Mobile Health Applications Future Trends and Challenges

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Abstract. Digital technologies are now a big part of the healthcare industry. With the rapid evolution of information and telecommunication technologies, mobile phones offers amazing opportunities to improve healthcare system, in the way that physicians, patients and other health system actors are more interconnected than it is in the traditional healthcare system. The goal of this study is to present the current and future trends in the field of mobile health (mhealth) and also to present the challenges in the use of mhealth apps.

Keywords: mhealth · Mobile health future trends · mhealth opportunities

1 Introduction

Mobile health can be defined as *a medical and public health practice supported by mobile devices, such as mobile phones, patient monitors, personal digital assistants, and other wireless devices.* Digital technologies has become an integral part of the health sector. With the rapid evolution of information and telecommunication technologies, mobile phone offers tremendous opportunities to improve the healthcare system. In [1] they estimate that 500 million patients would use a mobile health apps to help them manage their disease now. These apps are used as tools for personal electronic records, disease management, clinical alerts and reminders [2]. Our work consisted on the realization of a state of art on the theme: *Mobile Health Applications future trends and challenges* and its aim was to determine future trends and challenges in the field of mobile health applications. For this, we first present the current state of these applications that are oriented towards the monitoring of patients suffering of chronical diseases. Then we present, in a short term line future those technologies and application in use, trends, their impact on health systems, and how much they improve patient's lives. Finally, we present the challenges facing mobile solutions such as usability, privacy, security, authentication, as well as those related to the processing of

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large data generated by this plethora of applications commonly called Big Data. All these elements mentioned above were the subject of our study. This paper is organized as follow: Section 2 presents the current state of mobile health; Sect. 3 the future trends of mobile health apps; Sect. 4 the challenges and the last section concludes our paper.

2 Current State of Mobile Health Applications

In this section we describe the current state of mobile health applications. We present the use of smartphones in the field of health and how people can use them to manage their disease. According to the World Health Organisation Chronic diseases are long-term conditions that generally progress slowly. Responsible for 63% of deaths, chronic diseases (heart disease, stroke, cancer, chronic respiratory diseases, diabetes ...) are the leading cause of death in the world. Of the 36 million people who died of chronic disease in 2008, 29% were under 60 and half were women [3]. According to [4] the mobile health is define as *medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices*. There is an estimated 500 million patients who potentially use mHealth applications to support chronic health and self-care [1]. They have their advantages such their simplicity, and their low cost; they also provide an immensely user-friendly service and are have a potential to enhance the speed and accuracy of healthcare delivery.

Medication adherence and compliance can be defined as the *act of (the patient) conforming to the recommendations made by the provider with respect to timing, dosage, and frequency of medication taking*. To improve medication adherence the following strategies are used: reminder strategy, educational strategy and behavioral strategy [5]. Varkey et al. [6] found that medication adherence apps are available to patients having smartphones however, most of the current medication adherence apps do not track the important health parameters for diabetes management, according to the DSMES guidelines such as FBS, HbA1c, weight loss, exercise, carb intake, stress management and BMI.

Nowadays there are many kind of mobiles health applications which are used as tools for remote data collection, to access patients records, to access health information databases, for census taking, and for electronic health records creation and storage. We can find theses type of applications in the Google/Apple market. Health informatics emerged as a separate discipline which lead the improving of accuracy, timeless and reliability of decision making in the healthcare field by the involvement of computers and communication technologies used to acquire, store, analyse, communicate, display medical and health information [7]. In the case of hearth failure self care the features of mobile applications vary widely from the medication management, weight and symptom assessment, mobile messaging on hearth failure self-management and hearth failure education. All these features might help patients to improve their skills on health failure self-care management system. The Internet of Things (IoT) is a concept reflecting a connected a set of people, anytime, anyplace, any service and any

network and its gaining more and more importance in the field of health care domain. The wearable sensors are ideal for monitoring a patient's health without the interruption of his daily activities [6]. There are many mobile health applications architecture which integrate the use of wearable device such as smart watch, smart clothes, etc.

