

myDR: Improving the Self-Care Process for Caribbean Patients with Type II Diabetes through Mobile Learning

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ABSTRACT

Diabetes self-management education plays a vital role in the treatment of people living with diabetes. The paper describes some of the practices in diabetes education delivery in the Caribbean region and some of the challenges currently faced. It focuses on a new channel for the delivery of personalized diabetes education for diabetic patients– the mobile phone. It discusses how mobile learning can be used to improve the self-care practices of patients with diabetes. It presents a mobile application called myDR (short for my daily record) that is used to retrieve and store the blood sugar and blood pressure levels of a diabetic patient. The system is designed to utilize the patient's current and previous readings along with the patient's health context to deliver diabetes self-management education using the mobile phone. The results of a usability study on the application are also presented; these indicate that the majority of the participants found this system to be an improvement of their current diabetes education programme. Furthermore, they valued the need for more relevant and timely information which is afforded by this new medium.

Keywords: *Diabetes Self-Management Education; Mobile Learning; Mobile Telemedicine; Personalization; Type II Diabetes.*

INTRODUCTION

Chronic non-communicable diseases (CNCDs) account for almost 60% of all deaths worldwide. Diabetes, in particular, is a major non-communicable disease in the Caribbean region. Caribbean history tells the story of the movements of populations throughout the islands. This has shaped an ethnically and culturally diverse society which in turn has influenced the clinical pattern of diabetes in the region (Hennis & Fraser, 2004).

The high prevalence of this disease today can also be attributed mainly to the inadequate health care infrastructure in the region as well as poor patient self-care practices (Douglas 2007). Many of the approximately thirty countries in the region are considered less developed, with their population living at poverty levels well below the world average. The public health care systems in Caribbean countries currently face a crisis due to factors such as shortages of medical staff, lack of proper facilities, insufficient funding and poor patient self-care practices. Therefore, new approaches to managing health care and promoting healthier lifestyle practices are needed to address this problem.

Diabetes left unattended can lead to several complications including heart disease, retinopathy, kidney failure and neuropathies. Many of these complications can be prevented but current health care practices do not embody the necessary mechanisms to initiate change. CNCDs require lifelong, continuous medical care. Health care services in developing countries are oriented to acute medical care. These episodic problems are urgent and usually require diagnosing, testing and relieving symptoms of some kind. Preventative care, on the other hand, requires a different model in which current health care systems fall short (WHO, 2002). A more interactive approach is required at the primary health care level with patients, their families and other health care providers. This is where mobile technology has the potential to make a great impact.

This paper focuses on Type II diabetes. Type II diabetes, also known as adult-onset diabetes, is much more common than Type I diabetes, and accounts for around 90% of all diabetes worldwide (WHO, 2008). Type II diabetes is considered a lifestyle disease. This means that many of the factors contributing to the severity and control of the disease can be attributed to factors such as diet, exercise, and other lifestyle practices. Therefore better management of these factors would result in better management of the disease itself. Empowering patients to be more responsible for their health is an important part of the disease management process and this paper describes how the mobile phone can be used as an alternative channel for health care education.

This research focuses on the design and development of a patient interface using mobile telephony called myDR (short for *my daily record*) to address some of the existing shortcomings of the present patient self-care practices. It makes use of mobile learning as a means of improving patient self-care management by providing a new channel for educating the patient on better lifestyle choices. Given the high prevalence of Type II diabetes in the Caribbean region, the system concentrates on this category but can be extended to cater for other diseases in later versions. This application is one of the components of the Caribbean-wide Healthcare Management System called MediNet (Mohan et al, 2008) currently being developed by researchers at The University of the West Indies.

LITERATURE REVIEW

Diabetes Self-Management Education

Diabetes self-management education (DSME) is the process of facilitating the knowledge, skill, and ability necessary for diabetes self-management (Funnel et al 2009). It takes into account the needs, goals, and history of the person living with diabetes and is guided by evidence-based standards. The overall objective of DSME is: to support informed decision-making, self-care behaviors, problem-solving and active collaboration with the health care team. The end results are improved clinical outcomes, better patient health status, and an enhanced quality of life for the diabetic (De Weerd et al 1989).

DSME has evolved over the years. One important change is the understanding of the need for ongoing support for patients to sustain the new self-care practices being developed. Funnel et al (2007) refer to this as Diabetes Self-Management Support (DSMS). This paper falls under the umbrella of DSMS but concentrates on the role education plays in the self-management process. In this paper we use the term DSME to refer to educational dimension of the DSMS initiative.

