Health@Home – An e-Service Model for Disease Prevention and Healthcare in the Home

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Abstract. The ageing of the population, the growth of chronic diseases, and the explosion of healthcare costs jeopardise the sustainability of healthcare systems in many European countries. This opens opportunities for innovative prevention and healthcare services supported by information and communication technologies (ICT). The natural focus for providing such services is the home. However, the e-health services provided in the home so far are limited in scope and fragmented. This paper suggests a comprehensive service model for home-based e-health services in Europe, which aims to overcome the current service fragmentation. The Health@Home model integrates disease prevention and healthcare for different groups of citizens at different stages on the health scale. The technical challenge of this model is the national and Europe-wide integration of heterogeneous systems and services in a way that makes them reliable and easy to use for all citizens, particularly those with low technical abilities and severe impairments.

1 Introduction

The ageing of the European population has a dramatic impact on healthcare systems in Europe. The cost of treatment has risen to a level, which threatens the functioning and financing of the national healthcare systems. At the same time, these expensive healthcare systems are decreasingly capable of providing the level of care that citizens need, especially elderly citizens and patients with chronic diseases.

The growth of the number of patients with chronic diseases is not only driven by the growing number of elderly people. It is also driven by an unhealthy lifestyle in developed European countries, which affects citizens in other age groups as well, causing further financial burdens for the healthcare systems. According to a Eurobarometer survey done in 2007, already 29 percent of EU citizens have chronic diseases, 5 percent more than in 2005 [1].

The current healthcare system is ever less able to cope with these challenges in a financially feasible way. The cost of treatment of chronic diseases alone makes it necessary to look at new ways of providing care. Empowering patients in order to take

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care of their health is a consistent and effective way to overcome these challenges, reducing the dependency on frequent support by healthcare professionals. The most effective way to achieve this is via ICT-enabled health services, and the best place to provide those services is the place where citizens live, in their homes.

The home offers the perfect environment for providing e-health services, either for prevention, continuous care, or treatment of chronic diseases: the environment is favoured by patients and has in itself a positive impact on the mental well-being of patients, compared to hospitals, practices of general practitioners, and care facilities. The evolution of ICT has reached a level that makes the cost-effective provisioning of e-health services in the home a realistic option.

ICT-enabled services in the home are especially important for the growing number of elderly people with chronic diseases, who live independently in their private homes, but lack the support of relatives, while their conditions are not bad enough to be eligible for financing of professional care services by the healthcare system or hospitalisation.

On the other end of the health scale, there are young and middle-aged people with chronic diseases or – due to their life style – the risk of getting chronic diseases. They could benefit from ICT-enabled health information, consulting, and monitoring services as a prevention mechanism.

2 Stakeholders in Home-Based Prevention and Healthcare

The main stakeholders in home-based prevention and healthcare service scenarios are the citizen/patient, healthcare professionals (general practitioners, doctors at hospitals, homecare providers, etc.), ICT service providers and network operators, providers of health monitoring and ICT devices, the national healthcare service and health insurance companies.

There is a paradox situation in Europe today: a growing share of citizens has broadband connections and feature-rich communications and consumer electronics equipment, but only very limited access to e-health services. The few existing healthcare service platforms are limited to special medical conditions (e.g. diabetes or chronic obstructive pulmonary disease – COPD) and proprietary devices. The user access to services is mostly through the Internet via PCs or via plain old telephony services. Patients with chronic conditions have already some health monitoring devices, like, e.g., blood pressure meters, at home. However, the access to the collected data is usually done via proprietary protocols and applications, which makes it almost impossible to connect these data to any kind of electronic health support service. Some services for elderly patients, like, for instance, half-automated emergency call services, rely on telephony and offer only a limited scope of support.

The reasons for the lack of prevention and healthcare services in home networking are mainly related to technical and organisational issues. On the technical level, the integration of heterogeneous services and devices via a home platform has not yet been fully achieved. On an organisational level, there is a lack of coordination between the major stakeholders in home-based prevention and healthcare service scenarios.

In order to implement the proposed Health@Home service model, the current stakeholder roles have to change, and integration on the technical and organisational level has to be a central concern.

In the envisaged Health@Home service model, patients will become empowered to take control and responsibility for their own well-being to the extent possible, with health support services being available and accessible when needed.

3 The Health@Home Service Model

In a number of EU-funded research projects, like, e.g., CAALYX – Complete Ambient Assisted Living Experiment [2], scenarios for ambient-assisted living (AAL) in an intelligent home environment have been explored. There are also special projects on AAL scenarios for the elderly, like, e.g., OLDES - Older People's e-services at Home [3]. First commercial services in this area are already on the market [4]. Both, research prototypes and the few commercial services, are fragmented solutions for limited groups of patients with a very limited scope for interconnectivity.

