

Mobile Phone Messaging in Health Care – Where are we Now?

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Abstract

Mobile phone text messaging (Short Message Service, SMS) has proved to be a powerful tool for many tasks in health care. It is affordable and instant way for communication between health care personnel and patients, enabling different kinds of control and monitoring applications, improving adherence in self-management of chronic diseases or healthy lifestyle programs etc. However, it is not only textual data that can be transmitted by mobile phone messaging. Multimedia Message Service (MMS) makes it possible to send images, video sequences and audio attached to the message. This has significant potential in health care applications, and an amount of research has been made recently on this field. In this paper, we review the recent development in the mobile phone messaging in health care. Special attention has been paid in the discussion of the current state of the art of text messaging as well as the potentiality of multimedia data that can be utilized by means of multimedia messaging.

Introduction

Mobile computing and communication technology interventions for improving health care and health service outcomes, referred as M-health [1] are used nowadays on a wide range from data collection and information transmission to supporting health behavior change. Many practicalities of the health care system can be made automatic and easier for both patients and health care stuff by using mobile phones. Text messaging, i.e. short message service (SMS) and multimedia messaging service (MMS) are the most widely used mobile communication methods after phone calls. In principle, text message can be used either as a one-way communication to provide the user information such as reminder, alert, etc, or as a two-way communication that enables the user to send and receive information (such as question and answer). Mobile messages are an excellent aid for communication when there is a need to submit information also at long distances or without well working health infrastructure, or when the people cannot physically meet the health care workers. Provided that the cost of the text message is very low and it is available to practically everyone, it has been found useful to employ the text messaging in many routine-like health care applications. Typical examples of these application areas are e.g. different kinds of reminders and instructions, reporting of laboratory test results or home measurements, remote controlling and monitoring etc. By using this kind of communication, it is possible to save resources by e.g. avoiding unnecessary hospital visits and phone calls, and make health care process more efficient by automatically sending, receiving, storing and processing the patient data.

The mobile phone messaging in health care has been a subject of active research work about a decade. Wei et al. [2] presented a literature review including 24 articles on the use of text messaging for clinical and healthy behavior interventions. In paper of Cole-Lewis and Kershaw [3], a review on the behavior change interventions for disease management and prevention delivered through text messaging is presented. Krishna et al. [4] have made an article on the state-of-the-art of the use of mobile phones and text messaging interventions in improving health outcomes and processes of care.

The present study has three major goals. First of all, we review current state-of-the-art of the work made on the use of the text messages (SMS) in health care applications in general, without emphasizing merely on any specific area as the survey papers mentioned above. The second goal is to review the work made on the usage of the multimedia messaging (including images, video and audio) in health care related messaging. The multimedia messaging (MMS) has great potential in health care applications, but it has received reasonably low amount of attention in the literature. For this reason, the third goal of the paper

is to analyze and discuss the possibilities of the use of the multimedia data in health care related mobile messaging, and identify the benefits and drawbacks.

The review made in this paper was carried out as a Internet database search in April-July 2011. A search of PubMed database was conducted using the keywords: (mobile phone messaging OR text messaging OR multimedia messaging OR SMS OR MMS) AND (health care OR telemedicine OR telecare OR e-health). In addition, we examined the reference lists of the papers that were found in the database search. In practice, the most of the relevant papers were found in the leading journals in the field of telemedicine, telecare and e-health. To ensure that all the relevant papers were included, the database search described above was repeated also in the databases of these journals. All the relevant papers were reviewed, and those suiting to the scope of this article were selected. The inclusion criteria for the papers selected for the review were the following: 1) Publication year: 2000 or later, 2) the paper clearly presents an application of mobile phone messaging (SMS or MMS) in health care, 3) The paper includes experimental data on the use of mobile phone messaging in health care.

In addition to these reviewed papers, we have included several other studies from other journals and conferences that bring additional viewpoints and use cases for this article. Many of these additional articles were found from the reference list of the reviewed papers.

Text Messaging (SMS) in Health Care – A Review

The text messaging applications can be divided into four major groups. *Remote controlling and monitoring applications* are used as a tool to support e.g. home management of some chronic diseases or to send notifications on emergencies. In the *information services*, the goal is to employ mobile messages to send and distribute information. In the applications related to the *adherence*, the messaging is used to support e.g. treatments, healthy lifestyle programmes or self-management. In

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the final group, *management*, the messaging is used as a tool in health care management practices. The work made in this area is summarized in Table 1.