DSMS is strongly emphasized by the Chronic Care Model shown in Figure 1. Wagner (1998) presents a framework for reengineering chronic care delivery systems; one that is more aligned with preventive care. The underlying principle of the Chronic Care Model is that improved outcomes will result from productive interactions between informed, empowered patients and prepared, proactive, practice teams. These enhancements in self-management are sustained by information support, delivery system redesign, decision support, links with community services, and health system support.

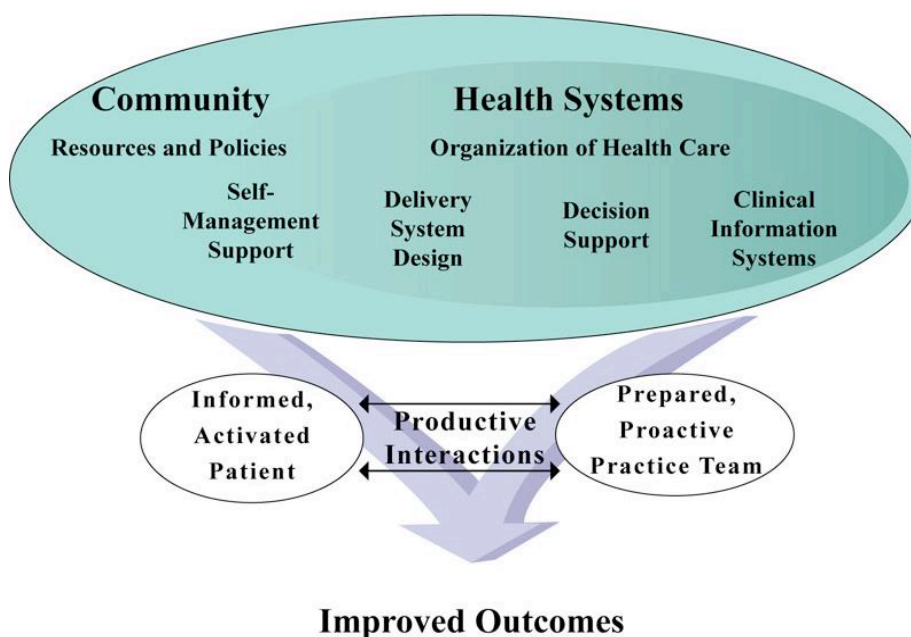


Figure 1: Chronic Care Model, sourced from The MacColl Institute © ACP-ASIM Journals and Books.

Four Models of Self-Management

(AHRQ 2007) has identified four models of self-management support: the internal primary care model, the external on the ground model, the external call center model and the remote model.

In the primary care model, self-management support is usually provided directly by the health care provider's offices and usually includes face-to-face contact in an office setting. In contrast to the primary care model, programmes that fall in the external on-the-ground model are managed from outside the primary care setting. Such programmes differ from each other in the nature and degree of personal interaction between the self-management providers and the patient.

In the external call center model, self-management support is provided under the coordination of an organizational entity external to the local health care. Self-management support is provided by phone from a centralized call center as opposed to face-to-face interaction.

The authors describe the remote model as programs that deliver education content through some computer-generated means, e.g. via the Internet or voice automated call center and with no personal interaction, limited focus, and usually with little feedback from patients. The research described in this paper is extending the definition of the remote model to include technologies that foster personalization and collaboration between health care provider and patient.

Current Approaches and Challenges Faced with DSME

Research (Noriss et al 2002) has shown that most of the present education initiatives have involved programmes at community gathering places, at the home, in camps, schools and in some cases the worksite. Community based initiatives often offer the benefit of cultural relevancy. Each culture may have a different learning style that can be catered for in a community setting. Interventions that take place in the home involve an educator visiting the home to assess and address diabetes related issues with the patient that may be more challenging to attend to in a clinical setting. Diabetes self-management education in schools and camps focuses on the use of established institutions for adolescents with Type I diabetes. The objective is to educate the children on personal responsibility for the care of their disease while providing them with a traditional schooling or camp experience. Interventions at the worksite make it easier for people with diabetes to attend while including their supervisor, managers and colleagues who may also gain from the knowledge.

