Mobile Health Access for Diabetics in Rural Areas of Turkey – Results of a Survey

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Abstract. Extending the reach of medical professionals in rural areas is one of the goals using mobile health technologies. This paper illustrates the results of a survey conducted in 2008 in Turkey asking medical professionals about their current ICT usage and opinions about using mobile technologies in order to help patients with diabetes. The goal is to reduce the information gap between patients and medical professionals by allowing sending the information electronically using mobile technologies. This will improve both the interaction between various actors and also improve the treatment, as important trends of this chronic disease can be discovered on time.

Keywords: mobile health, diabetes, turkey, survey, rural area, mhealth, ehealth.

1 Mobile Devices in eHealth

A very large percentage of the European population owns at least one mobile device, typically a mobile phone. Their ubiquity, connectivity and increasing features are reasons for their use in the electronic health sector.

A number of researchers have worked on the idea of assigning mobile devices to patients. Furthermore, the WHO interprets the high demand of non-OECD countries for telemedicine and the use of remote medical expertise as the need to improve the available health care resources in less developed areas [1]. It is possible to discriminate between the following three domains of mobile health applications:

1. Mobile devices are used to help the patient by providing information.
2. Mobile devices are used to transmit physiological parameters.
3. Mobile devices are used to alert patients or medical professionals when certain physiological parameters become critical.

1.1 Providing Information to Patients

The medical assistant HealthPal is an example of the first domain. This dialogue based monitoring system aims at supporting elderly people in their preferred environment [2]. Another example is proposed in [3], where the system provides help for younger people suffering from overweight.

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1.2 Transmission of Physiological Parameters

An example of the second domain has been implemented within the MOEBIUS project (Mobile extranet-based integrated user services), which integrates doctors and patients by submitting different physiological parameters [4].

The use of mobile devices in order to assist young cancer patients is described in [5] and the authors conclude that such a system has a number of advantages:

- Higher compliance of appointments with alerting functionality.
- Higher data quality.
- Less work on part of the doctor to prepare the documentation.
- Fewer errors in the documentation.

1.3 Alert of Patients or Medical Professionals with Critical Values

An architectural and conceptual overview of an application of the third domain is outlined in [6] and focuses mainly around the actors patient, doctor and nurse. The use cases for a mobile alerting system are built around them.

Another example is SAPHIRE, a monitoring and decision support environment that generates alerts if the patient's state becomes critical in a home-based scenario. It bases on guidelines that are able to evaluate the incoming data and infer critical states. The communication with a clinic able to handle the situation is solved using a secure VPN connection; potential updates to the guidelines are automatically downloaded upon start-up of the application and are therefore always up-to-date [7].

2 The eSana Framework

The eSana framework, developed at the University of Fribourg, allows the creation of applications in the second domain. It is illustrated in figure 1 and the approach has been described in more detail in [8] and [9]. The main goals of mobile medical applications using this framework are as follows:

- Location and time-independent communication between doctor and patient.
- Customizable processes and user interfaces per patient.
- Integration of the patient into the disease management and documentation process (patient empowerment, see level-of-care pyramid in [10]).
- Integration of contextual parameters from the environment of the patient (see [11]).
- Integration of new consumer applications receiving physiological parameters.

The eSana framework considers the needs of several actors, e.g. patients, doctors, nurses, health care administrators, by allowing the development of various mobile medical applications. One abstract scenario is the transmission of physiological parameters. Several medical devices transmit their measurements to the mobile device of the patient (e.g. a cell phone) by using Wireless Personal Area Networks such as Bluetooth. The requested information (e.g. weight, glucose, photo of the current meal) is part of a process description which contains a number of forms as user interfaces; it can either be received from a nearby medical device or entered manually.

Both the process definitions and user interface descriptions are stored external to the application as XML artifacts and can be adapted per patient (e.g. by the doctor).

