MOBINET: e-Wellness services fostering citizen empowerment

Pantelis Angelidis and Markela Psymarnou

Abstract— The Mobinet service concept emerged, as points of care move closer to the patient and the citizen undertakes a more active role in healthcare monitoring and prevention. Today's advances in monitoring devices and telecommunication networks have made possible a viable solution regarding the provision of continuous health monitoring services seamlessly. Utilizing the information and communication technologies (ICT) and medical industry advances, Mobinet exploits a modular telemedicine platform, to provide a personalized and location independent service focusing on prevention (rather than disease management) to support increasing patients needs for self-empowerment and increasing the quality in the healthcare delivery away from the traditional nursing areas. The business plan explores the potential of telemonitoring services and draws the business, financial and marketing strategies for the successful penetration to the Greek market. The paper presents two models for the provision of health-telemonitoring services to all citizens and examines the added value and effectiveness of the proposed services. Data from real life case studies are extracted. The future of mobile healthcare is discussed.

I. Introduction

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Utilizing the ICT and medical industry advances, Mobinet exploits a modular telemedicine platform, to provide a personalized and location independent service focusing on prevention (rather than disease management) to support increasing patients needs for self-empowerment and increasing the quality in the healthcare delivery away from the traditional nursing areas.

The Mobinet business plan explores the potential of telemonitoring services and draws the business, financial and marketing strategies for the successful penetration to the Greek market.

The service was initially piloted with the aim to develop a sound business case regarding the provision of innovative telemedicine services to citizens with chronic conditions, as well as those who monitor their health status closely for "wellness" purposes. Thus, Mobinet is directed at the "chronically ill" as well as the "worried well" citizens.

Various clinical, technical and business settings have been explored and currently, Mobinet is set for commercial launch in Greece. The service commercial deployment is envisaged to contribute to the exploration of the dynamics of interactive monitoring.

Two different models for service provision have been designed, focusing either on the patient-end (patient-centric) or the healthcare professional-end [General Physician (GP) –centric]. In both cases, lightweight handy devices are used for the collection and wireless transmission of the vital signs to a web server.

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Pantelis Angelidis is with the Health Telematics company VIDAVO, 57001 Thessaloniki, P.O. Box 60521, Greece (phone: +302311999955; fax: 2311999956; e-mail: pantelis@vidavo.gr).

Markela Psymarnou is with the Health Telematics company VIDAVO (markela@vidavo.gr).

II. Mobinet Services

A. Mobinet Concept

The Mobinet service concept emerged, as points of care move closer to the patient and the citizen/patient undertakes a more active role in healthcare monitoring and prevention.

The system enables remote monitoring and transmission of the patients vital signs via wearable monitoring devices with transtelefonic transmission capabilities over PSTN or GSM / GPRS. The system provides the possibility for doctor-patient ubiquitous communication and support, while the patient is at home, work, vacation (i.e. away from the traditional nursing areas). More than this, Mobinet triggers a patient-centric process, focusing on prevention rather than disease management and treatment and initiates patients' active involvement in healthcare.

The need to provide cost-effective healthcare services for continuous telemonitoring of vital signs to remote or on the move patients has been early identified, to bridge the gap in healthcare provision. This gap is created by the inability of healthcare providers to offer continuous monitoring, seamlessly to chronic patients and worried-well citizens.

B. System description

1) System architecture

The system is composed of two main units: a) the patient unit, which is comprised by the micro-telemedicine device and the IT-telecom component (i.e. PC, PDA, or mobile

phone) and b) the web-center, which is comprised by the SQL server, the central database and the portal for the web access of physicians and patients/citizens to their personal pages. The patient web interface directs the user to the interconnected Electronic Medical Record (EMR) files, containing all of the medical data. The EMR files are automatically updated each time a new measurement arrives at the central database.

The system architecture is open, allowing easy integration of individual service components and enabling interoperability with third, complementary applications (i.e. Hospital Information Systems, etc). Communication is achieved via standard communication protocols for medical information exchange, such as the HL7, while shortly the system will be expanded to support Electrocardiogram (ECG) transmission protocols, such as the OpenECG [1].