The Health@Home approach goes beyond current models by providing e-health services in the home comprehensively, including prevention, treatment-related monitoring and alerting in an integrated framework driven by the patient needs.

The proposed model is based on an open, secure Health@Home service platform that integrates information from different communication and monitoring devices. In order to achieve its purposes, the platform will have a number of essential characteristics:

1. The platform will be based on open standards, in order to make the service provisioning easily extensible, easily accessible for users, and independent of specific home user devices.
2. The platform will enable multimodal access via multiple devices. Especially elderly patients will often not be able to handle their health information via a common PC, and in some cases, even easier accessible text-based systems are not usable for them due to impaired vision. Thus, voice-controlled access will be a key feature, e.g. via easy-to-use handheld devices, or intuitive pictorial-based access and service control via highly familiar devices, such as, e.g., the television set.
3. The platform will enable advanced service scenarios, which perform the collection of health monitoring data, e.g. from blood pressure meters or heart rate meters, in a way that does not require the active intervention of the patient.
4. The platform will access electronic patient record information, in order to match monitoring data and drug prescription information with the patient's medical history and medication record.
5. The platform will be customisable to the personal needs of the user and patient. This includes also the handling of health data collected via health monitoring devices and sensors in the home, granting the necessary privacy levels when exchanging information in the home network or via the telecommunications provider infrastructure. Users will, by default, have the capability to determine who should obtain access to the health data that are stored on the remote Health@Home server. In addition, users will have the option to store the data locally.
6. The platform will be comprehensive, usable by all users (e.g. patient, relatives, homecare personnel) and adaptable to different care conditions. A modular and adaptable approach will be adopted in the platform development ranging from preventive care, with a focus on risk monitoring and prevention (e.g. overweight, high blood pressure), to chronic disease monitoring and treatment.

7. Mobility aspects will also be covered, especially concerning chronic diseases. Most chronic diseases, like chronic heart failure and COPD, require permanent monitoring and supervision by either heart or pulmonary specialists. Collecting and automatically transmitting physiological measurements to the platform via mobile devices is, thus, very important for the patient's safety and well-being.
8. Portability of the platform. Services running on the platform will be portable as much as possible, and this imposes several requirements on the home network.

Figure 1 gives an overview on how the Health@Home service will work.

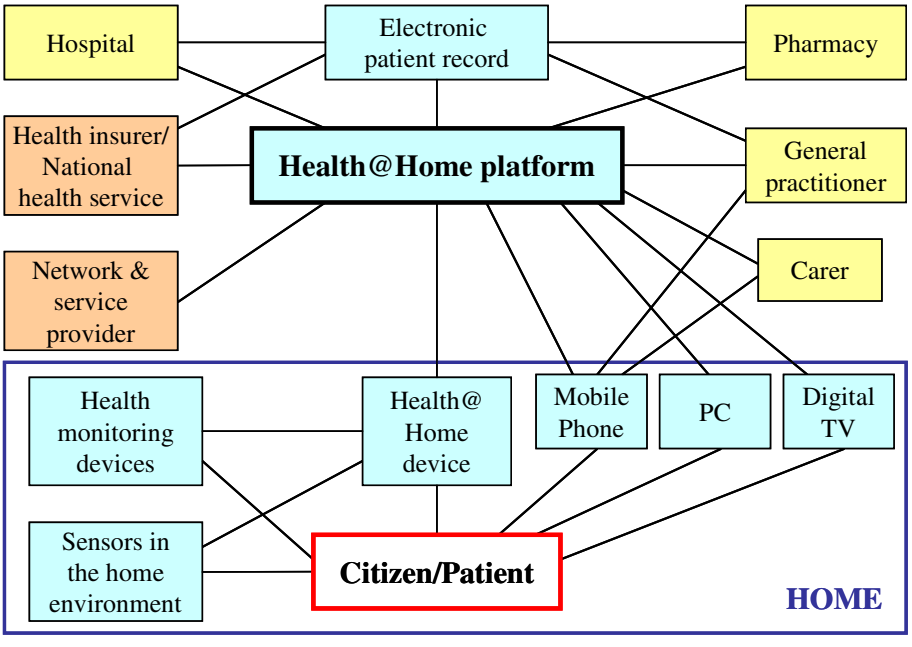

Fig. 1. The Health@Home service model

At the centre is the citizen/patient in his home, who – depending on his health status – can use a variety of monitoring devices and sensors in his home environment to collect and analyse his personal health information. All the data will be wirelessly sent to a Health@Home device that has an easy-to-use multimodal interface. The device is connected via a wide area network (WAN) and a home gateway to the Health@Home platform, a remote data server. It will be important to integrate platform operation and maintenance with the set-up of the home network, in order to achieve a maximum synergy and cost-effectiveness in the Health@Home business model. Network service providers are in a key position to embrace this challenge, due to their technological expertise and the established access to the citizens' homes. The service offering could be financed by the national healthcare authority or a health insurance company, depending on the healthcare system in the respective country.