Remote controlling and monitoring

Home telemonitoring is a typical example of the monitoring applications carried out by text messaging. In a regular home

Authors	Year	Ref	Area	Short description	Region	Participation	duration
Remote control and monitoring							
Terry	2008	5	Home telemonitoring application	The patients can sign onto the service every day and answer to the specific questions about their health	USA		
Ferrer-Roca et al.	2004	6	Diabetes management	Patients sent manually the home measurements to server	Spain	23 diabetic participants	
Istepanian	2009	7	Diabetes management	Automated glucose measurement by Bluetooth device	UK	137 patients	9 months
Cho et al.	2009	8	Diabetes management	Comparison between "diabetes phone" and Internet-based glucose monitoring system on management of type 2 diabetes.	Korea	69 patients	3 months
Prabhakaran et al.	2010	9	Asthma management	Patients sent manually the home measurements to server	Singapore	120 patients	11 months
Holz and Whitten	2009	10	Asthma management	Patients sent manually the home measurements to server	Michigan, USA	4 patients	
Ostojic et al.	2005	11	Asthma management	Patients sent manually the home measurements to server	Croatia	16 patients	4 months
Information and education services							
Downer et al.	2005	12	Reminder service	It has been shown that failure to attend rate (FTA) of the patients that received the text message reminders was significantly lower than in the case of patients that did not receive these messages.	Australia	1382 patients	1 month
Mao et al.	2008	13	Mobile pharmacy service	The patients were provided with reminders and information about the medication via text messages	China	100 patients	3 months
Mäkelä et al.	2010	14	Psychiatry	Text messages sent between the hospital visits can encourage the young people to stay in touch with the hospital staff more frequently	Finland		
Wangberg et al.	2006	15	Diabetes education	Parents of children with type 1 diabetes received messages containing diabetes information	Norway	11 parents	
Terry	2008	5	Sexuality information service	Sexual advice to young people provided via text messages in San Francisco via a	San Fransisco, USA		
Juzang et al.	2011	16	HIV prevention	Text messages about HIV prevention were sent to a group of young men in Philadelphia	Philadelphia, USA	60 young men	3 months
Gold et al.	2011	17	Sex and sun safety	The effectiveness of text messages related to safer sex and sun safety was evaluated	Australia	7606 mobile advertising subscribers	
Cochrane et al.	2009	18	Warning about an invasive disease	Text messaging was used to warn contacts of patients with invasive meningococcal disease.	Australia	14 people	
Adherence							
Harris et al.	2010	21	Improving adherence among HIV positive people	Usability of a pager-based text messaging system for improving medication adherence was evaluated	Seattle, USA		
Dunbar et al.	2003	22	Improving adherence among HIV positive people	An automated two-way messaging system to enhance antiretroviral adherence of HIV positive persons	Seattle, USA	25 HIV positive people	208 days (median)
Woolford et al.	2010	23	Weight management	Text messaging was used to increase adherence in a weight-management program	Michigan, USA	20 adolescents	3 months
Gerber et al.	2009	24	Weight management	Text messages were used to support weight loss maintenance program among African-American women	Chicago, USA	95 African-American women	4 months
Joo and Kim	2007	25	Weight management	Text messages concerning about diet, exercise and behavior modification were used to increase adherence in a weight-management program	Korea	927 participants	3 months
Kornman	2010	26	Weight management	Text messaging was used to increase adherence in a weight-management program of 13-16 year old obese people	Australia	49 participants	2-12 moths
Whittaker et al.	2008	27	Smoking cessation	Mobile phone-based targeted to young people used text and video messages to improve adherence	New Zealand	180 young people	1 month
Management							
Al-Hinnawi	2009	28	"Patient keeper" application	A mobile phone application for doctors to store e.g. the diagnoses and findings and send this information to the server by using a text message.	Syria		
Herriot	2005	29	SMS notification system for cornea donations	Text messaging is used to notify the Eye Bank of South Australia of potential corneal donors	Australia		

Table 1: A summary of the reviewed text messaging applications.