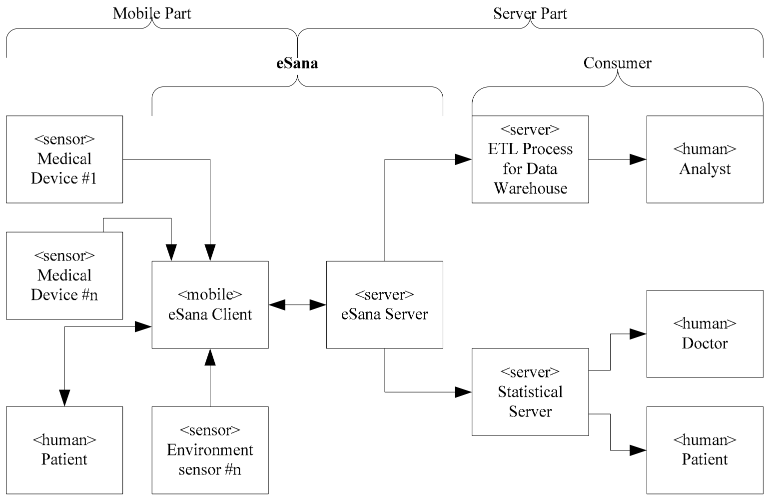

Fig. 1. Overview of the eSana framework with example consumers

The process descriptions base conceptually on the UML state event diagram. Each state contains a reference to a user interface described in a separate artifact.

The eSana framework also specifies and interprets a third artifact containing information about the entry screen of the application. It allows the inclusion of additional applications for a specific problem field. Therefore, new domain-specific applications can be embedded into the entry screen. An example of such a specific application is a snippet, which retrieves and visualizes all physiological data of the patient.

Once the patient decides to send the data to the server, it is transformed and dispatched to a number of interested subscribers. These are not part of the eSana framework and can be added depending on specific requirements. For example, a subscriber to dermatological information can offer tools to process the incoming image information in a way that the dermatologist can work with it [12].

Security is a fundamental issue for the exchange of medical data and has already been researched for similar settings (see [13]). It can be summarized by using the following technologies mapped onto the approach above:

- Use of Bluetooth security between the medical and mobile devices.
- HTTPS with client and server X.509 certificates between mobile device and server and also between servers on different systems.
- HTTPS between the service providers and the end users. Whether client X.509 certificates will be used depends on the service offered. Typically, an application communicating with a medical expert will require a stronger authenticity.

3 Survey

Based on the possibilities available with the eSana framework, a survey was conducted in Turkey in order to analyze what medical professionals think about using a mobile application in the specific case of diabetes. Other surveys were already conducted in Switzerland (for cardiology [14] and dermatology [15]), but lacked two important aspects: (1) Switzerland has virtually no rural areas with difficult access to healthcare and (2) the health system in Turkey is in a state of paradigm change and open to new ways of integrating ICT in order to improve medical access.

3.1 Introduction

The survey was conducted in August and September 2008 in Turkey. In order to get a good response rate, the interviews with the medical professionals were conducted face to face with the help of the ministry of health in Turkey. The sample was chosen from the following three cities near rural areas: Adiyaman (eastern representative), Bolu and Duzce (both western representatives). These cities were chosen because they represent the regions that were transformed first within the new health system in Turkey. All chosen medical professionals are family doctors and are therefore regularly confronted with diabetes cases.

336 doctors were included in the sample. Of these, 239 have participated in the survey resulting in a response rate of 71.1%. The rate does not differ significantly between the cities. 72.4% of the respondents are male and the overall average age is 34 years. In average, they have 8.4 years of medical experience. The vast majority (98.7%) works in a Family Medical Center Unit.

3.2 Diabetes Application Context

Several questions were asked about the diabetes use case. The first question was whether and how the respondents were regularly tracking scientific development of diabetes. 77.2% answered that they did. Of these, 70.9% answered that they use publications to keep up to date. 48.0% use electronic databases, 33.5% attend conferences on the subject and 27.9% follow courses in order to extend their knowledge.