In Fig. 1 Deshkar et al. [8] present a new Internet of Thing (IoT)-based platform to support self-management of diabetes.

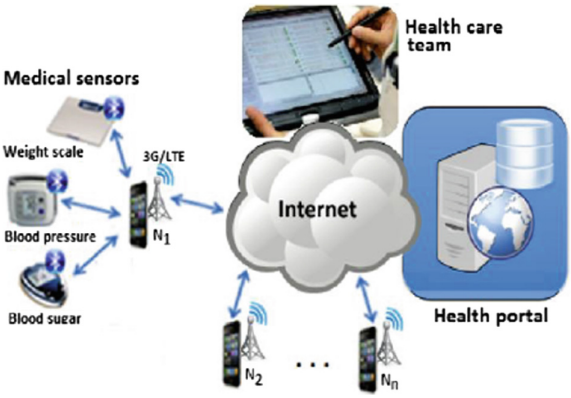

Fig. 1. Architecture of the smart phone based e-Health system [8]

Kitsiou et al. [9] present Icardia in Fig. 2 an innovative platform designed to support remote monitoring and health coaching of cardiac rehabilitation patients.

In their architecture they used a fitbit wearable sensor devices, a smartphone equiped with android, iOS, windows OS and cloud services; they tried to add SMS based features and tried also to subscribe to the fitbit cloud-based server API to get data from patient and integrate them in their web-based application. Another study shows that looking down to the phone is equivalent to placing a 60 pound weight on one's neck. The continue use of the computers and smartphones without a survey to maintain straight posture causes many backs diseases such as low back pain, kyphosis and pain in the neck because the tilt the head down to check Facebook or write a message on your smartphone leads to a stress of the spine [10]. To avoid these complications there are several posture monitoring systems. There is some posture monitoring systems based on the weight information, based on the tilt angle information or on the spine curvature information which use many sensing technologies that are able to provide this information to posture monitoring system in order to elaborate decision about the person posture.

To summerize, there are many mobile health applications which can help patient to improve their life style and their wellness or can help doctor to better provide healthcare even if the patient is not near from him. Given the role

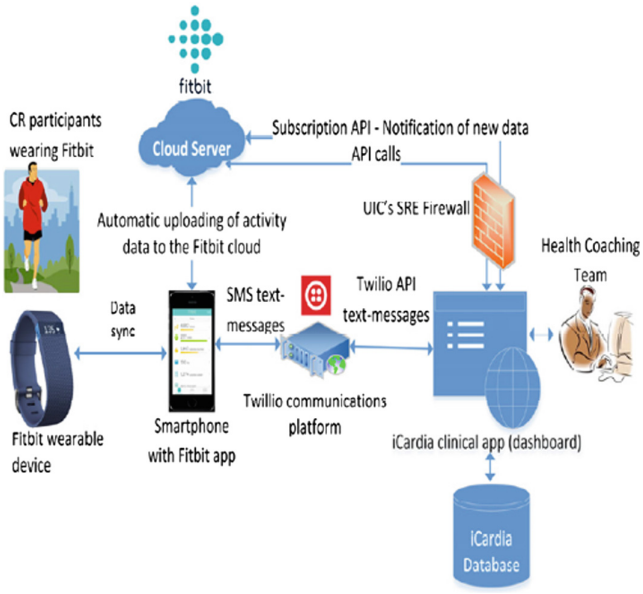

Fig. 2. iCardia platform components and architecture [9]