telemonitoring application [5], the patients can sign onto the service every day and answer to the specific questions about their health. Diabetes management is one of the most widely employed text message based telemonitoring approach. In the study of Ferrer-Roca et al. [6], a group of 23 diabetic patients used text messages to transmit data such as blood glucose levels and body weight to a server for an eight-month period. The server collects the data for health care personnel's use and automatically sends monthly calculated result to the patient by text message. In the approaches reported by Istepanian [7], the patients were provided with a glucometer that can be connected to mobile phone via Bluetooth connection. By using this automated measurement scheme, the patient data can be transmitted from mobile phone to the server by means of a text message. Cho et al. [8] have tested a mobile phone integrated with a glucometer. This "diabetes phone" transmits the glucose-monitoring data automatically to a web service, which sends medical recommendations back to the patients via text message. Asthma management is another central area in the remote monitoring approaches. As in the case of diabetes, also in the asthma home monitoring the patients use text messages to report the home measurement results. Prabhakaran et al. [9] evaluated a text message application for symptom monitoring in patients with asthma. The results of 11-month testing period were promising, since the number of nebulizations and emergency department visits was reduced in the intervention group. In the studies of Holtz and Whitten [10] as well as Ostojic et al. [11], the asthma patients participating the study reported their daily peak flow reading by text message to a web server. If the patients failed to do this, the server sent a reminder message [10].

Information and education services

Text message has been found to be a suitable method for providing information for individual patients or larger groups of people. There are many existing applications in which text messages are used to remind the patients about their appointments and medication. For instance, Downer et al. [12] demonstrated that failure to attend rate (FTA) of the patients that received the text message reminders was significantly lower than in the case of patients that did not receive these messages. In the work of Mao et al. [13], a mobile pharmacy service system is utilized to deliver individualized pharmaceutical care, such as medication reminders, adverse drug reactions and other information via text messages sent to the mobile phones of patients. Mobile phone messaging can also be used in the follow-up the patients e.g. after some medical operations. In Mäkelä et al. [14], a text messaging system merged with an electronic patient information database was employed for a two-way treatment messages in psychiatry. The text messaging was found to be particularly suitable for young people who have to travel to the outpatient clinic over long distances or who face the risk of social exclusion. According to clinicians, the text message reminders sent between the visits can encourage the young people to stay in touch more frequently, which will help to improve their relationship with the hospital staff. Wangberg et al. [15] used text messaging in diabetes education. In their study, eleven parents of children with type 1 diabetes received messages containing diabetes information. The reminding effect of the messages in busy everyday life was noted as positive among the participants, but the inability to store all the messages or to print them out were seen as major disadvantages in this system. Juzang et al. [16] present a programme in which text messages about HIV prevention were sent to a group of young men in Philadelphia. Based on the results, the awareness of sexual health was increased in this group compared to the control group. In [17], Gold et al. made a randomized controlled trial to evaluate the effectiveness of messages related to safer sex and sun safety among 7606 mobile advertising subscribers aged 16–29 years in Australia. Cochrane et al.

[18] used text messaging to warn certain people about meningococcal disease that was occurred in their friend.

Adherence

Supporting the self-management of the patients suffering from some chronic diseases, or participants of the programme aiming at lifestyle changes or therapeutic use, is a key challenge in today's health care [19]. Text messaging applications can be used to improve the adherence in many ways. For instance, reminders or support messages can be used for this purpose. In a feasibility study of Hanauer et al. [20], the participants in a group that received text message reminders responded more often than those receiving the email reminders in blood glucose measurement. Harris et al. [21], examined the overall usability of a pager-based text messaging system designed for improving medication adherence among the HIV-positive patients. The results revealed that the majority of the participants were satisfied with the medication reminders, which were found helpful. Dunbar et al. [22] presented a two-way messaging system to enhance antiretroviral adherence of HIV positive persons. In this automated messaging system, the participants received multiple short daily messages designed to remind, educate, encourage adherence and solicit responses concerning side effects and self-reported adherence. The participants could use the system to report e.g. about missing doses or side effects.

