

Continuous home care monitoring services through INTERLIFE

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Abstract - INTERLIFE [1] is a revolutionary product that can radically change the way healthcare services are offered by introducing new means for quality health care management by the healthcare providers, and by improving the patients', health providers' and citizens' quality of life. INTERLIFE is a technological and medical knowledge management and processing infrastructure able to support an early discharge and a continuous home monitoring service thus leading to reduction hospitalisation rates and to the increased efficacy of healthcare service delivery of patients suffering from chronic diseases such as CHF, COPD and Diabetes as well as a special category of acute health care related patients. Six test sites are participating in the validation trials, more specifically EAP Sardenya and MUTUAM in Spain, Hippokrateion Hospital and AHEPA Hospital in Greece, RAMIT in Belgium and University of Regensburg Medical Centre in Germany.¹

I. INTRODUCTION

Homecare delivery is a key point for the management of chronic diseases, which demand continuous monitoring of basic parameters of the patient, so as to avoid complications [2]. Information technology based applications for home care delivery are important media to increase healthcare quality, improve quality of life, and create a better educational platform, which in turn is expected to be instrumental in creating a collaborative, mutually beneficial environment between the patient and the physician [3], [4].

Information technology (IT) applications in medicine are rapidly expanding, and new methods and solutions become available everyday since they are considered pivotal in the success of preventive medicine [5]. In the past days, IT

applications were mainly applied at the secondary health delivery level, and even at specialised hospital departments. These applications were difficult to use, maintain, and they were quite expensive. Today, due to the fast growing and penetration of the Internet and mobile telephone technology, the IT applications in the health care environment are focused at e-consultation [6] and home care delivery [7] and the use of triage systems [8].

There is growing evidence that the current health systems of nations around the world will be unsustainable if unchanged over the next 15 years [9]. Globally, healthcare is threatened by a confluence of powerful trends such as increasing demand, rising costs, uneven quality, misaligned incentives. If ignored, they will overwhelm health systems, creating massive financial burdens and devastating health problems for the individuals. Fortunately, the health system all over the world has been drastically changing moving from acute health delivery to prevention, from secondary health care delivery to primary care and to home care, from patient health care delivery to wellness. One of the major directives is the involvement of the patient and the family environment in the managing of his/her own disease or health problem. New solutions are emerging from beyond traditional boundaries and innovative business models are being formed as healthcare delivery is decentralized and globally distributed. Despite the complexity of the challenges that the healthcare industry faces, successful initiatives often involving technological innovation, preventive care and consumer-focused business models occur already [10]. These efforts have improved health outcomes as evidenced through randomized controlled trials [11].

INTERLIFE introduces a generic and modular contact center platform for the communication, management, processing and assessment of multimedia medical information and the provision of high quality pervasive telehealth services to the citizens. It introduces new generation telemedicine services for home care to improve quality of health care and create a large new IT market by involving every single home and every single health care provider.

From the healthcare quality improvement's point of view, INTERLIFE aims to:

- involve citizens in health care delivery through the use of microdevices and all available telematics infrastructure;

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- develop a continuing education process and a revolutionary medical education based prompting system;
- provide the clinical staff with better diagnosis opportunities;
- assess a mechanism of home care delivery via randomised control trials and the development of a transeuropean network for home care delivery in order to exchange data and experiences.

Last but not least, the economic and business objectives of INTERLIFE aim at the creation of a major market for health care delivery both for patients and healthy individuals, analogous to that of the Internet market.

II. INTERLIFE DESCRIPTION

INTERLIFE architecture is its generic applicability. As a consequence, communications with several medical devices and the INTERLIFE services are possible, and different patient target groups can be addressed.

