

# M-Health: Use of Mobile Devices in Telemedicine

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**Abstract:** This paper presents an overview of the healthcare system which needs to be permanently adapted to the newest technologies in order to assure the quality and performance improvements of the medical services. The mobile environment adaption in telemedicine has developed a new domain named m-Health. In the end of the paper I'll briefly introduce my proposed pilot development of a mobile health application. My ongoing research has been focused upon conceiving a way to increase the efficiency and quality of the medical care system from the physician's point of view.

**Key-Words:** m-Health, mobile devices, healthcare, telemedicine, architecture, quality, performance

## 1. Introduction

The medical care system confronts with a wide range of challenges, seeking to making difficult diagnosis, avoiding errors, ensuring highest quality of the provided services, maximizing efficacy and reducing costs. Information and mobile technologies have the potential to reduce clinical errors and also to optimize the clinical processes and workflows.

Mobile health technologies (also known as m-Health) represents a key enabler that can improve the quality of care by enhancing operational effectiveness, delivering collaboration care for prevention and wellness and also achieving improved outcomes.

M-Health [3] means the entire medical situation in which the mobile technologies resources are being significantly used for:

- collecting and analyzing medical data;
- providing useful information to physicians, researchers, patients or other employees from the medical sector;
- real-time consulting and monitoring;
- patients diagnosis (name, values and interpretations of the various analyzed performed).

The healthcare system it's one of the most important domains for improving a country prosperity [6] and economy. Medical informatics has an important role in obtaining resources, their

maintenance insurance, storage, retrieval and use of information in the clinical workflow.

Therefore, the main purpose of information system integration in health care is to provide benefits to the two main actors: patients and doctors. Some of these benefits include the following:

- management appointment (add, modify or cancel appointments);
- unbundled and easy access to patient history in real-time;
- use of expert systems that can lead to making a medical diagnosis etc.

This kind of integration is needed due to the fact that the mobile services market faces different issues related to lack of funds, overcrowding and low quality among managed services and treatments. Using a specific mobile application can streamline activities in a manner that allows a better overview which leads to a better control over the needed resources. By controlling costs and resources an integrated flow automation solution is ensured. This can provide accurate information exchange and improves medical institution profitability.

Thus implementing a mechanism for reducing physical flows for document management [4] within a medical institution and promotion of electronic documents, leads to cost control by reducing them (it eliminates the cost of papers, film, use of space and other physical devices).

Integrating mobile technologies aimed at streamlining medical processes, leading to reduce patients waiting time in terms of consultation and/or its medical diagnosis is reflected ultimately in a decentralization of health services. Reducing document flows has a significant impact on physician competence, they can get real-time information, regarding patient's history or they can pass medical observations really quickly to a specialized center for their management.

Also, other premises of developing m-health consists in the existence of isolated geographic areas and / or exposed to natural disasters (floods, earthquakes, etc.), situation which involves the need of rapid medical interventions, provided in most cases, remote and, on the other hand in the existence of a health care system with large gaps in the territory, manifested as gaps in enrollment and medical personnel in terms of technologies.

Therefore, innovation [1] in the healthcare field by using mobile technologies is needed for the following reasons:

- to transform business and clinical processes to optimize workflow;
- to control and minimize medical costs;
- ensure quality and providing time access to care;
- encourage the use of mobile applications that enables greater productivity and collaboration;
- maintenance security and data protection;
- help patients live healthier lives with fewer hospitals and clinical visits;
- can trigger new business models and opportunities to enhance quality of care like. diagnosis or patients management solution for vital signs irregularities etc.

Regarding the categories of features implemented in this area of m-Health, I can group them in the following categories of applications:

- Information - applications for public awareness campaigns on health
- Services for alerting patients - applications that aim to inform patients at regular intervals on the actions needed during their treatment.
- Ask away - allow communication between patients and doctors specialists when they are not in the same location
- Remote monitoring - program that allows keeping the medical history of patients and follow their progress
- Medical diagnostics - tools for physicians and patients that aim to facilitate the process of establishing a preliminary diagnosis
- Emergency services - provides the ability to call on medical services and ambulance or other specialized organizations.
- Helpline - service that can be called for documentation about medicines, equipment and other medical information.