There are many challenges with the current approaches to DSME. Firstly the number of people living with diabetes is increasing. It is estimated that by the year 2010, the number of Caribbean people living with diabetes will be 20 million (Jones, 2004). Next there is presently a shortage of diabetes educators in the region. A diabetes educator is someone who assists in the advancement of diabetes self-management training practices as an integral component of health care for persons with diabetes. In 2003, the International Diabetes Federation for the North American region organized a series of diabetes courses geared towards diabetes educators (Jones, 2004). The aim of these courses was to ensure a high standard of diabetes education in the region. This programme was one of the first of its kind and an advanced programme is expected to be developed and rolled out soon.

Another challenge is that the number of persons receiving DSME is small. In the Caribbean, people are usually exposed to DSME: (1) in a clinical setting, usually once every three months, (2) at their monthly diabetes association meeting, and (3) through the media (Ragbirsingh, 2005). These forms of education delivery are useful in providing information on diabetes but not as effective in enforcing or developing better self-care habits as follow up is rarely performed. Diabetes is a disease that requires daily control and therefore some ritual building techniques are needed in order to effect change (Sultan et al, 2009).

The current delivery of DSME is provider-centric. To some extent it can even be a stressful experience as the patient has to wait in line at the clinic for the majority of the day to be seen by a health care provider. During the patient's session, feedback is given on the current reading and does not take into consideration other factors which may be undocumented or unavailable at that time. In this way the evaluation does not take into account the entire picture.

People also find it difficult to incorporate DSME into their daily routine. For example, some persons living in rural areas which do not have a clinic and therefore must travel a great distance, and even in some cases to another island to receive treatment. Attending DSME meetings is also a challenge as other high priority items come up during the course of the day and therefore the commitment to attend dwindles. Additionally, because of security concerns, people may be reluctant to attend such meetings at a late hour which is the typical timing of such meetings.

One of the most common hurdles to overcome is that some people are not aware that they need education. Even if the person is diagnosed, they may not know how lifestyle practices affect their control of the disease. Furthermore, poor communication structures may be present between the patient and the educator whereby the patient does not keep a daily record of her reading and therefore the information provided may not necessarily be tailored to the patient's present

condition. Also, the educator may not convey the information in terms that the patient understands.

Lastly, DSME requires team care. Therefore a number of specialists are required to assist the diabetic in each area of the DSME curriculum – Figure 2. Presently such an initiative will require a separate meeting with each specialist and more effort and stress on the part of the patient. Therefore there is a need for collaborative health care delivery.

In summary, instead of trying to fit patients into predetermined self-management programmes, flexible self-management interventions that are tailored to the individual lives of patients are needed. The DSME initiative should also be easily accessible to all patients regardless of economic, social, and environmental circumstances.



Figure 2: Standard 6, National Standards for DSME (Funnell et al, 2007)

Mobile Telephony as an Alternative Platform for Health Care Delivery

The use of mobile telephony as a channel for health care services is a recent trend. (Longoria 2001) explains that mobile phones have four characteristics that make them suitable as a new health care platform: personal, ubiquitous, connected and increasingly intelligent. Since each phone is associated with a person, applications can be customized and personalized to suit. Mobile users can also monitor their health on the go, anywhere and anytime. Lastly, the connectivity and networking capabilities allowed by these portable devices can also harness the benefits of community based interventions.

Mobile telephony is a very attractive platform for use in the Caribbean region. The cost of owning a mobile phone has dropped significantly over the years and almost everyone today owns a mobile phone and some even own two. Furthermore, wireless communications infrastructure has wider reach and appeal and is capable of providing a range of services on the go. It is primarily this low cost and ubiquity which makes mobile telephony particularly suitable for developing a solution to address the DSME challenges of the Caribbean.

Many systems have been developed to address the need for proper health care self-monitoring and recording through the use of mobile phones (Becker et al 2004 & Holopainen et al 2007).

However, very little research has been conducted on the use of mobile phones as a channel for personalized health care education. The myDR application addresses this area.

The system focuses on the delivery of adult education given the fact that Type II diabetes usually occurs in the later stages of life. Demirbilek (2009) discusses how recent advances in information and communication technology (ICT) have created new opportunities for adult education, impacting on the way we teach, learn and deliver education. Furthermore, the use of ICT facilitates adult learning principles, namely: non-linearity, instant feedback, and allowing the learner to reflect their opinions and experiences.