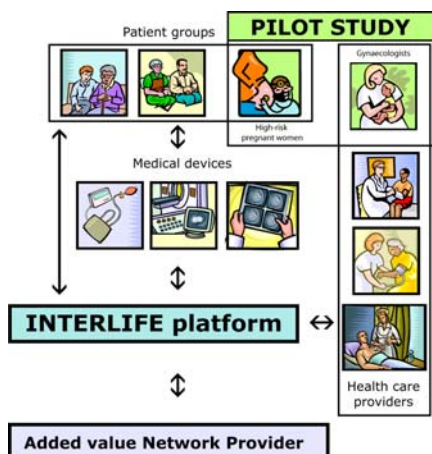


Figure 1: The INTERLIFE e-Health monitoring platform

INTERLIFE Services

INTERLIFE system provides a variety of care support functions, including:

- Reception of information from measurement devices;
- Step – by – step instruction for the patient to perform measurements;
- Decision support to identify and correct measurement problems;
- Storage of collected information in a patient database;
- Forwarding and downloading data to and from the clinical centre unit;
- Prompting the patient with messages to address education, disease management and monitoring issues.

INTERLIFE modules / sub-products

The INTERLIFE product is based on the outcome of the EU funded IST project with acronym CHS (Citizen Health

System). More specifically the modules/sub-products of the INTERLIFE system are the following:

- Telecommunications and I/F module: provides effective, ubiquitous and trouble-free communication between the contact center and the patients through the three different communication platforms supported. It provides means where feasible for logging and monitoring of the communication actions.
- Educational and reference library module: provides through the telematics infrastructure easy-to-understand guidance, evaluation, measurement and monitoring messages as well as medical knowledge to the patients, ensuring the optimal use of INTERLIFE system.

Information processing and archiving module: provides a frame for customized medical personnel driven processing of the medical data accrued from the patients.

- Database module: provides the most basic component of INTERLIFE system, where all data structures and relationships reside and where the information shared between the contact center and the patients are stored and then used by all the other INTERLIFE Modules. This module is extendible especially as it concerns the medical knowledge, medical instrumentation and medical data components.

- Decision support module: provides advanced tools for medical decision support processes such as help for medical queries construction, data mining tools, monitoring of INTERLIFE system's function, and finding the problematic features and processes of INTERLIFE system through the use of intelligent agents.

- Microdevices supported information module: this sub-product is a list of microdevices and electronic instruments supported by INTERLIFE contact center. It includes information on the manufacturer, and instructions on how to use the recording microdevices at home and communicate the measurements to the contact center in a certified way.

- Evaluation and design of clinical and other types of studies: Here INTERLIFE experts can provide additional consultation regarding the way somebody can set-up successfully studies using contact centers. This is a service that can be widely available and can be given by a 'pool of experts' through INTERLIFE.

Fig. 2 shows a general scheme of INTERLIFE modules developed corresponding to specific entities of the above mentioned products of INTERLIFE line. The above-mentioned modules constitute the core of INTERLIFE system, they can be used independently or as an entity, according to the scenario that each healthcare provider has.

INTERLIFE is an innovative product that permits to improve the quality of life, evidenced through clinical trials, for three areas: Congestive Heart Failure (CHF) (Greece and Spain), Diabetes Mellitus (Greece), COPD (Spain), Post-surgical and traumas care (Germany) and high risk pregnancy (Belgium).

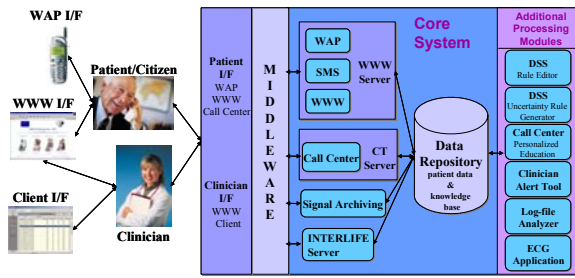


Figure 2: The overall architecture of INTERLIFE system

INTERLIFE choice of pilot sites

6 test sites will participate in the validation trials, more specifically EAP Sardenya and MUTUAM in Spain, Hippokrateion Hospital and AHEPA Hospital in Greece, RAMIT in Belgium and University of Regensburg Medical Centre in Germany. More specifically: Congestive Heart Failure (CHF) (Greece and Spain), Diabetes Mellitus (Greece), COPD (Spain), Post-surgical and traumas care (Germany) and high risk pregnancy (Belgium).

