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Future Healthcare Services over Telecom

LUKAS HOHL UND EDWIN WIEDMER **Healthcare services over telecom are an interesting market opportunity not yet developed. For example, it can be expected that many patients with chronic diseases will be cared for safely, even when they are mobile or staying at home. In general, many healthcare services will not only be provided at the hospital or by the physician, but at any place a client may stay.**

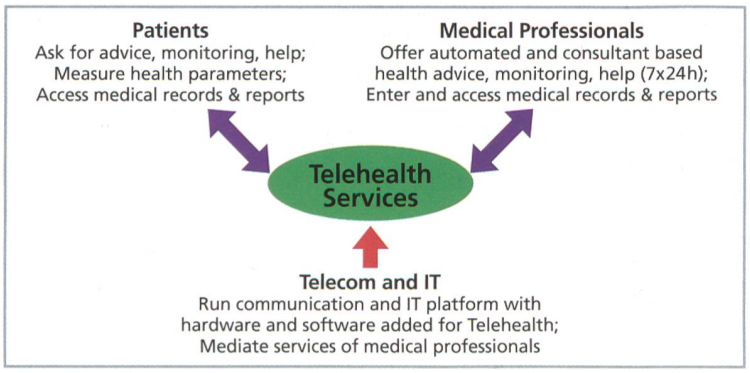
This article describes remote healthcare services, the roles of medical professionals, patients, and telecom and IT service providers, as well as technologies enabling these services.

New Roles for Patients and Medical Professionals

Healthcare over telecom (telehealth) has been limited in the past to special circumstances, such as countries covering big geographical distances. However, with communication and information services becoming available everywhere and for everyone, new trends in medical care are emerging. Patients do not only make medical appointments or urgency calls by phone, they also ask for medical advice or medication prescriptions. Not only billing information is stored electronically and exchanged over the Net, but also lab reports, specialist reports, urgency data and eventually patient records with detailed notes, pictures, measurements, etc. Medical measurements will be taken increasingly by patients themselves, independent of traditional points of care. This will give more freedom to patients to be mobile or to stay at home and still be cared for.

For services offered over the Net, medical professionals will set up and run 7 x 24 h services. This will enable health monitoring and organisation of medical help at any time. Patients can be reached anywhere on the move or at their family homes. Video calls and remote home control will make it possible for home care nurses, relatives and others to remotely provide assistance for patients and elderly people.

Fig. 1. New roles for patients and medical professionals in telehealth.



Managed Care and Remote Monitoring reduce Health Risks

Especially in the US, an important trend is managed care and regular monitoring of patients conditions. Several studies show that regular control with appropriate measures in case of diabetes, hypertension or other chronic diseases significantly reduces the risk of serious medical incidences and the need to stay at a hospital. Currently, different types of networked medical devices and analysis software are being developed for this purpose. In the future, it will be easier for medical professionals and patients to realise managed care. This implies that managed care will not only be applied for the most expensive patients, but also in lower risk cases and for prophylactic reasons. This potential market segment would cover approximately 20% of the population. However, care standards and processes as well as reimbursement must be defined in order to develop this market.

Role of Telecom and IT Providers

Telecom operators and providers of IT services will have to prepare platforms for telehealth services. They will connect, run and manage devices, workplaces, servers and software. In order to integrate different systems and services and to support joint care processes and technologies, it will be important for the different players to cooperate. Before rollout, it will be necessary to verify care processes and technologies in demonstrators and field trials. First tests will focus on technical feasibility and acceptance by the different players. Later it should also be verified that it is easy for patients to connect devices and to subscribe to corresponding services. Furthermore, it should not require too much effort for medical organisations and professionals to get servers, data, software and devices installed and supported.

Telehealth becomes Mobile Health

Today, telehealth systems are mostly installed in the patient's home in the US and typically use analogue telephone lines.

Mobile healthcare is a newer segment of telehealth where medical services are provided to mobile patients and wireless networks are used for communication. This enables telemedicine everywhere and allows travel for patients who would otherwise have to stay at home. Currently existing telehealth applications will certainly have a mobile successor in the future.

How to build a Mobile Health Application?

Mobile healthcare has various conceptual aspects (Fig. 2), some of which are shared with telehealth in general:

Medical Measurements Entrance: This is usually done via mobile sensors (or by typing them in) for patient monitoring. Medical sensors with Bluetooth connectivity are appearing on the market and can transmit data onto a mobile phone which acts as the gateway for accessing a database on a server. Alternatively, PDAs (Personal Digital Assistants), laptops and specially built devices may act as mobile gateways. Furthermore, there are also devices which combine gateway and sensor, for example mobile phones with built-in ECG functionality have already been in existence for several years.