2) Vital signs monitored via Mobinet

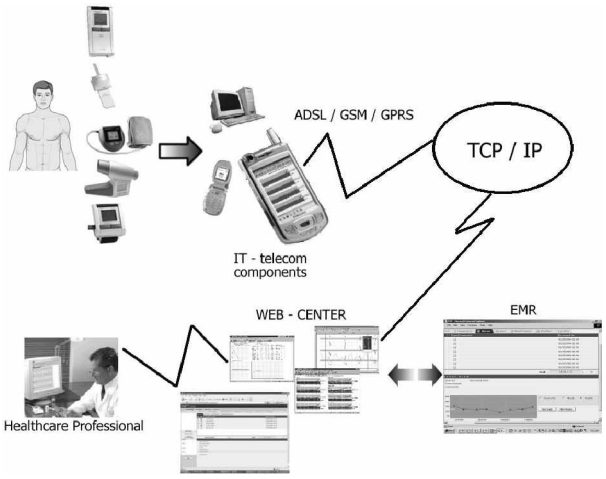

Fig. 1. Mobinet architecture.

Mobinet Wellness is a novel service for the worried well citizens and chronic patients, enabling disease prevention, and monitoring of chronic diseases like chronic obstructive pulmonary disease, diabetes, hypertension, heart diseases, etc.

The service contributes in the ubiquitous monitoring of the chronic patients health status, regardless of geographical or other constrains, exploiting the capabilities of micro-telemedicine devices and wireless communication networks.

The vital signs that can be recorded and transmitted via the Mobinet service are ECG, sets of pulmonary function parameters (i.e. FVC, PEF, etc), heart rate, diastolic & systolic blood pressure, SPO2, and blood glucose.

3) Mobinet functionality for the health-care professional

The system allows immediate access to patient medical data, current and previous, and easy navigation to previous test results, as well as comparison between baseline measurement and other new medical results. The EMR application enables paperwork minimization and thus, error risk minimization. Additionally, the system enables communication and interaction between healthcare professionals and consultations between doctors of different specialties, for a holistic approach to patient care. Access to the center and medical data is achieved via a range of different communications modes, wired or wireless, while the notification feature of the system ensures timely processing of medical data.

4) Mobinet functionality for the end-user

The system relies on the ease of use of handy micro-telemedicine devices. The application on the IT-telecom component is straightforward and not time-consuming. The application allows interaction with physicians and second advice from experts (where needed). In addition, Mobinet enables electronic storing and handling of patient medical data, sharing the functionalities of EMR applications. The personal electronic medical record of the patient is automatically updated.

C. Customer typology & other stakeholders

The customers (buyers) of the service are the private and public healthcare providers (i.e. hospitals, clinics, diagnostic & medical centers), the insurance companies that include medical care in their premium packages, and the associations of healthcare professionals wishing to enjoy the benefits of networking. The Mobinet users can ensure improved patient and data management, timely access to medical information, and improved resource management, enhancing thus their efficiency.

The end-users group includes, but is not limited to the following subgroups:

- Chronic patients (cardiac & pulmonary diseases, diabetes, hypertension, etc)
- Post-surgery patients, while recovering at home, following hospitalization
- Older people who must monitor their health status
- Athletes and sports team, monitoring their health status and keeping records on their vital data, prior and after exercise in the sports field
- *All citizens wishing to monitor their health status so as to safeguard wellness*

The end-users of the service benefit from ubiquitous communication with healthcare professionals and enhanced feeling of safety, as well as elevated quality of life for patients and carers, deriving from patient active role in healthcare management and prevention.

Further stakeholder groups that gain added value via Mobinet include healthcare authorities and specialized healthcare associations, telecommunication and e-services companies, pharmaceutical companies and all other institutions directly or indirectly involved in the healthcare and more specifically in the e-health supply chain.

III. MOBINET SERVICE MODELS

A. Mobinet service provision

The Mobinet service was initially piloted with the aim to develop a sound business case regarding the provision of innovative telemedicine services to citizens with chronic conditions, as well as those who monitor their health status closely for "wellness" purposes. Thus, Mobinet is directed to the "chronically ill" as well as the "worried well" citizens.

Various clinical, technical and business settings have been explored and currently, Mobinet is set for commercial launch in Greece. The service commercial deployment is envisaged to contribute to the exploration of the dynamics of interactive monitoring.

B. Patient-Model

The Mobinet patient-model service provision concerns interaction between individual patients and their GPs / carers. The patient (user) is equipped with one or more devices for vital data recording and an IT / telecom component. The user is able to record medical data at predefined intervals, based on his/her personalized care protocol, or at any other time. The data is automatically transmitted to the IT/telecom component and by pressing one button to the remote web-center and the personal health record of the user is automatically updated. The authorized healthcare professionals can access the medical data, process it and provide feedback to the user, in the form of SMS or message posted on the users' personal web pages.