Woolford et al. [23] used tailored text and multimedia messages for increasing adherence in a weight-management programme. The participants of the programme mostly found the text message service as personally relevant, and improved the participants' adherence to healthy lifestyle practices. In the work of Gerber et al. [24], text messages were used to support weight loss maintenance program among African-American women. The messages included tips on health eating and physical activity. A similar kind of approach was employed also by Joo and Kim [25] and Kornman et al. [26], in which text messages were used to deliver short messages about diet, exercise and behavior modification for the participants of an anti-obesity program. The text messages have also been used in smoking cessation interventions. Whittaker et al. [27] report about their mobile phone-based cessation program that was targeted to young people.

Management

Al-Hinnawi [28] introduced a client-server application, called "Patient Keeper". By using this mobile phone application, the doctors are able to store e.g. the diagnoses and findings like temperature, blood pressure, medications, analysis, etc., and send this information to the server by using a text message. The server stores the information in a database, and can also respond to any request from the mobile phone client. Herriot [29] presented a framework in which a SMS notification system has been introduced in Australia to facilitate the retrieval of cornea donations. The text messaging is used to notify the Eye Bank of South Australia of potential corneal donors.

Multimedia Messaging Approaches (MMS)

Multimedia Messaging Service (MMS) standard allows the user to attach images, video or audio to the message sent by a mobile phone. It is obvious that this kind of messaging capability has many potential use cases in health care related messaging. In this chapter we review the work made in this area. The reviewed papers are also summarized in Table 2.

Messages containing images

In the early days of camera-equipped mobile phones, a low-

Author	Year	Ref	Media type used in messaging	Short description	Region	Participants	Duration
Multimedia message as a consultation tool							
Wallace and Gibson	2004	31	Image	Transmission of digital X-ray images to a mobile phone by means of multimedia messages	UK		
Farber et al.	2011	32	Image	Using multimedia messages containing images of patients as a working consultation tool between plastic surgeons	Israel	58 consultants	8 months
Bellina and Missoni	2009	33	Image	Using multimedia messages to transmit pathological microscope images for consultation purposes	Italy		
McLean et al.	2009	34	Image	Investigating whether it is possible to use the camera phones in telehaematology by sending a blood film for diagnosis by means of a multimedia message.	UK	33 camera phones tested	
Chandhanayingyong et al.	2007	35	Image	Teleconsultation of emergency orthopedic patients using multimedia messages	Thailand	59 patients	
Erranki et al.	2010	36	Image	Orthopedic images were sent to a register by means of multimedia message along with a brief clinical synopsis	Australia	40 patients	
Ng et al.	2007	37	Image	CT/MRI images were sent for diagnosis by means of a multimedia message	Singapore		12 months
Lim et al.	2010	44	Video	Teleconsulting using video sequences captured by a mobile phone camera about cardiac echocardiography.	Korea	70 patients	
Follow-up							
Walker et al.	2011	38	Image	Primary closure of simple facial lacerations is followed by asking the patients to send a photograph of the laceration six months and 12 months afterwards.	Ireland	50 patients	
Martinez-Ramos et al.	2009	39	Image	The patients were asked to send images of surgical wounds captured by a mobile phone camera to the hospital to enable the follow-up after ambulatory surgery.	Spain	96 patients	
Pérez et al.	2006	40	Image	The patients were able to send pictures and pulse oximetry measurements to a hospital serve after day surgery.	Spain	49 patients	5 months
Sending measurement data as multimedia message							
Tahat	2009	41	Image	Measurements like electrocardiogram (ECG) and body temperature are transmitted by using multimedia message.	Jordan		
Mitra et al.	2008	42	Image	An image of ECG measurement is captured by a mobile phone camera, and sent for the analysis as a multimedia message	India		
Adherence							
Kummervold et al.	2008	45	Audio	Persons who were unable to read text messages directly were provided with the messages presented as speech	Norway	12 visually impaired persons	3 months

Table 2: A summary of the reviewed multimedia messaging applications.

