HEARTFAID

D49 – Final Report

Submission date: 29/07/2009
Due date of document: 30/04/09

HEARTFAID

A KNOWLEDGE BASED PLATFORM OF SERVICES FOR SUPPORTING MEDICAL-CLINICAL MANAGEMENT OF THE HEART FAILURE WITHIN THE ELDERLY POPULATION

Project summary	
Project acronym:	HEARTFAID
Project identifier:	IST – 2005 – 027107
Duration of the Project:	01/02/2006 – 30/04/2009
Project Co-ordinator Name:	Domenico Conforti
Project Co-ordinator Organisation:	UNICAL University of Calabria (Italy)
Thematic Priority:	Information Society Technology-ICT for Health
Instrument:	Specific Targeted Research Project

Consortium

- UNICAL- Università della Calabria (Italy)
- UNICZ- Università degli studi Magna Graecia di Catanzaro (Italy)
- UNIMIB- Università degli studi di Milano Bicocca (Italy)
- JUMC- Jagiellonian University Medical College (Poland)
- VMWS- Virtual Medical World Solutions Ltd (United Kingdom)
- FORTHNET S. A.- Hellenic Telecommunications and Telematic Applications Company S. A. (Greece)
- SYNAP- Synapsis s.r.l. (Italy)
- CNR- Consiglio Nazionale delle Ricerche (Italy)
- FORTH-Foundation for Research and Technology Hellas (Greece)
- RBI- Rudjer Boskovic Institute (Croatia)
- AUXOL- Istituto Auxologico Italiano (Italy)

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Document summary	
Document Title:	Final Report
Document Classification:	Deliverable D49
Dissemination level:	PU
Period covered:	From 1 February 2006 to 30 April 2009
Submission date:	29 July 2009
Due date:	30 April 2009
Authors:	Domenico Conforti – UNICAL Debora Minardi – UNICAL
Work package:	WP0 – Management
Report Version:	1.2

Short Description
The document summarises the major issues of Heartfaid project, in terms of project execution and dissemination and using of the relevant results.

Change Record		
Version Number	Changes	Release date
1.0	First draft of the Document	30/04/09
1.1	Further contributions and final draft version	15/06/09
1.2	Final Version	29/07/09

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A knowledge based platform of services for supporting medical-clinical management of heart failure within elderly population

FP6-IST-2005-027107-STREP

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Section 1 – Project execution (Publishable Summary)

Health care government policy makers, health insurance companies, service providers and users' organizations are changing the face of health care delivery, taking place at different aspects around the world, requesting that the quality and the cost efficiency of the healthcare, the safety and the empowerment of the patients play an ever more crucial role in the management of the national and regional healthcare systems. In particular, the following issues are increasing the pressure on healthcare systems:

- consumers are more and more demanding for high quality care;
- managers are struggling to deliver health care services at reasonable costs while there is an increasing diffusion of chronic diseases as well as, due to the progressive ageing of the population, a rising number of patients that need long-term continuous health assistance;
- clinicians are placing increasing emphasis on the practice of evidence-based medicine whereas citizens are improving their sensitivity regarding the clinical risk management;

- health care systems are seeking to meet these demands by operating into a framework of continuous quality improvement.

Improving health care quality while reducing costs requires the elimination of unintended and unnecessary overhead in the entire care process (prevention – diagnosis – prognosis – therapy) and the application of new and more accurate procedures for the clinical risk management. To this end, eHealth technologies and applications can play an ever greater and crucial role. In fact, during the last years we have assisted to an increasing development of high technological effective solutions (such as Electronic Medical Records and Clinical Decision Support System prototypes) to foster evidence based medicine and best clinical practices. These solutions have the potentialities to help in reducing unreliability and errors by improving effectiveness and efficiency.

In this context, HEARTFAID project has provided an integrated and holistic approach, based on the continuity and personalization of patient care, by devising and developing optimal health care procedures and workflows based on scientific evidence and yet consistent with best practice, thus defining effective personalized care pathways.