MYDR APPLICATION

myDR is a software application, based on the Chronic Care Model, specifically designed to be used on a mobile phone to assist patients in managing their diabetes. It allows the user to enter and record their readings obtained from the selected glucometer and blood pressure meter. The application was developed for the HTC Touch Smartphone (HTC Corporation, 2009) and uses the LifeScan OneTouch Ultra 2 Meter (LifeScan Inc. 2009) with the Polytel Wireless Glucose Meter Accessory (PolyMap Wireless 2008) and the A&D blood pressure meter (A&D Company Ltd. 2009).

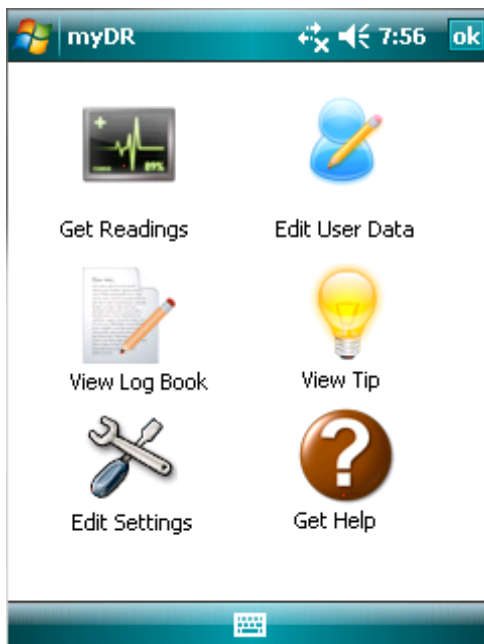


Figure 3: myDR Application Main Menu Screen Shot

Figure 3 displays the graphical user interface of the myDR application. It contains options such as:

- *Get Readings* from meter,
- *Edit User Data* to update the patient's profile,
- *View Log Book* of previously measured readings in the form of tables and graphs,
- *View Tip* to advise the patient regarding the accumulated measurements, and
- the *Get Help* feature provides the user with instructions on how to use the system.

The patient uses the system to log readings taken using a Blood Sugar and Blood Pressure meter. These readings are captured along with some context information regarding the reading taken including diet, time of day, exercise level and stress level.

The education provided through the system is tailored to the individual patient, taking into consideration the current readings obtained from the patient, historical readings stored in a patient model, and knowledge areas about diabetes stored in a content knowledge base. Algorithms determine what knowledge area to focus on given the current situation of the patient. Personalization is also done at the group level where diabetes related information is sent to all users of the myDR application via SMSs. The group level education allows for the delivery of information that is relevant to all members of the target group, for example, nutrition data on local foods. Figure 4 illustrates an example of individual feedback received after a reading and a group SMS relating to diabetes education.