Mobile Medical Data Processing: Recording and storing measurements are only the first steps of data processing done on mobile devices. The challenge is processing and classifying signals and managing data collections on mobile devices which have relatively poor performance and limited storage.

Wireless Transportation: Both short and long range wireless transportation is needed in mobile healthcare. Bluetooth, ZigBee or DECT (Digital Enhanced Cordless Telecommunications) are valid options for short range transportation between the medical sensors and the mobile gateway. Between the mobile gateway and the service provider, GSM, GPRS/EDGE, UMTS and Public Wireless LAN are currently available.

Healthcare Service Centre: The core of any telehealth solution is a service centre, both technical and medical, which further processes the medical data, takes care of patients and connects medical professionals via mobile and other gateways.

Central Data Hosting: This is where traditional eHealth (electronic healthcare) issues such as electronic medical records and patient cards and the corresponding security infrastructure for transmission are situated. Telehealth services will work with such central data hosts.

Implementation of a Mobile Health Prototype

The mobile phone is expected to become the personal access device for remote health data and services, but currently there are very few mobile health applications running on mobile phones (often in a very early state of development). Therefore Swisscom Innovations has developed a mobile phone-based application to actively demonstrate the concept of mobile healthcare using currently available technology and a prototype from collaborating with CSEM (Centre Suisse d'Electronique et de Microtechnique SA). The application was intended to be multipurpose and to have a generic design which is reusable in various scenarios and setups. This resulted in probably the first completely Java-based mobile health application including Bluetooth devices.

In our mobile health prototype (Fig. 3), a mobile phone

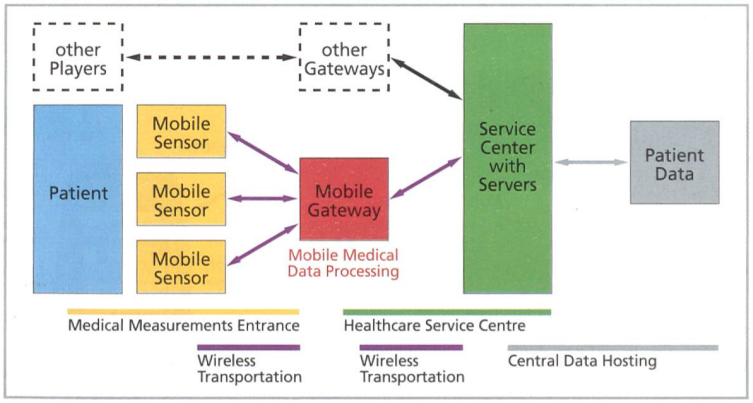


Fig. 2. Concept of mobile health applications.

hosts a client application and acts as the gateway for health-related devices at the customer site. Further, there is a server application for data storage and Web access. The client and the server communicate via GPRS and the server is able to send notification messages to any mobile phone. The prototype is relatively simple but still forms a complete system and demonstrates different use cases and technologies. Multiple means of communication are included, for example Bluetooth communication between a mobile phone and medical devices, HTTP communication between a mobile phone, server and Web browser, and SMS messages sent by a server to other handsets.

The client application in the demonstration setup is a MIDlet, a Java Micro Edition (J2ME, the Java edition for mobile devices) application. Despite current limitations, J2ME is a very popular platform. With the definition of additional application programming interfaces (APIs), the number of I/O interfaces (especially important for the integration of medical devices, e. g. via Bluetooth) and other features in J2ME is constantly growing.

The client MIDlet consists of several modules supporting different types of measurements. Pictures are manually taken with the phone camera and stored by the user with various functions for visualisation and synchronisation with the server. Answers to questionnaires are interactively entered on the phone and when finished automatically sent to the server. Changes of GPS location and events at the medication dispenser from CSEM are automatically detected with the corresponding Bluetooth devices and sent to the server. Heart rate and oxygen level measured by the Bluetooth pulse oximeter are even tracked and transmitted continuously.

The server software has a Web interface for each type of measurement (e. g. displayable on a PC or in a mobile browser), allowing a physician to view the history of measurements sent to the server. The physician can also observe the evolution of continuously monitored medical values and set certain alarm rules. SMS notifications can be automatically sent to the physician's mobile phone according to these settings.

What comes next?