In order to achieve these ambitious goals, the project has faced the following major issues:

- integration of Healthcare Environments in order to have a unique vision of the patient and of both his/her wellness and healthcare processes;
- use of Wearable and Portable Biomedical Sensors and their integration through Wireless Biomedical Data Communication infrastructure with the whole HEARTFAID platform, in order to improve the treatment and management of the diseases outside healthcare centres;
- integration and management of the knowledge generated by the patient itself during his/her contacts with different health care environments (implementing technologies such as Biomedical Data Warehousing and Management, Decision Making and Statistical Inference, Knowledge Discovery in Databases, Medical Ontologies and Knowledge Representation);
- definition of new services based on the integrated vision of the patient and on the possibility to recover information from multiple sources (such as Web-based services accessible anywhere and anytime);
- provision to both medical personnel and decision makers of new and advanced mechanisms for decision support (including advanced Biomedical Data Processing and Decision Support Systems, such as computerized clinical practice guidelines);
- definition of a new regulatory framework for the healthcare delivery as a consequence of the above mentioned aspects (e.g. acknowledgment of remote data control as a medical activity, not equivalent but similar to the face-to-face visit).

In this respect, the HEARTFAID project has aimed at following such an integrated approach and at testing its feasibility and usefulness in a very challenging medical field: the management of CHRONIC HEART FAILURE patients.

Due to the complex nature of heart failure and several co-morbidities (also related to other clinical domains such as lung diseases, renal diseases, diabetes, etc.), the heart failure field represents one of the domains that can strongly benefit from the development and application of well tuned decision making methodologies and information and communication technologies (ICT). In fact, there is an increasing need for better care, which might be provided not only by highly specialized centres, but also by small hospitals and by field cardiologists, a need that has to be matched with a policy of cost containment. Progress in technology may offer an important support to make this possible, allowing adequate knowledge to be made available to all health care providers in this field. It might also offer new methods for regular and accurate collection of biological signals in patients living in their home environment, making use of sensors, either traditional or wearable, able to provide a continuous monitoring also through telemedicine facilities. More recent progress might further offer an advanced platform of services for the automated integration between the signals collected both at home and in the clinic environment on one side, and the available state-of-the-art knowledge on the other side, providing intelligent support to clinical decision. The proper adoption of these tools might help improving the daily care of chronic heart failure patients, through a prompt titration of treatment in response to early detection of even minor changes in clinical conditions, as well as through a reduction of diagnostic and therapeutic errors, by reinforcing the implementation of the most advanced recommendations provided by international clinical guidelines. Such an approach might also help in improving the cost/effectiveness of heart failure care, facilitating the implementation of a disease management approach, where therapy, education, and follow-up are well-tailored for each patient by a multidisciplinary team that is constantly supported by an advanced platform of computerized services. In this way, the clinical decision is guided through a continuous up to dated of patient's clinical conditions, which are allowed by advanced wireless telecommunication technology.

HEARTFAID has been a research and technological development project, whose strategic aim was to integrate scientific and technological knowhow, medical domain expertise, healthcare government policy knowledge with the objective to devise, design, develop and deploy an advanced and innovative technological platform of services and functionalities.

HEARTFAID platform has been focused on health status monitoring and management of heart failure patients that can concretely allow:

- Driving and effectively supporting all the relevant health care operators and the patients themselves, during the evolution of the disease and across several integrated health care environments.

- Provide appropriate support for making more efficient and effective all the processes related to the clinical management of heart failure patients, through the suitable integration, in closed-loop systems, of innovative processing of heterogeneous biomedical data and expert feedback and care.
- Personalizing the care solutions by remotely monitoring various health parameters, environmental information and behavioural data.
- Educating and empowering patients to participate in healthcare processes facilitating remote monitoring and care at the point of need, including homes and on-the-move, for promoting the continuity of care.

Fig. 1 – Virtuous loops that will be supported by the HEARTFAID platform

The HEARTFAID platform has been designed following an integrated and holistic approach with the precise goal to implement and activate virtuous and continuous health care closed-loops (Fig.1). In particular, the platform supports the complete integration and interoperability, in a cooperative and collaborative patient centric context, of the main health care environments, Home Care, Primary Care and Secondary Care.