Congestive Heart Failure	
Devices	Blood Pressure Monitor, digital scale, thermometer, CG2206 single lead ECG device
Interfaces	Patient: Call Center (Web also available) - Greek Clinician: Web. Signal reception: Transtelephonic Signal viewing: Viewer from Carguard Patient: Web - Spanish Clinician: Web or client/server. No EEG for the Spanish pilot
Measurements	Measurement and transmission of: Blood Pressure, Heart Rate, Weight, Temperature, Single Lead ECG (only for the Thessaloniki pilot) Questions: 1. Were you breathless during the night? 2. Are your legs swollen? 3. Do you feel more tired today? 4. Do you have more dyspnea today? 5. Have you taken all the medications? If any values exceed "Target range" values then patient receives a warning: "Please contact the emergencies right away"
Education	Educational Voice Messages and tips on CHF available via the Call Center. Topics: (1) Knowledge and Prevention, (2) Therapeutic treatment, (3) Exercise, (4) Salt, (5) Fat, cholesterol and weight, (6) Fluids and alcohol, (7) Same information available on the WEB
Diabetes Patient Group	
Devices	Glucometer, Blood Pressure Meter (conventional can also be used), digital scale The patient takes the blood glucose measurement based on the "patient diary". However, he/she may send values whenever he feels dizziness or other symptoms.
Interfaces	Patient: Call Center (Web is also available) Clinician: Web and client/server
Measurements	Measurement and transmission of: Body weight, Blood Glucose, Blood pressure, Yes/no answers on 4 questions: (1) Have you followed your diet plan during the last two days?, (2) Have you followed your exercise plan during the last two days?, (3) Have you taken all your medications?, (4) Have you been feeling any symptoms?
Education	Available in text and voice messages. Information on topics such as : (1) Knowledge and Prevention, (2) Blood Glucose, (3) Coping with Diabetes, (4) Diet and Exercise

Also educational tips in all these categories. Clinician can customise the tips that the patient will hear.

Post Trauma Patients	
Devices	Tablet PC, body thermometer, Digital Camera (home care nurse)
Interfaces	Patient: Web. Clinician: Web Nurse: Web Image reception: Digital camera (manually by nurse)
Measurements	Temperature Wound assessment Wound image Electronic personalized questionnaire about health condition with the following possible items: (1) General condition, (2) Pain, (3) Medication, (4) Circulation, (5) Mobility, (6) Sensitivity, (7) Physical therapy, (8) Body temperature
High Risk Pregnancy Patients	
Devices	CG Fetal Monitor, digital Blood Pressure meter, digital weight scale, thermometer, colored sticks for the Urine Analysis test
Measurements	Blood Pressure, Urine Analysis, temperature, weight values and answers to questions are sent via the patient WEB interface.
Interfaces	Patient: Web. Clinician: Web and client/server Signal reception: Transtelephonic, CG Fetal Monitor, to be tested at Ramit Signal viewing: Viewer from Carguard, integration tools supplied by AUTH. Customisation at Ramit.
Category A Hypertension group	
Measurements	Blood pressure, Urine analysis, Temperature, Weight, CTG
Warning:	If the systolic Blood Pressure is higher than 180 or the diastolic Blood pressure is higher than 110 then a message is displayed saying: "Please call the hospital at 09/240.21.10 or 09/240.20.43 right away".
Questions	Does the baby kick regularly? YES Are you feeling okay? YES Any vaginal blood loss? NO Is your vision normal? YES
Warning:	Any unusual sharp pain in the stomach or liver area? NO Do you have headaches regularly? NO If at least one of the questions is not answered as above, then a message is displayed saying: "You need to come to the hospital as soon as possible"
Category B Preterm labor patients	
Measurements	Blood Pressure, Pulse, Urine Analysis, Temperature, CTG
Warning	If the temperature is above 38 °C then a message is displayed on the screen saying: "Please call the hospital at 09/240.21.10 or 09/240.20.43 right away".
Questions	Does the baby kick regularly? YES Are you feeling okay? YES Any vaginal blood loss? NO Any loss of fluid? NO If fluid loss is the fluid green? NO Any painful contractions? NO
Warning	If at least one of the questions is not answered as above, then a message is displayed on the TV screen saying: "You need to come to the hospital as soon as possible"
Category C Intra – Uterine Growth Retardation Group	
Questions	Blood Pressure, Pulse, Temperature, CTG Does the baby kick regularly? YES Are you feeling okay? YES Any pain or vaginal blood loss? NO
Warning	If at least one of the questions is not answered as above, then a message is displayed on the screen saying: "You need to come to the hospital as soon as possible"
COPD	
Devices	Handset - Motorola A1000 UMTS Pulse oximeter: Nonin – 4100 (Nonin Medical Inc.)