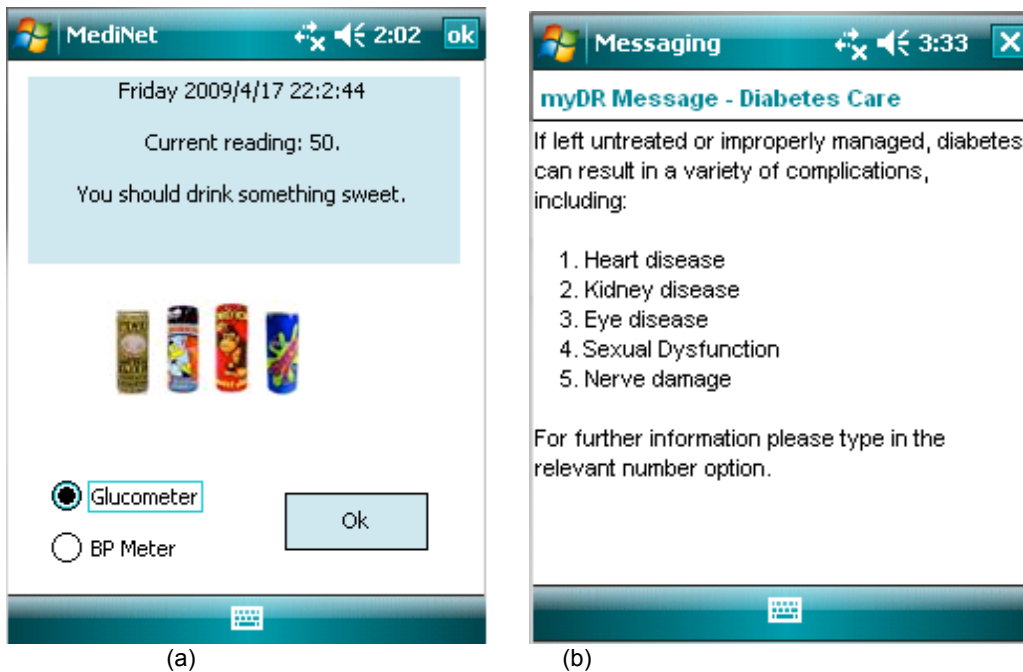


Figure 4: (a) myDR Individual Feedback (b) myDR Group SMS

EXPERIMENTAL DESIGN

The deployment of the system is broken up into six stages: (1) usability testing of the myDR application with 15-20 patients, (2) infrastructure testing with 15-20 patients in Trinidad and Tobago (3) clinical trials with 150-200 patients in Trinidad and Tobago, (4) system made available in Trinidad and Tobago, (5) clinical trials with 150-200 patients from the wider Caribbean region and (6) system made available in Caribbean region. This paper focuses on the first phase of the deployment, the usability testing.

The usability testing was one of the first stages in directly testing the hypothesis that diabetes-centered mobile learning will improve the self-care practices of the patients living with diabetes. To test the hypothesis, the myDR mobile application was used.

The participants were invited to the study on a volunteer basis. Table 1 shows a summary of the participant profile. At the start of the study the objectives and confidential nature of the study were explained and each participant signed a consent form. Two questionnaires were administered to the group at the beginning of the trial. The first questionnaire was used to gather information on the participant's current health care process (if any) and the second questionnaire was used to obtain information on the participant's mobile phone usage.

During the study there was an independent observer who recorded all of the participants' feedback. All participants were asked not to talk to the observer during the trial and use the "think aloud" approach when navigating through the system. The users were observed as they interacted with the system and all observations were recorded, including any challenges faced.

Table 1: Participant Profile

Diabetes	Type II	Owns Glucometer	6
Age Range	45-70	Owns Blood Pressure Meter	6
Gender	4 Males and 11 Females	Non Mobile Users	3
Residence	Trinidad and Tobago		

RESULTS AND DISCUSSION

The objective of the user study was to obtain some preliminary feedback on the usefulness and feasibility of the myDR mobile learning initiative.

73.33% of the participants were inclined to use the system as a channel for diabetes education. The other 26.67% had no preference. The most popular reasons for using the system were: "availability, almost everyone owns a mobile", "easy to use" and "the information provided was meaningful and relevant to the patient." All the participants, with the exception of one, were not enrolled in any formal diabetes education program. One participant was a member of her local diabetes association and attended meetings every three months.

Most of the participants obtained their health care education from their health care provider, TV shows and articles. The participants also unanimously believed that the system will improve their self-care process. They especially liked the idea of the reminder feature to take their next reading as well as the feedback obtained on each reading. Timely feedback was important as it kept them motivated in maintaining their self-care regime.

FUTURE WORK

The next stage of the project is on the way. This involves the testing of the different information technology components of the MediNet system: health care devices, mobile phones,

telecommunications infrastructure, and server-side processes. The clinical trials are expected to begin in November 2009.

Additional features will be implemented in the myDR system. This will include a peer support network which will enable patients to share and learn from each other's experiences. It will also provide different modes of interacting with the system. Currently the patient uses the stylus of the phone to select the different menu options and activate the required features. Voice input, gesture input and camera input will be evaluated as alternative forms of interacting with the system. Moreover, new visualization strategies will be used to represent the health education being delivered.

Delivery will also take into account the culture of the target group so as to have a greater impact. Culture is important in this type of system. An understanding of the cultural differences is central to the success of any educational intervention (Ragbirsingh, 2005). Religious ceremonies are an integral part of life for people living in the Caribbean and as in most festivals, food plays an important and sometimes symbolic role. The system would educate the patient on the consumption of alternative foods that are lower in caloric and fat content while recognizing the cultural significance.

CONCLUSION

Research has shown that diabetes self-management education is effective in the treatment of diabetes. However, there exist some challenges with the current practices used. The paper lays the foundation for further research in providing DSME in the Caribbean region using mobile telephony. The ubiquity of the mobile phone and the fact that it is available anywhere and at anytime makes it a good candidate for health care education initiatives. This paper presents results of a usability study conducted for a new mobile learning application called myDR. The myDR application provides a new channel for the delivery of diabetes education. The application provides education both at the individual and group level. The results of the user study show that the majority of participants preferred this system over their existing diabetes education programme. Moreover, the participants believed that the relevance and timeliness of the information delivered contributed to its effectiveness. Future research on the application will involve peer support mobile networks, multimodal input methods and the utilization of appropriate visualization techniques which will exploit the capabilities of the mobile device.

