protocol
  - Registration and Eligibility tracking
- Specimen Manager
  - Specimen tracking that includes details about specimen handling, tests, and storage
  - Interface to define storage setup
  - Outcomes management for Biomarker, Soft Tissue, and Bone response
  - Specimen transfer tracking
  - Specimen search based on clinical or pathological details
- Project Manager
  - Define key milestones on a per project basis
  - Organization and Contact management
  - Graphical view of project progress (Gant Chart)
  - Integrate LOI / Project request form
  - Publication tracking
  - Protocol integration to track concept development

4 Conclusion

4.1 eHealth Projects with Clinical Perspective

MyHealthAvatar will be built on the latest ICT technology with an aim of engaging public interest to achieve its targeted outcomes. As conclusion, the chapter 'eHealth Projects with Clinical Perspective' brings a detailed description of the top eHealth research projects. This complies with the priority of this document to describe the state-of-the art frameworks and research actions in the eHealth domain, and constitutes a preparatory action aiming at the grand challenge on a "Digital Patient", which is currently the subject of a roadmap in the VPH community.

4.2 Services, Software, Repositories and Tools

The chapter 'Services, Software, Repositories and Tools' presents and describes the top and state-of-art personal health records systems, 3D human anatomy tools, available biomedical resources and the open-source clinical trial management systems. We didn't focus our activities on reviews; the presented and described tools and software are known (and have been discussed) by MHA project partners, additionally, MHA project partners are actively enrolled in other research projects. Here, by example, we would like to mention that ObTiMA clinical trial management system is continuously developed in the frames of p-medicine project where USAAR is the main coordinator.

4.3 Data protection and data security framework

It is not the aim of this document to describe a completely new data protection and data security infrastructure for medical scientific research from scratch. MHA project consortium is suggested to (re)use the work done in p-medicine project as a starting point. The analysis shows that p-medicine project already described a high level of data protection and data security framework.

p-medicine project, recently published the main, open-access document from the WP5, named Legal and Ethical Framework. The available documents are:

- D5.1 Setting up of the data protection and data security framework
- D5.2 Report on legal and ethical issues regarding data warehouse, data mining and IP issues
- D5.3 Report on legal and ethical issues regarding access to bio-banks
- D5.5 Report on legal and ethical issues for p-medicine tools used for international GCP trials

Of highest interest for MHA data protection and security framework could be D5.1 Setting up of the data protection and data security framework[21].

[21] D5.1 Setting up of the data protection and data security framework http://p-medicine.eu/downloads/deliverables/ [October 2013]

Appendix 1 – Abbreviations and acronyms

CORDIS	CORDIS is the Community Research and Development Information Service
ICT	Information and Communications Technology
MHA	MyHealthAvatar
CTMS	Clinical Trial Management System