The platform accesses the electronic health record of the patient, which is stored on a protected server under the auspices of the national healthcare authorities. The platform would both match the patient's monitoring data with the data in the patient record and also provide the monitoring data to the general practitioner or doctors at the hospital, who would, in turn, be able to update the electronic patient record, if required. Other actors in this model would be the pharmacy, which would be involved via e-prescription and which could also offer a service for automatically delivering required drugs to the home, if the patient cannot go to the pharmacy himself. Finally, in a homecare scenario there is the carer, either a nurse or a relative, who would also have access to the platform and could check the monitoring data, e.g., would receive an alert, if a sensor indicates that the patient is in a critical condition.

Automated alerts, e.g. medication reminders, could be triggered by the platform, based on the data provided by the doctors treating the patient. For citizens who just need the platform for prevention, no health professionals would have to be in the loop. He or she could just send vital data, e.g. blood pressure, heart rate or weight, to the platform, which would send back an automated analysis of these data, combined with specific health advice.

In the ambient-intelligent environment of Health@Home, sensors play an important role for monitoring the patient's vital functions and general well-being, as figure 2 illustrates [5]:

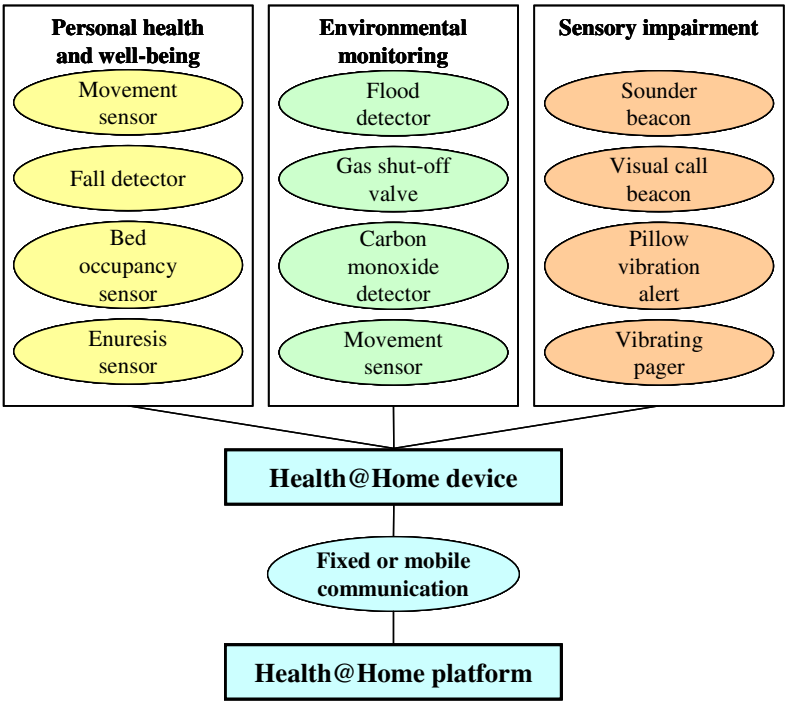

Fig. 2. Sensors in the Health@Home services model

4 Feasibility and Mid-Term Implementation Prospects

The Health@Home model's feasibility depends on many factors, like technology, standardisation, interoperability as well as privacy, security, and user acceptance.

Integration of technologies and devices
The integration of heterogeneous technologies and multiple devices in the home is currently being driven by a number of home networking projects that promise to provide high-speed data access anywhere via any device in the home [6]. Additionally, the Continua Health Alliance is currently working on developing and promoting open standards and guidelines that enable interoperability of health monitoring devices from different suppliers [7]. This type of integration is one of the pre-conditions for making the Health@Home model feasible.

Standardisation
Standardisation in the field of e-health is not yet mature. There are a number of relevant standards, like, for example, HL7 – Health Level Seven on clinical and administrative data and ISO 27799 on security management in health. However, the choice and implementation of these standards are not yet unified, and for electronic patient records, no widely agreed standard has emerged yet.