The patient model has been designed with the aim to empower citizens in their own self-care. The service provision principles include:

- Scalability: the service can be easily expanded either in terms of multiple signs monitoring by a single patients or in terms of serving individual patients combining different business perspectives and reimbursement approaches.
- Portability: the patient unit is lightweight and easy to use, enabling efficient health monitoring independently of the user setting & location.
- Ease of use / attractiveness: the application on portable patient unit and web-application are constructed with the aim to appeal to the user who is not familiar with new technologies. The process is straightforward, providing also further "advanced" choices for the experienced user. In addition, micro-telemedicine devices share modern design and simple interface.
- Interoperability: open architecture and exploitation of standardized communication protocols ensure reliable information exchange and interconnection with different systems.

C. GP-Model

The Mobinet GP-model service provision concerns interaction between GPs and experts. The GP, usually located in remote – isolated areas in the Greek rural or island regions, is equipped with a set of devices and an IT / telecom component. The GP can keep electronic history records for his/her regular patients, locally in the database of the IT component. In addition, the GP may send anonymous medical data to the web center, where networking specialized doctors may login upon the system notification in order to provide medical advice and expert support.

The anonymous bulk medical data on the web-center is also utilized from the authorized healthcare professionals for research purposes and the conduction of statistical and epidemiology studies regarding public health.

The GP-model has been designed with the aim to facilitate healthcare professionals in completing every-day tasks and providing quality healthcare services to all citizens. The service provision principles include:

- Connectivity: the service enables networking between healthcare professionals, either in real time or asynchronous.
- Interoperability: open architecture and exploitation of standardized communication protocols ensure reliable information exchange and interconnection with different systems.
- Availability: the service enables availability of healthcare in remote and isolated regions.

IV. CASE STUDIES

A. Patient-Model: The Metropolitan-Hospital Project

The Metropolitan-Hospital project concerns the implementation of the Mobinet patient service model. In the frame of this project, the Metropolitan hospital in Athens, Greece, will provide the Mobinet telemonitoring services to post-surgery patients and patients with cardiovascular diseases.

During the project pilot operation phase eight (8) patients will be equipped with medical kits, each including three telemonitoring devices, an ECG recorder, a blood-pressure monitor and an oxymeter, as well as a mobile phone. Each patient that will participate in the pilot operation, following his discharge from the hospital, will receive a complete kit

and training on the use of the devices and the mobile application for data transmission. The patients will then be responsible for recording their vital data on a daily basis and sending it to the Mobinet web-center for review and consultation by the hospital specialized staff.

The pilot operation of the Metropolitan-Hospital project is scheduled for three months, starting on the 2nd of August 2006. Following the three month pilot operation the hospital will proceed in evaluation, and, based on the outcome, to business planning, so as to expand its service portfolio with added value telematics services.

B. GP-Model: The 2nd Regional Health Authority of Central Macedonia Project – Sponsored by Vodafone-Greece

The 2nd Regional Healthcare Authority of the Region of Central Macedonia (2nd RHM-CM) in Greece is in the phase of implementing the GP model of the Mobinet service provision. The project is sponsored by Vodafone-Hellas S.A as part of its Corporate Social Responsibility activities.

The 2nd RHM-CM is responsible the coordination and implementation of health care policies and services in the corresponding geographical region. In the frame of the Mobinet GP-model project implementation, the 2nd RHM-CM will equip the health-centers with sets of telemonitoring devices in the following regions: Diavata, Litohoro, Skidra, Pella, and Malgara for the provision of health telematics services to the population of those regions. The GPs at the local health-centers will utilize the equipment and the Mobinet services in order to provide health-telematics services to the population of these regions. The recorded data will be stored in patients' electronic records in the local center, whereas anonymous information will be send at the appointed specialized hospital for consultation and feedback.

Vodafone-Hellas S.A. sponsors the whole effort. The first training session has been completed successfully and the participating GPs provided the following additional implementation scenarios: a) utilization of the Mobinet service for the annual health check up of students, in order for them to be authorized to participate in the school athletic events, b) use of the equipment at the emergency department for real-time consultation and support.

Following the scheduled six-month operation, the whole project will be evaluated and future implementation scenarios will be developed, based on the experiences gained.