Along the loops, chronic patients have to be managed through:

- a strongly and well tailored personalised monitoring for addressing real time assistance and crisis management;
- a set of services for the health care operators and patients themselves, based on multi parametric analysis of acquired data (at home, on-the-move, in clinical laboratory, etc.);
- a more coherent management of possible hospitalizations, with a consequent strong reduction of inappropriate hospitalizations.

In this way, HEARTFAID will drive and control the chronic heart failure patient through the evolution of the disease, trying to avoid the worsening of patient condition or the occurrence of further illness. These objectives have been achieved through the technical solutions synthetically depicted in Fig. 2.

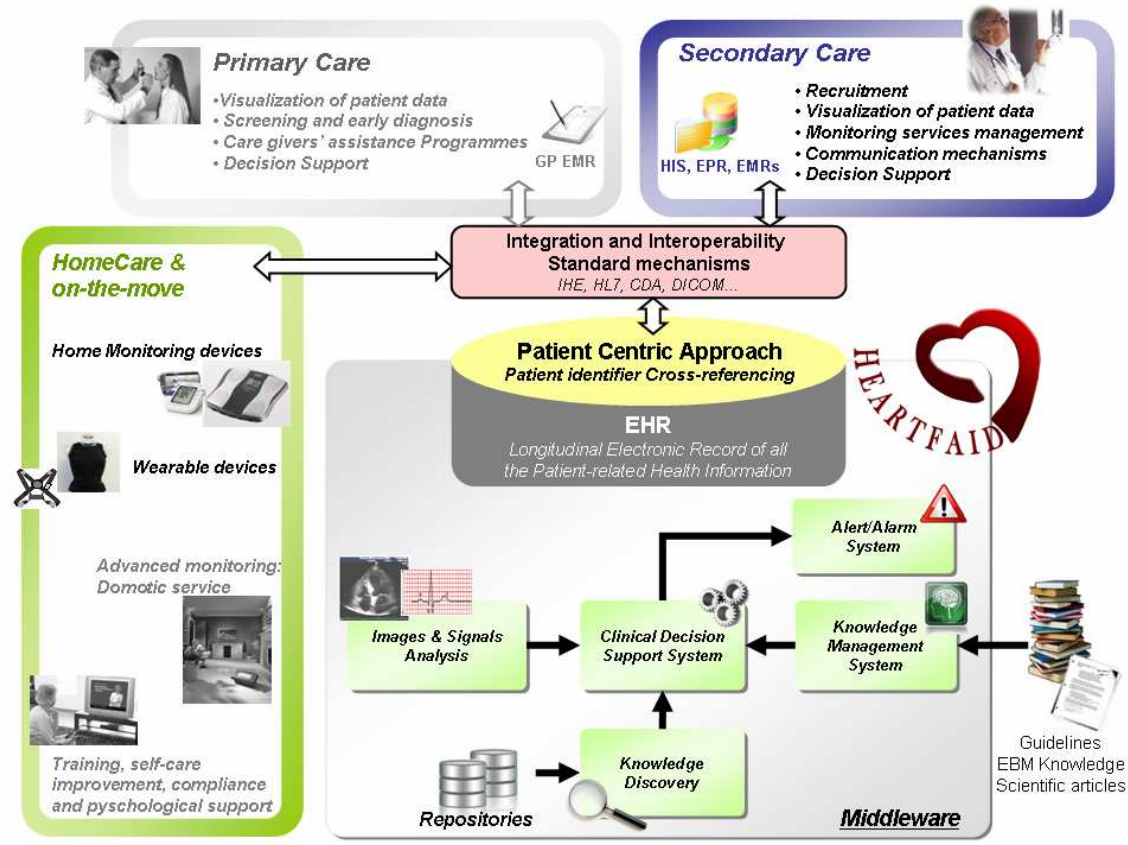

Fig. 2 – Architectural overview of HEARTFAID platform

As Fig.2 suggests, the architecture of the platform is highly modular, and it is composed by several components:

- the ***Electronic Health Record*** (EHR) module, together with the ***Integration and Interoperability Standard*** mechanisms, ensure a full integration between the different health care environments and the platform itself. In particular, data integration has been performed following a "Patient Centric Approach", that allows to identify univocally the patient, both across the different care environments and within the ICT solutions available in the medical domain.
- The "brain" of the platform has been constituted by the ***Knowledge Management*** and ***Knowledge Discovery*** modules. All the medical knowledge available within heart failure clinical guidelines and from the scientific literature has been formalized in a computer understandable form (ontologies and workflows) and enclosed in the ***Knowledge Management***

System. Meanwhile, the data collected by the platform has been used in order to extract new knowledge and to build predictive models by using the ***Knowledge Discovering System***. In particular, the predictive models aim at assessing the risk of further complications or patient status worsening. Finally, the ***Images & Signal Analysis*** component provide a set of functionalities in order to extract useful information from medical images and signals.

- All the knowledge enclosed in the platform is exploited by the ***Clinical Decision Support System*** **(CDSS)** in order to provide valuable services. In particular, the CDSS analyzes and integrates heterogeneous data with established biomedical knowledge and expertise in order to derive clinically relevant and useful information, such as suggestions for therapy adjustment based on remotely monitored changes of patient health status. Moreover, the CDSS contacts the ***Alert/Alarm System*** in case the analysis of patient data revealed any potentially dangerous condition, in order to advice the most appropriate persons or structures.

The internal communication between the modules has been ensured by the ***Middleware***, an integration system that has been developed following well recognized and accepted Interoperability Standards (e.g. XML based communications, HL7, DICOM, etc.).

Moreover, the platform deploys its services also within the heart failure patient home, through its ***Personal Devices Infrastructure*** (detailed in Fig. 3), which provides several home and "on the move" monitoring solutions and devices. Since heart failure patients are extremely heterogeneous in terms of health condition and presence of comorbidities, the basic idea is to provide the most appropriate remote monitoring service for the particular health status of each patient.

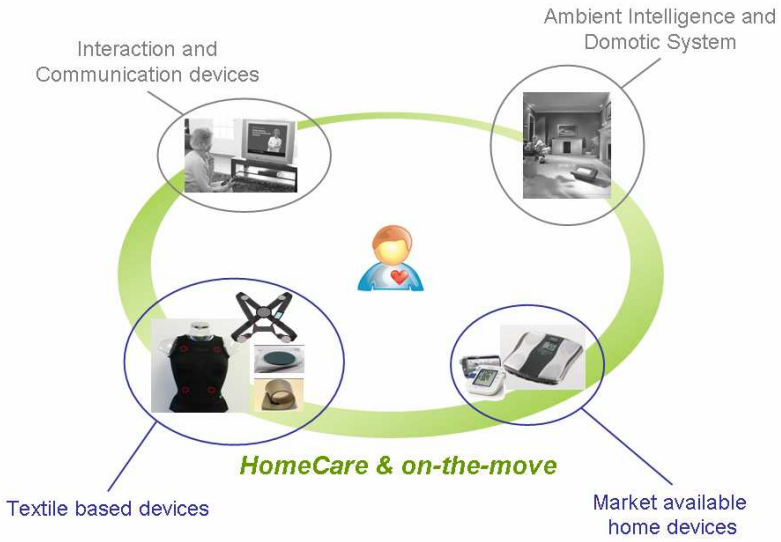

Fig. 3 – Personal Devices infrastructure of HEARTFAID platform

The field of ICT based applications for heart failure is particularly wide and changes quite quickly. Remote monitoring, Clinical Decision Support Systems and Data/Services Integration Solutions are only a few examples of possible applications of ICT technology that can be used in the domain of heart failure.

Due to the huge potential impact of this field, the EU promoted several initiatives during the Sixth and the Seventh Framework Program for the research and the development of ICT based solutions able to improve and support the current heart failure care practices.

Within this competitive scenario, HEARTFAID was one of the first EU funded project with the ambitious objective of unifying, within the same ICT platform, Remote Monitoring services, Knowledge Management/Discovery, Clinical Decision Support Systems, Signal and Image Processing on the background of the integration of different Health Care Environments.