Mobile gateways are essential for patient access to mobile health services. Mobile phones are currently limited (screen size, input capabilities, processing power, memory, persist-

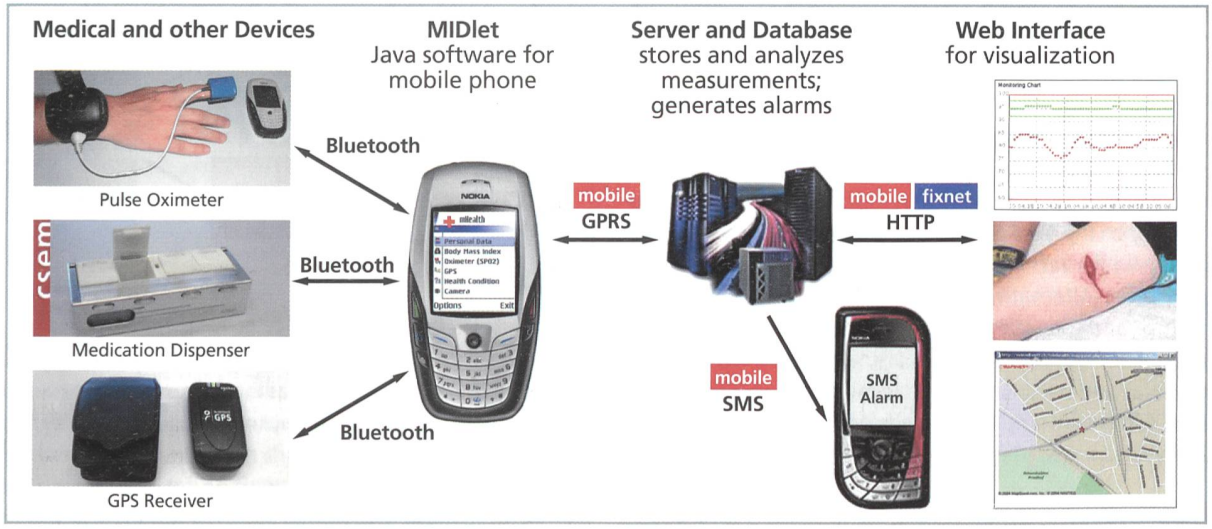


Fig. 3. Mobile health prototype. The mobile phone is used as normally for calls and messages, and, additionally, for connecting medical devices and for running the user interface for health services. The oximeter measures blood oxygen level and heart rate. The medication dispenser (courtesy of CSEM) controls taking of medicaments. The GPS receiver determines the geographic location. Measurements are forwarded via the mobile phone to a server and can be viewed by medical professionals in a Web Interface on a PC or mobile phone. Rules for sending automatic alarms via SMS can be defined.

ent storage, battery life) and other devices or even specially built gateways might be preferable for usability, performance or reliability reasons. Nevertheless, mobile phones and the corresponding development platforms have a continuously growing set of features and it can be expected that they will soon be able to securely and efficiently deal with all telehealth tasks, for example signal processing in the personalised context, diagnosis based on the history of recorded personal medical data, well-designed user interfaces to communicate a diagnosis unambiguously and to make services accessible even in emergency situations.

The evolution of mobile healthcare will probably tend toward "ubiquitous healthcare". Medical sensors need to be close to the body, but unobtrusive (non-invasive sensors are of special interest). A key for this is the further miniaturisation of medical sensors and their integration into everyday utensils: For instance the evolution of pulse oximeters from finger clips to ear clips will probably lead to the integration into jewellery. Other sensors might be included into clothes; ECG shirts are commonly cited examples. In some cases, it may even be feasible to embed devices into the body itself using implants.

Different types of highly reliable network technologies are needed to ensure optimal connectivity between all points of personalised care and to ensure that vital data, images and other medical information are properly stored on servers and are easily accessible. Thus electronic medical records are another key aspect for the introduction of general telemedical solutions. Intelligent server applications analyse the data on behalf of physicians and other healthcare players. The latter are reached by various means of communication.

Conclusion

Telehealth will blur the boundaries in healthcare today. Healthcare services will not only be provided at the hospital or by the physician but at any place a client may stay. Care will not be limited to episodic treatments but include a lifetime health coaching.

Extending healthcare from hospitals and clinics into the home and eventually to all places at all times requires an ambitious integration effort from numerous players. No partner is capable of tackling all of the complex challenges involved. The eHealth sector is still plagued by different motivations, lack of standards and regulations, lack of interoperability of existing systems, privacy issues and fear of loss or stealing of sensitive patient information.

Depending on the application scenarios, needs of users and remote care providers vary strongly. However, there are also common elements like fix and mobile access to net-based health services, sending of alarms to care callcentres, storage of patient data, monitoring via remote medical instruments and hosting and billing of care services. Swisscom could take a central integration role and extend its communication and IT platform with seamless connectivity and data services for patients, professionals, medical devices and infrastructure. ■

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