When asked, why they think that their patients do not come regularly for the visit, the following answers were given:

Table 1. Reasons why diabetics do not follow up regularly (ordered)

Reason	Percentage
The patient is doesn't know the importance of his disease	72.0%
The patient chooses to ignore his disease	65.7%
The patient lives in a rural area	54.8%
There are traditional treatments in place	38.5%
The patient has a low self-control	16.7%
The patient is unable to accept his disease	15.5%
The patient is afraid of his disease	13.0%

Regarding patients that live in rural areas, only 27.7% of the doctors think that they are able to make regular visits.

The respondents were also asked about how they think the situation may be improved. 34.3% think that communication must be improved generally. Only about one fifth (20.1%) think it makes sense if doctors are made available at regular intervals in the rural areas. The majority of 61.5% thinks that setting up a solution that allows sending the necessary parameters (e.g. blood sugar level, weight) using mobile technologies, including a feedback mechanism from and to the doctors, makes most sense for patients living in rural areas.

On the final question, whether the respondents would like to trace their patients remotely using ICT such as internet, mobile technologies or videoconferencing, 79.6% answered yes against 20.4% not thinking it makes sense.

3.3 ICT Infrastructure and Know-How of the Medical Professionals

In another part of the questionnaire, the respondents were asked whether they know specific technical terms and to rate their knowledge. Not surprisingly, more than 80% of the respondents said that they were using regularly (as both power and normal users) the following technologies: Mobile phones, SMS, Internet, Mail, MSN (chat). Mostly unknown (less than 20% of the respondents answered that they were average or good users) were the terms PDA, GPRS, EDGE. This result is also not surprising, as the terms are quite technical. The remaining terms are also known to a somewhat lesser extent: Bluetooth is used by 60.3%, MMS are known to 52.7%, WAP to 49.5% and the term Browser is only known to 42.3% (probably confusion with the term "Internet") of the respondents.

Only 14.6% think that ICT is used sufficiently in their daily work, 67.4% disagree (the rest is indecisive). However, 98.2% of all respondents have access to personal computers at the place of work, which indicates a rather good setup of the infrastructure. The computers are also heavily used: 58.1% of the respondents use them for more than 4 hours and another 20.9% between 3 and 4 hours every day.

3.4 Use of Mobile Technologies

The respondents use their mobile phones regularly. 76.6% answered that they always use it and 23.0% use it at least sometimes. The usage pattern indicates that the most used service is of course the normal voice phone call. Nonetheless, 65.3% use SMS regularly and even Bluetooth is used by 33.9% of all respondents.

When asked about their patients, the respondents said in 68.8% of all cases that their patients use their mobile phones to communicate with them. Of these, 89.6% of the patients normally use voice calls and 9.7% additionally use SMS to communicate with their doctors.

3.5 Potential Effects of a Mobile Diabetes Solution

A potential mobile solution to trace diabetes in rural areas was presented and evaluated in a number of questions. In one such question, the respondents were asked whether they think that such an application may reduce the number of deaths from diabetes or one of its symptoms. 29.6% do not think that such an application has any effect on the number of deaths, whereas 8.2% think it definitively does. The majority of 56.2% think that such an application may have a positive effect on reducing deaths.

Whether such an application would improve the relationship between the doctor and patients was asked in the next question. 71.0% think it would improve the relationship, whereas only 5.2% think the effects would be negative. 16.5% do not think that there would be any change in their relationship and 7.4% have no opinion.

When comparing the traditional tracing methods of diabetics with a mobile application in rural areas, 64.9% of the respondents think that the tracing would be facilitated against 10.8% thinking that the tracing would be complicated. 11.3% do not think that it differs much and 13.1% had no opinion.

An important factor for the acceptance of such a system is the question, whether the medical professionals think that such a system would cause more or less work. 74.7% think that their work load will increase, whereas only 19.7% think that it will decrease. Supporting a running environment is a complex issue and does not include considerations such as technical support of the patients.

Furthermore, the respondents were asked about possible effects of using such a mobile application and were able to answer that they agree, disagree or are not sure.