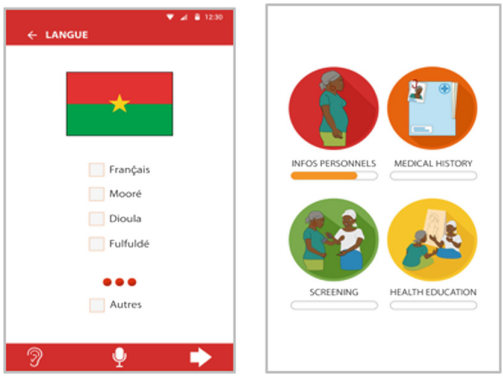

Fig. 3. PANDA *Pregnancy and Newborn Diagnostic Assessment* [11]

of mobile health applications in improving health status of patients and the support they could provide to health systems in developing countries, or other development countries like Burkina Faso have taken initiatives to appropriate these technologies. As example they use PANDA, as showed in Fig. 3, that is a system enabling doctors, midwives and community health workers to work together across traditional boundaries to provide antenatal care to vulnerable populations and to help prevent maternal and newborn mortality [11].

During breast cancer screening campaign, they trained all women who came to be screened for the use of the dearMamma application which provide reliable medical information about breast cancer for the poorest women around the world – especially for illiterate women who have been totally neglected by the health- or pharma-industry due to lack of spending capacity DearMamma as shown in Fig. 4.

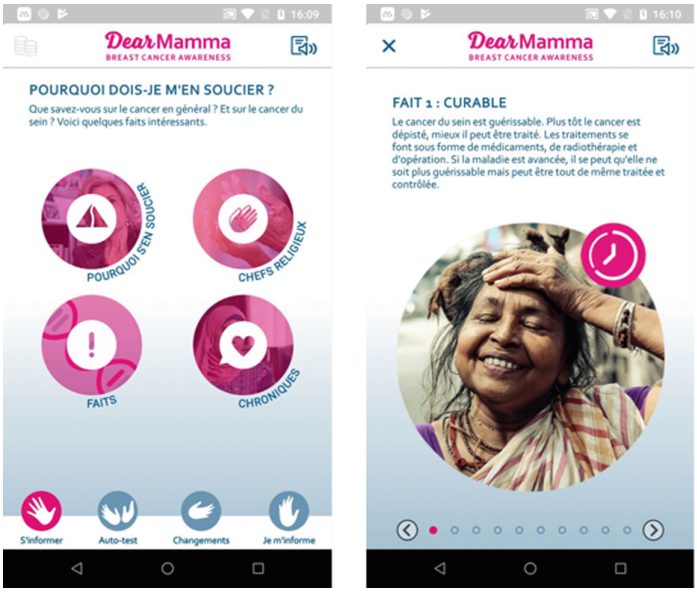

Fig. 4. DearMamma

3 Future Trends of Mobile Health Applications

The proliferation of mobile technologies has paved the way for the widespread use of mobile health devices (mHealth). This in turn generates a large amount of data, mostly large data that can be used for a variety of purposes. In addition, these Big Data are closely linked to the Internet of Things (IoT) offering new applications for your individual eHealth and mobile health technologies. Also with the likely arrival of 5G technology, it is obvious that it will have a catalyzing effect on health as well as on many other areas [12]. The global usage of mobile health applications is increasing rapidly and so is the voluminous data sets generated from these and other smart connected devices leading to complex, voluminous and multi-dimensional mobile health data that are collected and stored globally on explosive levels. This game-changing trend is largely propelled by the unprecedented global usage of the Internet connected devices, and