resolution camera was attached only to the most expensive phone models, but nowadays almost all the mobile phones on the market have some kind of camera. The resolutions of the camera sensors have increased from VGA to even 12 megapixels. In the same time, many factors improving image quality (such as efficient flash light and auto-focus) have been taken into use. Thanks to this development, the image quality of high-end camera phone and digital still camera are nowadays almost at the same level [30]. A clear benefit of the camera phone is a possibility to instantly send the captured image as a multimedia message. It is essential to note that when the image is sent this way, it is heavily compressed and its resolution is downscaled. This may impair the image quality of the transmitted image, and in some cases small details in the image may disappear. However, thanks to the improved mobile phone camera technology, the quality of the images sent this way remain usually at adequate level, and they can be applied to many health care purposes, as described later in this chapter. On the other hand when transmitting the image from the mobile phone

by means of email or Bluetooth, there is no additional compression. In telemedicine, mobile phone messages containing images have been a subject of research since 2004, when Wallace and Gibson [31] were among the first ones who reported on the transmission of digital X-ray images by means of multimedia messages. In their paper, the X-ray was cropped and encoded into JPEG-format after which it can be sent to a mobile phone as a multimedia message.

Multimedia message as a consultation tool: Farber et al. [32] studied whether it is possible to use multimedia messages containing images of patients as a working consultation tool between plastic surgeons. According to the results of a trial containing 58 multimedia consultations, the participating plastic surgeons were satisfied with this kind of consultation, and felt that the multimedia information contributed to their ability to independently handle similar cases in future. Bellina and Missoni [33] presented an interesting approach for using multimedia messages to transmit pathological microscope images via multimedia messages for diagnosis. According to the

results, the diagnosis is possible with the image resolution more than 0.8 megapixels. McLean et al. [34] investigated whether it is possible to use the camera phones in telehaematology. For testing purposes, they sent a single image containing white cells, red cells and platelets from a camera phone to 33 different camera phones. Too low display resolution or the lack of a zoom function of the image were found to be factors that prevent the diagnosis on the mobile phone display, but in most cases this was not a problem. The authors also examined the agreement between a hematologist using a suitable camera phones and the blood film report made in the usual way. In seven of the nine cases, the telehaematology responses were similar to the documented blood film reports. Chandhanayong et al. [35] used the multimedia messages in the teleconsultation of emergency orthopedic patients. Pictures of radiographs were taken using the mobile phone camera from a digital display screen in the emergency room and then transmitted to the camera phones of four assessors. Eranki et al. [36] report about a similar kind of approach, in which the images of orthopedic cases were transmitted to a register by means of multimedia message along with a brief clinical synopsis. According to the analysis, it seems that the images transmitted via multimedia message are not accurate enough to be used merely as a basis of diagnosis. However, when they are combined with existing clinical practice, it is possible to use them in e.g. patient screening and in communication between doctors. In a neurosurgical emergency case presented by Ng et al. [37], mobile phone camera to capture CT/MRI images directly from the computer screen, and sent them for diagnosis by means of a multimedia message. The results revealed that it is possible to make accurate interpretations based on the images transmitted this way. It also significantly improved the level of confidence of the senior-level staff in emergent clinical decision-making.

Follow-up: In addition to the consultation between doctors, it is also possible to use multimedia messages as information channel between patients and doctors in e.g. different kinds of follow-up cases such as postoperative management. Walker et al. [38] discussed about a possibility for emergency department staff to follow up the primary closure of simple facial lacerations by asking the patients to send a photograph of the laceration six months and 12 months afterwards. For this, they were instructed to use a mobile phone with a camera. In the work of Martínez-Ramos et al. [39], the follow-up after ambulatory surgery was improved by means of a camera phone. In this study, the patients were able to send images of surgical wounds captured by a mobile phone camera to the hospital, to assess local complications and avoid unnecessary hospital visits. Pérez et al. [40] utilized camera phones for the postoperative management of patients sent home after day surgery. The patients were able to send pictures and pulse oximetry measurements to a hospital server. This way, the health professionals could get information reported by the patients, and make a more objective estimate of the patients' status.

Sending measurement data as multimedia message: Tahat [41] presented a framework of a mobile monitoring system, in which electrocardiogram (ECG) and body temperature are transmitted via multimedia message. The system has a separate apparatus that is used to measure ECG and temperature, which are transmitted to a mobile phone by Bluetooth connection. There is a special application program installed on the phone that saves the ECG plot as an image before sending it as a multimedia message. In an approach of Mitra et al. [42], the ECG record is first printed on paper, and then an image is captured by a mobile phone camera, and sent for the analysis as a multimedia message.