## 2. Mobile devices: statistics, benefits and constraints

Over the recent years, mobile devices usage has been growing steadily. In our times, many of them have large touch screens, nice user interfaces and are highly optimized for web resources. The Forrester Research [7] report from February 2012 has shown that by 2020, 10 billion connected devices are expected to be in use and by 2016 over 350 million will use smart phones at work. Moreover, in January 2012 in a report from comScore [5] data it has been announced that the number of people using their mobile phones to access health-related information has grown by 125% in 2011. Also, in the figure 1, it can be noticed the evolution of the percentage number of people that are using their mobile devices in order to access health context from web.

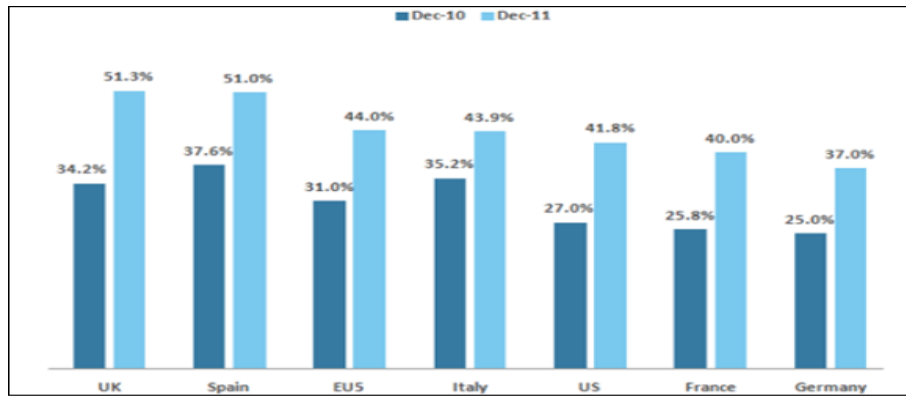


Figure 1. Use of mobile devices for accessing health context

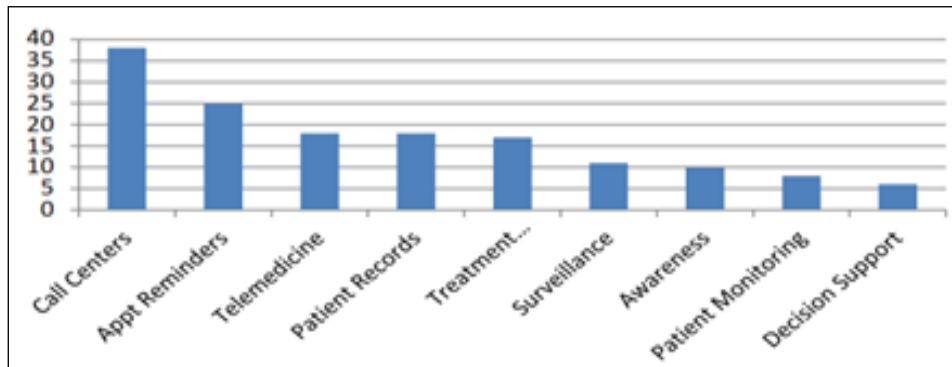


Figure 2. Adoption of m-Health Initiatives

These statistics [2] are showing that healthcare is one of the fastest growing categories that could be invoked in support of mobile Health like:

- flexibility: in this way, m-Health resources can be accessed from any environments (rural or urban), anytime. This is offered by the portability characteristics of the mobile devices;
- accessibility: the devices are accessible from any environment and provides access to many Health resources;
- portability: it refers to the adaptability and coexistence of all the common resources of the mobile devices with the application installed;
- reduce of time: based on the fact that technology expends time and compresses the space, there is no need for doctors and patients to be on the same place in the same time, they could just communicate in real-time through the mobile device applications.

A survey of 114 nations undertaken by the World Health Organization found

that m-Health initiatives have been established in many countries [8] but there is a variation in adoption levels as illustrated in image in figure 2.

The next common activity was the creation of health care centers which respond to patients inquiries. Next are the initiatives that are using SMS for appointment reminders, telemedicine, accessing patient’s records, monitoring patients etc.

All of these are affected by the technologies constraints of the mobile devices:

- limited computational power which is required by multimedia applications;
- low data input speed;
- small display which allows only small pieces of data to be displayed;
- limited memory in terms of RAM, video and storage;
- limited battery life that ranges from 1 to 3 days;
- reduced dimensions and bandwidth
- limited user interface.

The above constraints are influencing the way of designing, implementing and testing mobile Health Application and

these limitations lead to less functionality than the desktop devices. On the other hand, over the recent years it has been noticed a perpetual increase of the memory capacity, processing power and also of the displays size and resolution as new devices were developed.