V. DISCUSSION

The Mobinet concept generates significant social benefits, including improvement in the provision of healthcare services and elevation of the patient quality of life. Mobinet enables healthcare professionals to allocate their time in an efficient and effective manner, as they are able to manage more patients, since telemonitoring allows the simultaneous monitoring of the health status of multiple patients. Patient management and also, data management for each patient is improved, facilitating medication management and the completion of administrative tasks for the healthcare professionals.

Mobinet is a novel service concept within the Greek market, but also Europe-wide, and it is expected that part of the costs previously allocated to home visits and/or visits to the hospital will be allocated to Mobinet. Therefore, it is anticipated that the full market deployment of Mobinet will positively impact hospitalization duration and according expenses and that it will improve patient's morale since s/he will have an active role in monitoring his/her health condition.

The business plan focuses on the peculiarities of the local health market, explores the potential of telemonitoring services and draws the business, financial and marketing strategies for the successful penetration to the Greek market.

Based on the Mobinet business planning considerations, telemonitoring services can prove to be cost-effective either in the public or the private healthcare provision domain. On the one-hand public healthcare providers are able to reach remote isolated areas and possibly reduce hospitalisation expenditures in the long run. On the other hand, individual citizens may benefit from the service. Undertaking the cost of telemonitoring can save them the time and money previously allocated to visits at private medical establishments for the conduction of routine diagnostic tests. Additionally, when the service is provided by a private healthcare provider, it is considered as an added-value service to its existing portfolio of services, meaning that it can attract a wider customer base.

Although the market is still immature, the financial benefits generated for all parties involved create the potential for appealing to the general public. Nevertheless, there is still uncertainty about the impact telemonitoring will have when used in routine practice. The wider economic implications have not been comprehensively quantified and valued. In addition, long-term sustainable telemedicine programs must be consistent with business objectives and strategic plans, which is not always evident in the area of current applications [2].

The feasibility study in Greece has been validated and the outcome so far creates expectations for the full market deployment. The Mobinet concept directly targets citizens that reimburse the primary healthcare services they receive, via out-of-pocket payments. Whereas virtually all Greek citizens have coverage for healthcare services through statutory insurance or the National Healthcare System, there

is a large private sector market components consisting of consultations with physicians in private practice, visits to private diagnostic centers, as well as private hospitals for in-patient care. This is due to dissatisfaction with publicly provided services.

Nevertheless, public insurance funds, sooner or later, are expected to notice the advantages of (the Mobinet concept and other) telematic services and, overcoming their reluctance towards innovative technological systems, employ them. This allows a perspective of a much wider user base in the future.

VI. Mobile Healthcare

The health care industry is experiencing a substantial shift to care delivery away from the traditional nursing areas, due to the convergence of several technology areas. Increasingly capable health monitoring systems are moving the point of care closer to the patient, whereas the patient, better informed and aware now, undertakes an active role to self care and/or prevention. Emerging ICT technologies in conjunction to the medical device industry development (intelligent devices, biosensors, novel software, etc) demonstrate the personalized healthcare delivery potential without geographical limitations.

The concept of prevention prevails now against disease management and treatment plans. As patient-centric processes emerge, the citizens/patients undertake an active role in monitoring their health status, whereas e-wellness evolves to address the rising expectations of the e-health consumers, who are better informed, more demanding, and empowered. The empowered, worried-well, consumers require quality health services on the spot. The drivers are now connectivity, speed and personalization [3].

Waves of technology incorporation and scientific discovers, have driven the sector from reliance on direct communication and physician experience, to a higher reliance on technology and community information. This new web-enabled environment has taken health care from local areas, where Telemedecine left it, literally in to the patient home, and more recently with the m-Internet, to wherever the patient might be and whenever he need it [4].

m-Internet enables information exchange and promotes availability of services and communication modes to serve working teams with increasing mobility requirements.

Services are becoming personalised and location independent to serve increasing patients needs for self-empowerment and quality in the healthcare delivery away from the traditional nursing areas.

Further to the new approaches in the provision of healthcare services in the frame of e-health, wireless developments create new opportunities for the healthcare professionals, individuals and organizations, the patients and the health authorities. The scope of mobile health addresses clinical, administrative, and consumer health information applications and as it could contribute in the improvement of health outcomes, m-health may be utilized to measure the health status and population welfare.