the massive amounts of smart phone data generated by services and applications linked to these devices. As a consequence, there is major push on how to better manage, optimise and analyze this volume of data. Also, and more importantly how to convert these into meaningful information that can benefit patients, clinicians and other stakeholders. The recent developments from major corporations like Apple (HealthKit), Google (DeepMind), Microsoft towards developing smarter mobile healthcare systems are evident of these trends [13]. The adoption of the Cloud and Internet of Things (IoT) model in the field can bring multiple opportunities to medical informatics and experts believe that it can significantly improve health services and participate in its continuous and systematic innovation in a Metadata environment such as Industry 4.0 applications. Indeed, this model aims to deliver performance improvements in health applications while reducing the time required to complete stakeholder requests, optimizing the storage of large patient data, and providing realtime extraction mechanisms for these applications [14]. Regarding the 5G, it must be said that its impact on mobile health applications will include these elements namely continuous monitoring, which allows support for the continuous monitoring and treatment of sensory devices. Then, predictive analysis from where a continuous monitoring will feed the development of new data flows. There is the impact on business models hence the transition from fee-for-service, volume-based, and outcome-based payment delivery models could be significant following 5G activation. In addition, we have remote diagnosis and imaging through this 5G technology. Finally, the last point called improving the state of the art will be an important piece in the proliferation of data. The consolidation of the latter with predictive analysis as well as the autonomous training will allow doctors and researchers to access aggregated information and accumulated knowledge on treatment trends.

With the rapid evolution of information and communication technologies, the internet of things, smart cities increase the possibilities of mobile health applications, thus enabling the development of the concept of smart health, which is defined as the provision of health services in the preference to use context-aware network and sensing infrastructure of the identified smart cities. To explain this concept of smart health Al-Azzam et al. [18] take the example of a cyclist who wears a bracelet with built-in accelerometers whose main objective is to monitor an accident. The body sensor network helps to detect the fall of the individual and sends a notification to the city's infrastructure. As soon as the system receives a notification, the traffic conditions are evaluated and an ambulance is sent using the best selected route. Capossele et al. [19] illustrated in Fig. 5 a platform model that enables the development of shealth apps to collect, combine and analyze a variety of data provided by citizens and patients, social feeds and urban sensors. This model makes possible the reutilization of infrastructure and application interfaces already existing with mobile health applications that make them a full part of smart cities and so improve people's living conditions. In Fig. 6 they described the stakeholders required to make shealth apps development practical, the benefits they might gain from being part of the s-health ecosystem, and the barriers they face.

- AP: Asset providers use the common s-health platform to share existing infrastructures;
- AD: App developers create applications for Users, using assets (devices and data) provided by AP;
- UP: Use case providers (UP) are those providing use cases and business cases and incentives for new apps to be developed;
- PR: Policy makers and regulators (PR) can leverage the transparency embedded in the s-health platform contract layer to assess compliance;
- AU: Users (AU) are those consuming s-health apps for a given perceived benefit.

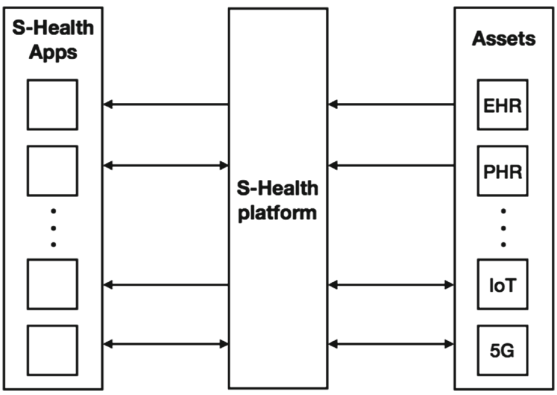

Fig. 5. S-health schema [19]

4 Challenges of Mobile Health Applications

Mobile health applications are good opportunities for developing countries. They can help them improve their health care system and provide more care to those who need it. But to develop a health system that takes into account the mobile health aspect, we have to deal with certain challenges. These challenges are related to a lack of ICT infrastructures, resources, security and privacy issues.

About the lack of infrastructures it mainly consist of a lack of coverage and quality by the telecommunication operators who are the main provider of internet. This is the cause of a low internet connection rate which is not negligible in the process of creating and using these mobile health apps. Internet is expensive in many developing countries and that consists in a real barrier to the mHealth implementation so that those countries people are not able to access health information.

The resource problems are mainly financial's, as health structures often fails to mobilize enough resources to acquire the infrastructure needed to computerize all or part of their health system.