The project produced several valuable results, especially in the field of the representation of medical knowledge in computer understandable form, advanced clinical decision support systems and innovative approaches for cardiovascular signal ad image processing. In fact, the Medical Ontology representing the Heart Failure clinical domain, developed by HEARTFAID project, was required both by the Stanford Medical Informatics Laboratory at Stanford University and by the of FP7 project HEARTCYCLE.

In order to understand the progress of HEARTFAID project beyond the state-of-the-art, Fig. 4 illustrates the difference among the several projects related to the management of heart failure and CVD within the 6th and 7th Framework Programs. The projects are characterized with respect to the presence/absence of different ICT solutions: Remote Monitoring services, Decision Support functionalities, and Integration/Interoperability solutions. Moreover, the clinical domain addressed by each project is reported (CVD means that the project is focused on multiple illness in the field of Coronary Vascular Diseases. CHF and HF stay for Chronic Heart Failure and Heart Failure, CAD means Coronary Artery Diseases, while AH is Arterial Hypertension).

Under this scenario, HEATFAID project has faced the attempt to proceed beyond the state-of-the-art of current EU funded projects, by adopting a more holistic approach for the management of heart failure.

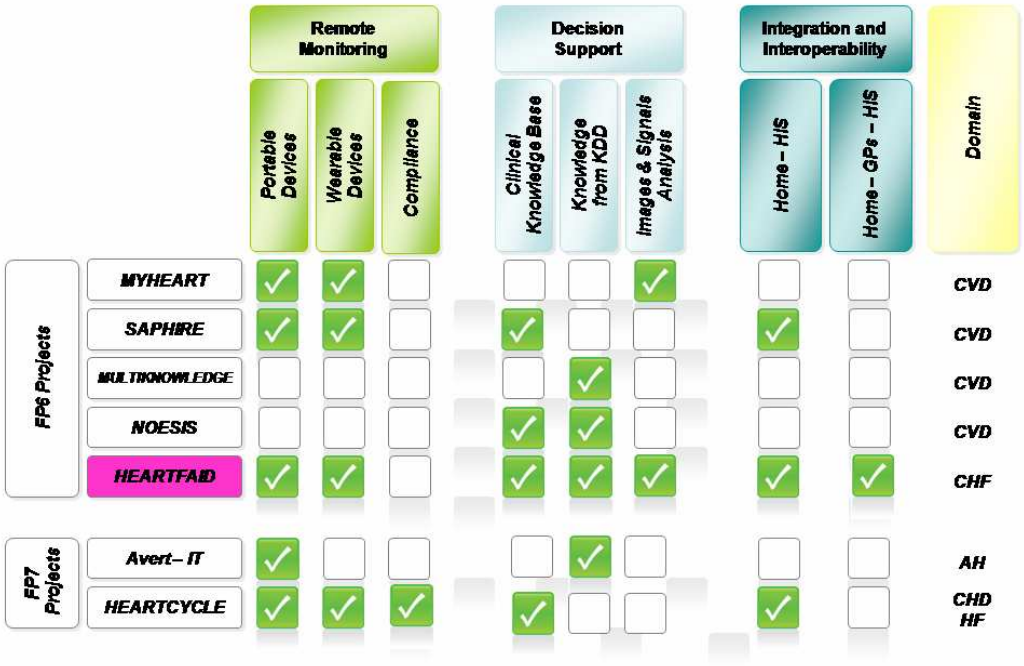

Fig. 4: Main properties of FP6 and FP7 projects related to Heart Failure and CVD domain

In fact, HEARTFAID went beyond the current state-of-the-art by integrating the various data sources, sensor data, hospital records and patients self-reporting into the suggested patient model, and thus really achieve a more holistically tailored intervention, rather than just tailoring on a few selected variables separately, as is currently done in most projects.