Among the technological premises that favored the development of telemedicine by integrating mobile devices are the following:

- High and growing proportion of mobile users in total global population
- Continued technological development of mobile devices: In this regard, it is noted improvements in terms of increased computing power of mobile devices such as PDA and the frequency of their processors, facilitating the development and use of multimedia medical applications. Develop iPad or tablet type devices characterized by larger screen sizes, facilitated the development of intuitive graphical interfaces. This allows easy use and rapid medical applications through these devices by medical staff, which generally has limited knowledge of the technology. Also contributing to this advantage the development and improvement of mobile devices based on touch-screen technology.
- Increasing the speed of data transfer that facilitates the development of telemedicine and real-time diagnosis of remote
- Decrease in prices of services offered by mobile operators
- Increased costs associated with healthcare while decreasing the time spent by the patient's physician

Another significant advantage of telemedicine solutions lies in efficient working time [8]. This advantage is obtained by:

- Optimization of management appointments and eliminate downtime during the day, the efficient allocation of medical staff (you can monitor and capitalize on

the employees as confirmed appointments by phone, SMS or web resources).

- Reducing the time taken for the transmission of medical investigations as integrated technologies can capture and automatically transmits via the Internet, in various formats such information directly to qualified medical personnel for their analysis and interpretation.
- Reducing the time and human errors in the registration process of patients arriving at the emergency room. Through telemedicine solutions can achieve the patient's electronic record that is to go to the emergency room for rapid intervention. This approach requires pre-registration forms via the internet, eliminating the physical document flow [4].

Another direct benefit is passed on to doctors performing field work, facilitating access to patient information by eliminating the physical transfer of files would be their medical records, and the possibility of further patients in the system. Specific application can be used in both urban and rural, with specialized information directly on your mobile phone or similar device, no need for consultation of specialized documents, connect to a network or the internet to provide important data for the medical diagnosis.

Also in this regard, it is noted advantages and the doctors working in the ambulance service, their making it a useful application to obtain medical records that you move, on which can determine the treatment necessary to provide first help. In this sense it can be seen on patient safety if he is allergic to different medication or suffer from a particular medical condition that would have caused the symptoms for which it treats. Moreover, following the diagnosis of the patient in question, the doctor may send you to the hospital by ambulance bound information to set up the preliminary diagnosis, and may announce such, if appropriate; a specialist will prepare you to take over

the patient or to make a video for a medical intervention.

### 3. The main features of the mAppHealth solution

A description of the proposed application functionalities it's illustrated in figure 3, which described the general use-case diagram with the main modules of the pilot solution.

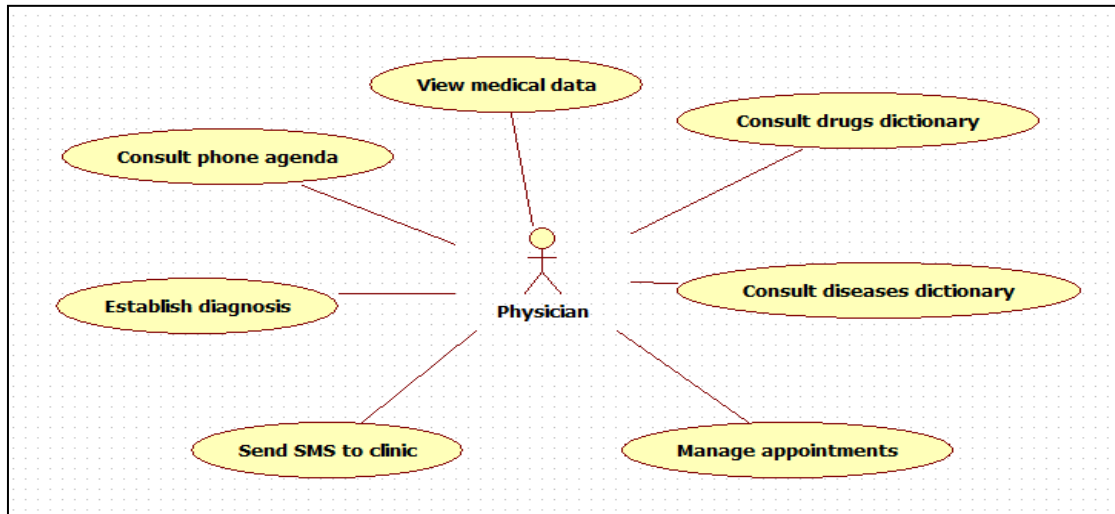


Figure 3. Use-case model of mAppsHealth

The application is designed for physicians performing field work, facilitating access to patient's medical record on real-time and fast, eliminating therefore the physical files with the specific data. It can be used in both urban and rural environments by connecting to internet network and access the needful data for the medical diagnosis process. On the other hand, it can be used by a doctor working in the ambulance service and the application can be useful for obtaining medical records that could help him to determine the necessary treatment for the first aid. In this case, it can be seen if the patient it's allergic to different medications or suffering from a certain condition that could have caused the symptoms for which is being treated. Moreover, following the diagnosis of the patient in question, the doctor may send from the ambulance to the hospital the preliminary diagnosis and may announce which specialist must prepare to take the case over.