Table 2. Various aspects of using a mobile application to trace diabetics (ordered)

Aspect	Agree	Indecisive	Disagree
Allows the patient to feel more secure	68.8%	19.9%	11.3%
Reduces complications of the disease	65.4%	24.2%	10.4%
Patient becomes more conscious of his disease	64.5%	26.8%	8.7%
Facilitates tracing of patients in rural areas	62.8%	25.5%	11.7%
Slows down progress of the disease	58.4%	27.3%	14.3%
Morbidity of diabetes will be decreased	57.0%	31.7%	10.9%
Mortality of diabetes will be decreased	55.5%	33.6%	10.9%

In the final question about the effects of such an application, the respondents were asked about the potential improvements for specific aspects of the disease. They were able to give a number like 1 (has no effect), 5 (has partial effect) and 10 (has clear effect). The next table illustrates the median values:

Table 3. Possible effects of a mobile application to various disease aspects (ordered)

Aspect	Median
Foot ulcers, slowly recovering wounds	7
Increase in heart disease, heart attack or apoplexy risk.	6.5
Retinopathy (Damage to the eye)	5
Nephropathy (Damage or disease of the kidneys)	5
Neuropathy (disorders of the nerves of the peripheral nervous system)	5

4 Conclusion and Outlook

4.1 Interpretation of the Survey Results

The survey results indicate several shortcomings in the current treatment of patients with diabetes. Patients in rural areas have difficulty or little motivation for regular medical visits and their knowledge about their disease is limited or is considered as a minor ailment.

On the other hand, medical professionals appear to have a good understanding of ICT and would therefore be able to instruct their patients to use such a mobile system.

Furthermore, they would be capable of analyzing the data using new technologies. One potential problem lies in the possible increased workload for the doctors. This can be limited by integrating the incoming information into the documentation process. Nonetheless, the current working processes need probably to be adapted in order to allow for some time (e.g. once weekly) to analyze the data of remote patients.

One big problem appears to be the missing awareness of patients for their disease. A prevention campaign can be partly supported by mobile communications. Technically, this could be done using SMS. Furthermore, the eSana framework allows the integration of dedicated application snippets. One such snippet could for example offer the patient a selection of possible meals that are adequate for his condition.

Certain findings need to be analyzed further using more specialized methods, for example why that 29.6% of all medical experts do not think that such an application may reduce the number of deaths or why 20.4% do not wish to track their patients using ICT technologies.

4.2 Components of a Mobile Diabetes Application

Based on the results of the survey, this section discusses possible components of a mobile diabetes application for patients in rural areas.

- Process to register the current condition of the patient by measuring his physiological parameters. This process can be personalized per patient. It should include a user interface that allows capturing foot ulcer images using the integrated camera of the mobile device, if applicable for the patient.
- Three additional applications: one that informs the patient about possible meals he can cook in order to improve his medical condition and another that allows the patient to view graphically a simplified view of his physiological parameters. The last application offers a small quiz in order to raise the awareness of his condition.
- A mailbox integrated into the diabetes application that allows a two-way communication between the actors. This would allow the doctor to write a short note to the patient after analyzing his data, if necessary. The communication is secured and may also include voice messages.

The server based application that acts as a consumer of the physiological parameters and is used by the medical professional should include the following functionality in a web interface or as dedicated client application:

- Tool for doctors to analyze the incoming parameters graphically in a browser and to set critical limits per patient with the escalation procedures (e.g. e-mail, SMS).
- Processing possibilities to analyze incoming foot ulcer images and mechanisms to make these images available to dermatologists.
- Mailbox that allows to send messages to patients and to read theirs. It may make sense to integrate this into the messaging solution of the doctor (e.g. MS Outlook).
- Possible export functionality of the parameters to a patient information system. The data is exported in the HL7 standard [12, 16]. Such functionality would greatly improve the documentation of the patient's condition and his medical history.

4.3 Outlook

The results of the survey will be analyzed in more detail within a Master thesis at the University of Fribourg in Switzerland. This thesis will also contain a model for such a medical application.

The eSana project is part of an ongoing dissertation and will be further refined. Finally, the LoCa research project, done by the University of Fribourg in collaboration with the University of Basel, analyzes the use of contextual information in a healthcare setting in order to allow actors to use adaptable workflows in their smart home or smart hospital environment.

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