Interfaces	Spirometer: NDD – EasyOne (Ndd Medical Technologies)
	Patient: Web enabled Call Center Clinician: Web based patient management application Signal reception: Bluetooth + GPRS Signal viewing: Viewer from Motorola Patient: Handset (Application in Catalan / Spanish versions) Clinician: Patient management application (Spanish), Motorola application (English).
Measurements	<i>Measurement and transmission of:</i> Oxygen saturation, Heart rate, Forced Spirometry parameters, Health status questionnaire Questions (health status questionnaire): 1. have you increased your breathlessness? 2. have your wheezing chest increased? 3. have you increased the quantity of sputum? 4. the sputum colour is different than the habitual? 5. have you had problems to sleep at night due to breathlessness? 6. have your foot swallowed? 7. have you had fever? 8. have you had sleepiness during the day? 9. have you taken your rescue medicine inhalers during the last 24 hours? 10. have you stop taking the prescribed medication?
Education	Feed back message (green condition, Catalan version) Feed back message (yellow condition, Catalan version) Feed back message (red condition, Catalan version) Printed education material available. Also electronically to the professionals.

Initial INTERLIFE Business Models

The following three business models (Figure 3) described can be feasible in Europe for the further deployment of INTERLIFE services:

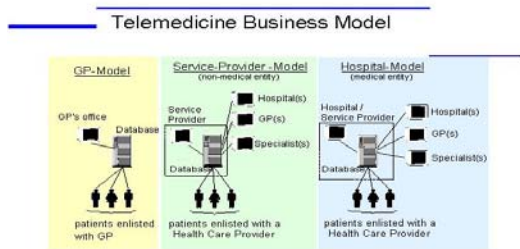


Figure 3: Telemedicine Business Models

GP – Model: This model has two possible customers. The GP or out of hospital specialists who would like to experiment with a low end system, or the large GP group practices and Out-of-Hospital specialist organizations with a sufficient number of chronic ill patients to justify investing in a Telemedicine organization.

Service-Provider-Model (or ‘Added Value Network Provider’ – model): Independent clinical service providers and pharmaceutical companies are starting to address this market, by signing contracts with patients GPs, specialists and hospitals offering to take care of specific patient groups. This model addresses insurance organizations, pharmaceutical companies, existing call centers, medical centers that provide healthcare services as well.

Hospital-Model: Tertiary care hospitals are trying to position themselves as Centers of Excellence for specific diseases, and plan to offer Telemedicine services to GPs and Out-of-

Hospital specialists. Reasons for wanting to indulge in this business are:

- Tertiary care hospitals need to extend their portfolio of services to counter the ongoing reduction in bed capacity and subsequent downscaling initiatives;
- Telemedicine is an ideal tool to build a link with patients at home, knowing that when they are admitted to a hospital they most likely come to the competence center. This specific business model could involve public or private Hospital. This model concerns the existing healthcare providers (public or private) to provide the INTERLIFE services. The service provision could be done:
 - Provision of the INTERLIFE service to subscribed customers. A customer wishing to have an active role in monitoring his/her health status in order to enjoy an enhanced feeling of safety and an elevated quality of life subscribed to the INTERLIFE service.
 - Joint venture with a remote public or private healthcare centre or a doctor in private practice. The local healthcare centre will be equipped with the INTERLIFE portable device. A trained employee (medical auxiliary personnel, nurse, etc.) will be responsible for conducting the measurements and their transmission to the INTERLIFE Contact Center.

III. DISCUSSION

INTERLIFE is a revolutionary product that can radically change the way healthcare services are offered by introducing new means for quality health care management by the healthcare providers, and by improving the patients’, health providers’ and citizens’ quality of life.

IV. ACKNOWLEDGEMENTS

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