To access the main feature of the application, the physician needs to authenticate by providing a username and password:

- *Patient* - the physicians are able to access a patient's medical record if it already exists in the system, otherwise he can register a new one. All relevant information provided are represented by the following: vaccines made (name, data on which it was made and the diseases for which it was done), pathology history, admissions history, medical investigation (values and interpretations of the various analyzed performed);
- *Diseases* - this option can be used by the physicians when they needs to find additional information regarding a certain disease characteristics;
- *Drugs* - this module provides access to different characteristics of a certain drug like: use (categories of persons to which it can be administered, their characteristics and the diseases for which it's recommended), administration (modality, dose and frequency) and side effects (may occur in different circumstances depending on the medical history of persons to whom it is given);
- *Diagnosis* - this module provides the ability to store the patient diagnosis

- (designation, description and indications);
- *Agenda* - another feature consists in access to phone contacts from various medical departments within the clinic where the doctor works. This reduces the effort of searching in the phonebook contact which can contain several hundreds of contacts;
  - *Consulting* - this helps physicians with the consultation management (establish a new appointment, view the scheduled for a specific date etc);
  - *Assistance in the diagnosis process* - this establishes a proper diagnosis based on the criteria entered by the application user and is determined based on some artificial intelligence algorithm.

Figure 4 illustrates the application integration scenario which is the proposed prototype solution of this research, with other external devices.

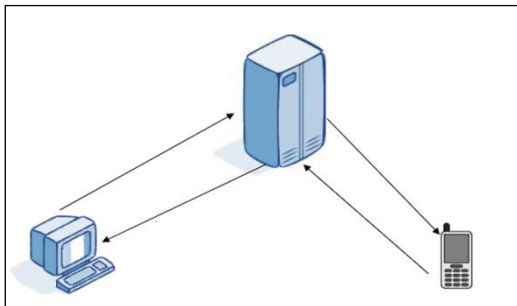


Figure 4. mAppsHealth Architecture

The application connects to a web service via a distributed database, the existence of a central server that provides communication with one or more workstations. Therefore, the existence of an internet connection, a wireless adapter and the existence of an Internet browser that allows browsing are some requirements to be met in terms of hardware and software to ensure the proper functioning of the application on mobile device which is intended to be used. Regarding the software resource requirements, the application can be installed and used on a mobile device that has a Java virtual machine (JVM). This is because the application is made based on J2ME

platform (Mobile Edition) that defines configurations, profiles and optional packages.

From this point of view, the necessary hardware involves the following items:

- Configurations, represented by sets of core Java libraries for different mobile devices
- Profiles, represented by specific libraries for the user interface, network, respectively, for data storage
- Packages that are extensions of profiles with different specific functions.

Therefore, the application can run on two main types of mobile devices, as follows:

- Powerful mobile devices (PDAs or network devices), which is characterized by the existence of a configuration called CDC (Connected Device Configuration);
- Resource constrained devices (mobile phones, PDAs or pagers some), it is characterized by the existence of known configurations CLDC (Connected Limited Device Configuration).

Therefore, with the functionalities described above, the application allows accessing health-related information in real time and quickly remove specific medical process flow documents, setting future reference, real time updating of patient records by entering information on the diagnosis established. All these aspects have a significant positive impact on streamlining and improving workflow specific medical diagnostic process from the perspective of a physician.

## 4. Conclusions

I personally believe that on the basis of our current society it is important to develop new application and to integrate more mobile technologies in health care domain. This is one of the fundamental part of solutions of the economy issues and it could represents the key for optimizing clinical workflows, controlling

medical costs, ensure quality and providing time access to care for everyone, encourage the use of mobile application that enables greater productivity and collaboration and also to enhance quality of care like diagnosis or patients managements solution for vital signs irregularities.

Parts of this research have been published in the Proceedings of the 12th International Conference on Informatics in Economy, IE 2013.

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