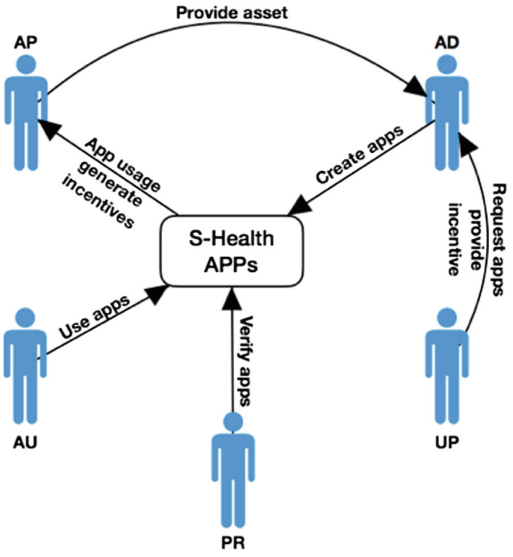

Fig. 6. S-health stakeholders interaction flow [19]

Albabtain et al. [15] shows a serious problem which is the low education and few health literacy skills in some countries of the developing world. This lack of education required are also important hurdles in the effective use of mHealth applications

According to [2] there is evidence indicating that the technology itself can also be part of the problem despite the benefits of their using; in fact, neglecting the complications and challenges of the use of emerging technology in the healthcare field may be dangerous and may have irreparable results. Tayebeh et al. describe in their study 6 kinds of challenges which are the user-related which correspond to users of system, infrastructure which are related to standard regulation, process which might be considered in every component of system, management related to weak quality control and legislation, resources related to hardware and software and training challenges related to the lack of user training and instruction. Other challenges are the security and privacy issues. Papageorgiou et al. [16] in their study found that some applications need for permissions to access certain features like the list of contacts or the dial phone number directory whereas the using of these applications did not show any functionality justifying such requests. They also used MobSF to evaluate the security of apps and found that many apps did not connect using https protocol which can cause several security and privacy issues. Also 45% of the apps tried to determine if the device was rooted which is a feature irrelevant to their goals. The usability of the mobile health apps is another key challenges that can act on it frequency and the use adoption. Teng et al. [17] evaluated in their study a set of health apps authenti-

cation and determine the burdens placed on the patients and providers and they conclude that:

- Username/password authentication approaches are not ideal for mHealth apps in acute care settings;
- Combining SMS with one-time-password (OTPs) significantly reduces the burdens on patients and providers but introduces the requirement that all patients have cellular service on a device and creates the significant potential that a patient's authentication credentials might accidentally be sent to the wrong person.
- The QR-code + OTP method preserves the key usability improvements of SMS + OPT authentication, but eliminates the requirement for cellular service and the potential of sending credentials to the wrong person.

We can cite the internet connection as another challenge to the use of the mobile health applications. In most of the cases, health apps needs to send collected data on the patient to a remote server for processing and/or visualisation by the professional health care purposes. A problem can occur if the patient's mobile devices doesn't have access to internet.

5 Conclusion

Mobile health is a medical and public health practice supported by mobile devices. There are many mobile health applications that help patients to improve their life style and their wellness or that help doctors to better provide healthcare even if the patient is not near from him. The IOT wearable devices are frequently use in the mobile health application for the patients monitoring and is very helpful in the decision making process by the doctor. The next 5G technology will come with the possibility of continuous monitoring which will increase the possibility in the field of IOT and mobile health apps. Despite the benefits in the use of the mobile health applications there is some challenges that if it is neglecting it will be dangerous and have irreparable results. These are the security, privacy, usability, internet connexion challenges that can make the use of the mhealth application burdens for the patients or healthcare provider. This first work consisted mainly on the state of the art on mobile health applications. The next step would be to work on the implementation of a mobile health application that would be suitable for developing countries like Burkina in view of the difficulties related to the Internet connection and the high rate of illiteracy.

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