Many healthcare organizations are investing in Information Technology (IT) projects that take advantage of new technologies in the mobile healthcare application space. Functionality that augments the capture of evidence-based patient plans of care is essential and must map and bridge the information flow for both inpatient and outpatient workflow clinical practice guidelines. As the medical community continues to embrace these new technologies, system integrators must provide functionality that reduces costs, improves the quality of care, and improves the ease with which caregivers can perform their everyday tasks [5].

The most significant challenge posed by mobile technology is the seamless integration of multiple hardware and software platforms with reliable, uninterrupted wireless services in a secure manner that will become mission-critical to successful healthcare organizations, payers and providers [5].

The current state-of-the-art technology in medical sensors allows for easy and unobtrusive electronic measurement of several health conditions. The sensors are often stand-alone devices, and sometimes comprised of two or more elements connected by a cable or wireless technology. Medical sensors have the capability to measure vital signs such as blood pressure, pulse rate, respiration frequency etc. Based on these medical parameters the medical professionals can monitor the patient's health condition, and act in case of an anomaly.

The application areas of the medical device wireless telemonitoring capabilities include:

1. Assistance in case of accidents and emergencies
2. Increased capacity and lower costs for hospitals
3. Assistance and monitoring in a home-care setting
4. Monitoring of chronically ill patients
5. Patient involvement in setting diagnosis
6. Medicine dosage adjustment
7. Physical state monitoring in sports
8. Monitoring of sporadically occurring symptoms
9. Emergency alarms [6]
10. Improved health management

As a result, the citizens can enjoy quality in the healthcare provision and an elevated quality of life. As underlined by the European Council objectives, set in Lisbon, "effective integration of healthcare and related support services by electronic means, including the widespread use of telecare, could improve the quality of life of citizens by enabling safer independent living and increased social inclusion."

The next few years will witness a rapid deployment in both wireless technologies and mobile Internet based m-health systems with pervasive computing technologies. The increasing data traffic and demands from different medical applications and roaming application will be compatible with the data rates of 3G systems in specific mobility conditions. The implementation and penetration of 4G systems is expected to help close the gap in medical care. Specifically, in a society penetrated by 4G systems, home medical care and remote diagnosis will become common, check-up by specialists and prescription of drugs will be enabled at home and in underpopulated areas based on high resolution image transmission technologies and remote surgery, and virtual hospital with no resident doctors will be realized. Preventive medical care will also be emphasized: for individual health management, data will constantly be transmitted to the hospital through a built-in sensor in the individual's watch, accessories, or other items worn daily, and diagnosis results will be fed back to the individual [7].

A 4th Generation m-health solution builds upon the Mobile Information Portal of a 3G solution by adding the multiple devices rendering capability of the 2G solutions. Now an end user has the ability to access any application with any device [8]. 4G solutions embrace the distributed and loosely coupled HIS applications throughout a health unit. A 4G solution can allow for acquisition of data from various sources and allow the mobile end user to view, analyze, manipulate, graph and merge data according to his or her needs right on the mobile device.

In the home of the future, some devices will contribute physiological information about the patient (e.g., heart rate, blood pressure), while other devices in and around the home will contribute information about the patient's environment (e.g., humidity, temperature, carbon monoxide level). In some cases, groups of devices will have enough collective awareness to function autonomously based on sensor data.

The challenge for the healthcare providers and health authorities lies on the comprehension of the end users needs for the effective integration of new technological capabilities to existing settings in order to leverage their capacities an quality of services.

VII. Conclusion

Services like the Mobinet concept enable patient-doctor continuous interaction, regardless of location and any other geographical limitation. Following the trend for healthcare service provision away of the traditional nursing areas (i.e. at the patient's homecare setting, work environment, or event at vacation, etc), ambulatory telemonitoring services have a direct impact on the patient's overall quality of life.

The enhanced monitoring capabilities of the Mobinet service concept are expected to have a positive impact on the time saving and the cost efficiency of the healthcare professionals, as the service enables the simultaneous monitoring of the health status of multiple patients. Patient management and also, data management for each patient will be improved, facilitating medication management and the completion of administrative tasks for the healthcare professionals. Additionally, Mobinet is anticipated to positively impact hospitalisation duration and costs, and also, to minimize transportation costs allocated by patients / citizens in remote areas to doctor visits for routine examination.

The two projects that have been presented here and are about to be implemented will significantly contribute to the definition and quantification of the impact of the health-telematics services in the private and public health sector.

The Mobinet service when fully deployed is expected to promote the wellness concept at the chronically ill and worried well market segments.

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