In February 2008, the three European standards organisations CEN, CENELEC, and ETSI announced the launch of the joint project "e-health-INTEROP", which addresses the requirements of the European Commission mandate on standardisation in the field of e-health. This mandate (M/403) aims to provide a consistent set of standards to address the needs of future healthcare provisioning.

Interoperability
A crucial factor for the feasibility of the Health@Home model is interoperability. The effectiveness of the model largely depends on standardised, interoperable electronic health records (EHRs), which are not yet in place in almost any European country.

In a Recommendation issued on 2 July 2008, the European Commission has made the cross-border interoperability of electronic health record systems a priority, with the target of achieving EU-wide interoperability by the end of 2015 [8].

The goal of interoperability is the smooth flow of information, which is also an important requirement for the Health@Home model.

Mobility
In order to provide seamless service continuation, when the patient is on the move, it is important to integrate mobile capabilities into the Health@Home platform. Especially patients with chronic diseases need permanent monitoring of vital functions, while they are out of their home. The monitoring data should be collected and processed via the Health@Home platform, in order to trigger certain actions, e.g. medication reminders or doctor alerts, if critical values are reached.

Privacy, security and data protection
The smooth flow of information entails critical challenges for privacy and data protection. Personal health data are very sensitive and critical for user acceptance, and the protection of these data has to be guaranteed, if the Health@Home model shall succeed. It will be crucial for the feasibility of the Health@Home model to develop

privacy-enabling technologies which provide differentiated access controls that are easy to handle and transparent to the user.

Scalability and reliability
From the start the platform must be designed for a large number of users. A platform that will serve millions of people will have to adhere to high standards concerning scalability and reliability. As the services running via the platform are critical, high levels of quality of service under any conditions must to be ensured.

Barriers for deployment
We believe that the technical challenges discussed above can be overcome in the mid-term. However, there are other non-technical barriers which could have a severe impact on the large-scale take-up of the Health@Home service model.

The three most relevant areas in which existing barriers need to be addressed are regulation, finance, and user acceptance.

Health regulation in most EU countries is not yet ready for an innovative e-health model like the Health@Home service. This is particularly relevant for the roles of hospitals and general practitioners, which would change significantly in the Health@Home model compared to the current situation. What is the legal basis for doctors performing tele-monitoring and tele-consulting via an e-health platform? How would doctors be remunerated for this? What are their liabilities if something goes wrong? These are some of the open questions that need to be addressed in the necessary revisions of European and national regulations on e-health.

The other barrier is finance. In the mid- to long-term, the Health@Home service model would lead to significant cost savings, due to better prevention and less time spent by healthcare professionals for in-patient treatment, while maintaining and increasing the healthcare quality. However, considerable investments would have to be made that would not lead to cost savings in the short term.

Finally, user acceptance could be a critical barrier. There is a general reluctance of doctors, because any e-health models, including remote monitoring, are not clearly regulated, so besides unclear remuneration there would be legal risks. In addition, there is widespread resistance of healthcare professionals to change – they envisage additional effort, but no clear benefits for themselves.

According to a poll by British newspaper “The Guardian” done in November 2007, almost 60 percent of general practitioners in the UK are unwilling to upload their patient data to a proposed national database. They fear that "sensitive personal data could be stolen by hackers and blackmailers" [9]. According to research commissioned by the UK Medical Research Council, the general public shares this feeling [10].

The main reasons for the widespread reluctance by patients towards e-health are that they feel overwhelmed by technology or they fear their private health data are exposed to abuse.

Implementation issues
There are a number of further issues that need to be addressed before the implementation of the Health@Home service model. These issues include questions like: Who will be the responsible for the maintenance and operation of the service platform? How will charging and billing be handled? How will the legal and contractual relations between healthcare and social welfare authorities as well as the platform service provider be organised?

Solving these issues requires the shared vision and political will to establish a Health@Home service on national level with the perspective of integrating the national platforms on a European level.

5 Conclusions

The Health@Home service model provides a promising opportunity for integrating prevention and healthcare in the home environment. The model goes far beyond current models that are too limited in scope and accessibility in order to serve a broad range of patients and to serve patients with multiple chronic diseases that are today not necessarily served via the same e-health platform.

Implementing the Health@Home service model will be challenging, as a number of technical and organisational issues would have to be solved in order to make it happen. However, the growing cost pressure and the growing demand by patients, especially elderly patients, is expected to accelerate the organisational changes that are required to realise a patient-empowering Health@Home service.

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