Finally, the Consortium of HEARTFAID project has been established with the aim to get a well-balanced combination providing all needed expertise, at a very high level of specialisation, in different topics. The consortium was based on 11 partners: 6 from Italy (University of Calabria, University "Magna Graecia" of Catanzaro, University of Milano Bicocca, Synapsis S.r.l., National Research Council, Auxologico Institute), 2 from Greece (Hellenic Telecommunications and Telematics Applications Company S.A., Foundation for Research and Technology Hellas), 1 from United Kingdom (Virtual Medical World Solutions Ltd.), 1 from Poland (Jagiellonian University Medical College) and 1 from Croatia (Rudjer Boskovic Institute). As far as the expertise and the contributions to the project are concerned, 4 partners came from the relevant medical domain (Cardiology Divisions of public hospitals), whereas the other 7 were related to the methodological and technological domain.

Section 2 – Dissemination and use

HEARTFAID has been a research and development project aimed at devising, developing and validating an innovative knowledge based platform of services, able to improve early diagnosis and to make more effective and efficient the clinical management of heart failure within elderly population.

In very general terms, the project aimed at a broader availability and extension of IST applications and services within the Health Care sector.

In particularly, by exploiting the up-to-date scientific and technical achievements on:

- data acquisition, transmission and management;
- knowledge representation, management and discovery;
- biomedical signal and image processing;
- decision support systems,

the main project goal has been to develop new systems and services that are able to effectively integrate and process relevant biomedical data and information for improving medical knowledge and processes related to the clinical management of heart failure patients.

Moreover, according to the overall vision of the IST priority in FP6, HEARTFAID project aimed at developing innovative intelligent environments that enable ubiquitous, effective and efficient management of citizens' health conditions and supporting health professionals in coping with major health challenges.

In particular, HEARTFAID provides healthcare professionals with access to timely relevant information at the point of need (i.e. different types of health care delivery environments), with a set of functionalities and services for acquiring up-to-date relevant medical knowledge that will provide a reliable support to healthcare professionals in their daily medical and clinical operations, enabling new ways of working as well as improved patient quality.

Under this respect, it is of strong strategic importance for HEARTFAID to devise and effectively implement exploitation and dissemination strategies, with the aim to emphasize the overall impact of the project's results.

As far as the "***using knowledge***" issues are concerned, since HEARTFAID is a project mostly implementation oriented, theoretical and methodological work are currently being rapidly converted to experimental and practical applications. Furthermore, the knowledge and experiences gained from practical experiments are going to be used by the HEARTAFAID partners for defining the next generation of products and services in the relevant domain.

More specifically, the industrial partners are developing an exploitation plan, based on the following steps: identification and evaluation of the most promising exploitable "parts" of the project results; identification of the market segments; detailed business plan; detailed identification of the potential markets and the competitive environment; assessment of benefits by end-users; establishment of a commercial agreement among partners on the joint commercialization and exploitation after project end; after project completion, development of the prototypes into industrial products.

As far as the "***disseminating knowledge***" issues are concerned, it is of strong interest to the HEARTFAID project and its partners to spread the knowledge, results, information and ideas related to the project as wide as possible. Dissemination is an important interactive interface for the project for establishing a close cooperation with end-users, scientific and professional communities and getting continued feedback on ideas and concept refinement.

Section 3 – Final Management Report

The Final Management Report refers mainly to the Final Summary Financial Report, detailed (attached) in an aggregate form, which shows the consolidated claimed costs for the full duration of the project.

The costs have been specifically reported in the following deliverables:

- D13: 1st Periodic Report : costs claimed in the first year.
- D26: 2nd Periodic Report: costs claimed in the second year.
- D43: 3rd Periodic Report: costs claimed in the 3rd Period.

At the end of D43 (page 86 of the final version) a cost budget follow up table has been inserted for the 3 periods showing the Actual Costs of each period.

Since the Requested Contribution for some partners exceeded the Maximum EC Contribution and for some partners is below the Maximum Requested Contribution, the Consortium will agree on the Distribution of the budget reporting it in the Final Report on the Distribution of the Community's Contribution consolidating the funding distributed to each contractor over the entire duration of the project to be sent to the Commission within 60 days after receipt of the final payment.