Video messages

The mobile phone cameras are also capable of recording video sequences. With the development of camera technology, also the video quality has significantly improved during last few years. This means that the resolution, frame rate and overall video quality has risen to a higher level [43], and nowadays the most recent models of smartphones are able to record high definition (HD) video. The multimedia messaging service standard allows the user to send video clips as an attachment of multimedia messages. From the health care point of view, this capability has several opportunities, since in some cases still images cannot transmit all the necessary information. For example, different kinds of image sequences used in medical imaging can be transmitted as video. The number of published work in this field is, however, very limited. In the work of Lim et al. [44], the feasibility of the use of video sequences captured by a mobile phone camera in teleconsulting about cardiac echocardiography has been assessed. In this study, short echocardiography video sequences obtained from emergency room ultrasound examinations were transmitted to a mobile phone. Three emergency medicine physicians evaluated the diagnosis performance of these videos displayed on the mobile phone display and on a LCD monitor. Although the image quality of the video sequence on the mobile phone was lower than that of the original, the analysis indicated that there was no significant difference in diagnostic performance.

Audio messages

Multimedia messages containing audio have also some application fields in health care. The audio messages are particularly suitable for those who have problems with reading the textual messages. Kumervold and Holte [45] have investigated how text messages communicating health information can be distributed to people with vision difficulties. In this research, twelve visually impaired persons who were unable to read text messages directly, were provided with the messages presented as speech. One approach for sending the message as speech was to use multimedia message containing pre-recorded audio message.

Discussion

In this article we have reviewed the work made in the field of mobile phone messaging in health care. Text messaging can fulfil many of the requirements and needs of health care, such as providing a platform for reminder systems for patients and clinicians, initially tasked to electronic health record systems (EHR) [46]. Several kinds of text messaging (SMS) based approaches are already in routine use, and commercial applications exist for health care purposes. Being affordable, simple and fast method for communication, the text messaging solutions have widely adopted to assist in many health care systems in both western industrial world and in developing countries. In both cases, the text messaging has been found to be a method that makes the communication easier and allows generalized information sharing and processing, which in turn, enables more efficient use of health care resources.

Multimedia messaging

Multimedia messaging (MMS) applications are an interesting yet not so much studied area of mobile phone messaging. Multimedia messaging standard extends the core SMS capability with a possibility to attach multimedia content (such as images, video, audio or rich text) to the message. So far, the most popular form of multimedia messaging has been to send images captured with camera-equipped mobile phones. On the other hand, video clips and audio messages are gaining

popularity as message content as well. In health care applications, the use of multimedia messaging opens many possibilities, as presented in Chapter 3. The literature survey shows that images captured by a mobile phone camera, and sent by multimedia message can be utilized in several manners, including consultation, diagnosis and post-operative follow-up. The images are able to transmit information that cannot be done by text, especially when the text messages have space for limited amount of characters. Imaging is a central part of medical diagnosis work, and from telemedicine point of view, a simple and fast method for sending images is essential. Based on the experiments and assessments made in the reviewed papers, in most cases it is technically feasible to capture and send images of sufficient quality for diagnosis purposes. It is also particularly interesting to see research results in which different kinds of medical measurement results are transmitted by means of multimedia messaging. For instance, ECG data can be sent by means of multimedia message by converting the data into form of image, and then sending it, as presented in [41]. This kind of approach requires customized software for the processing mobile in phone. Since the current operating systems of smartphones allow anyone to create and install software to them [47], these kinds of software packages customized for medical use can be easily utilized. A typical example of this kind of smartphone application is self-management system for pulmonary rehabilitation presented by Marshall et al. [19], and mobile phone assisted wellness diary developed by Mattila et al. [48]. Development of different kinds of health related mobile phone application software packages is currently a strong trend in telemedicine, and the currently available mobile phone messaging methods to are used to transmit information collected and processed by these applications. In the case of video messages, it is possible to transmit even more visual information captured by mobile phone camera. Sending echocardiogram videos [44] is one promising example of this kind of messaging for diagnosis purposes. The work made on video messaging should be possible to be generalized on many other areas of medical imaging and telemedicine, in which image sequences are analyzed.

SMS and MMS messaging vs. mobile email

Mobile email access has become a standard feature of the majority of the mobile phone models sold nowadays. By using email, it is possible to send and receive messages without the size limitations of SMS and MMS messages. For this reason, it is questionable whether the mobile email could replace the other forms of messaging also in the health care applications. There are, however, several reasons why these forms of messaging are more feasible to be used. On the first place, email access uses mobile data transfer system that is operator dependent, and in many cases relatively expensive for the user. Therefore those who use mobile email load the content on the handset only when it is really necessary, which means that the messages do not reach the user instantly as in the case of SMS and MMS messaging, which also have significantly lower cost. Another reason is that practically all the mobile phone users can use text messaging, but mobile email access is not so straightforward to use, and may appear as difficult for many people to use. Consequently text messaging with or without multimedia content is still the only mobile communication method that can be really used to reach masses of people. However, mobile data transfer can be utilized in the smartphone applications to send and receive data between the handset and a web server.

Challenges of mobile phone messaging in health care

It is somewhat unclear at the moment what is the actual impact of the text messaging in health care. Most of the available publications deal

with relatively small number of users, or are pilot studies of a particular application of the mobile phone messaging. It is therefore difficult to judge the actual impact of the text messaging on overall health care provision; clearly this technology area is still a "work in progress". Although text messaging can fulfil many of the requirements and needs of health care, it is unclear how this SMS data should be classified, since the legal framework for text messaging in healthcare is unclear. In some instances it can be equated with telephone contacts (i.e. no archiving requirements imposed on SMS messaging). In other contexts, it can be seen as a text based message that contains patient information, and as such could fall under the general guidelines set for patient information storage. There is a risk of over-regulating the mobile messaging services in health care, and instead of a simple, ubiquitous technology in general use, these services could be in a worst case scenario be saddled with so many legal requirements as to make their use impractical.

Communication requires effort and time for the organization doing the communicating. In a health care setting, it is clear that organizations must be willing and able to change their methods of workflow to utilize mobile messaging technology. Hence, text messaging could well be handicapped by the ability of health care organizations to adapt and change working practices. Also a simple interface and linkage with computerised databases are required in some SMS applications, but this in turn will bring up a host of legal and technical issues that could again complicate the use of a simple technology - as alluded to previously.

Future direction

In this chapter, we crystallize the central trends for the future in the health care applications of mobile messaging. The future direction of this area can be predicted based on the state of the art and the recent research work reviewed in this paper.

1. The large-scale deployment of text messaging applications continues, and it will spread in new areas of health care. Drug adherence-communication to patients at home is perhaps one of the most interesting applications of SMS in the near future. More and more health care practicalities will be handled and assisted by means of mobile technology.
2. Visual information provided by mobile phone camera will be utilized more in telemedicine applications. The image and video messages will be a standard communication tool beside the text messages in certain application fields like diagnosis, consultation and follow-up.
3. New kinds of application software for smartphones will be developed and used [47] to assist e.g. home management of chronic diseases [19] or support healthy lifestyle [48]. The application softwares use mobile phone messaging routinely to transmit the collected and processed information between the handset and web servers.
4. The current mobile phones include already a variety of different sensors that can be employed in health related measurements. The data provided by camera, GPS, acceleration sensor etc. can be processed by custom software on the mobile device, and then send by means of mobile message, such as SMS or MMS.

Concluding Remarks

Text messaging is a form of communication that is available for practically everyone in western world, and also rapidly gaining popularity in developing countries. It is by far the only form of mobile communication that can be used for sending information instantly for

multiple receivers so that the sender can be sure that the message will be notified. Text messaging systems also enable generalized, computer-aided storing, processing and analysis of sent and received data, which is particularly beneficial in many health care related applications that collect patient information.

Text messaging solutions for health care are now at the end their early years. How well and how extensively this technology will be adopted, depends on a host of issues, legal questions not being the least important. As presented in this paper, several kinds of text messaging applications for health care exist, despite its remarkable potential; multimedia messaging still waits for its commercialization in large scale. It should be emphasized that multimedia content provided by camera-equipped mobile phones can really bring benefit for many kinds of health care solutions, and therefore the research work on that area should be further encouraged. It is particularly interesting to see how different kinds of medical measurements, such as ECG, can be transmitted to a multimedia message and sent for analysis. Another field that has a great potential is software development for mobile use in smartphones. By using customized mobile software, new kinds of medical applications for e.g. home monitoring and management can be brought available for practically everyone.

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