REFERENCES

- Agency for Healthcare Research and Quality (AHRQ), Rockville, MD. 2007. "Patient Self-Management Support Programs: An Evaluation." Final Contract Report. AHRQ Publication No. 08-0011. Accessed at: <http://www.ahrq.gov/qual/ptmgmt/>.
- A&D Company Ltd. 2009. *A&D BP Meter Website*. <http://www.aandd.jp/>. Date last visited: May 6th, 2009.
- Becker, S., Sugumaran, R., & Pannu, K. 2004. "The Use of Mobile Technology for Proactive Healthcare in Tribal Communities." *Proceedings of the 2004 Annual National Conference on Digital Government Research*, pp. 1-2. Accessed at: <http://dgrc.org/dgo2004/disc/demos/tuesdemos/becker.pdf>.
- De Weerd I, Visser AP, van der Veen EA. 1989. "Attitude Behaviour Theories and Diabetes Education Programmes." In the *Patient Education Counseling* journal, Vol. 13, pp. 3-19.

- Demirbilek, M. 2009. "Exploring the Status of ICT Use in Adult Education: Perspectives from Eight European Countries – 'Reflections, Insights, and Challenges' ". In *International Journal of Education and Development using Information Technology (IJEDICT)*, Vol. 5, Issue 3.
- Douglas, D. 2007. Presentation on CNCDS in the Region, *CARICOM Summit on Chronic Non-Communicable Diseases*, September 2007.
- Funnell, M. et al. 2009. "National Standards for Diabetes Self-Management Education." In *Diabetes Care*, Vol. 32 Supplement 1, January 2009.
- Funnell, M, Tang, T. & Anderson, R. 2007. "From DSME to DSMS: Developing Empowerment-Based Diabetes Self-Management Support." In *Diabetes Spectrum*, Vol. 20, Issue 4, pp. 221-226.
- Hennis, A. & Fraser HS. 2004. "Diabetes in the English-speaking Caribbean". In the *Pan American Journal of Public Health*. 2004; Vol.15, Issue 2, pp. 90-3.
- Holopainen, A., Galbiati, F., & Voutilainen, K. 2007. "A complete mobile eHealth solution for diabetes management". Accessed at: <http://www.ehit.fi/resources/userfiles/File/Med-e-Tel%202007%20-%20Holopainen%20-%20Diabetes.pdf>.
- HTC Corporation. 2009. *HTC Touch website*. <http://www.htc.com>. Date last visited: May 6th, 2009.
- Jones, D. 2004. "Diabetes Education: Training Trainers in the Caribbean." In *Diabetes Voice*, March 2004, Vol. 49, Issue 1, pp. 14-16.
- LifeScan Inc. 2009. *OneTouch Meter Website*. <http://www.lifescan.com/>. Date last visited: May 6th, 2009.
- Longoria, R. 2001. "Designing Mobile Applications: Challenges, Methodologies, and Lessons Learned." In *Usability Evaluation and Interface Design: Cognitive Engineering, Intelligent Agents and Virtual Reality*, pp. 91-95. New Jersey: Lawrence Erlbaum Associates Inc.
- Mohan, P., Marin, D., Sultan, S., & Deen, A. 2008. "MediNet: Personalizing the Self-Care Process for Patients with Diabetes and Cardiovascular Disease Using Mobile Telephony." In *Proc. 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*. Vancouver, Canada, 20-24 August 2008, pp. 755-758.
- Norris S. et al. 2002. "Increasing Diabetes Self-Management Education in Community Settings – A Systematic Review." In the *American Journal of Preventative Medicine*, Vol. 22, Supplement 4, pp. 39-66. May 2002.
- PolyMap Wireless. 2008. *Polytel Wireless Glucose Meter Accessory (GMA) Website*. <http://www.polymapwireless.com>. Date last visited: May 6th, 2009.
- Ragbirsingh, Z. 2005. "Enhancing Diabetes Education and Awareness Using Limited Resources." In *Diabetes Voice*, March 2005, Vol. 50, Issue 1, pp. 22-24.
- Sultan, S., Mohan, P., Sultan, N. 2009. "Managing Change: Experiences from a New e-Health Initiative for Patients with Diabetes and Cardiovascular Disease." In 1st IEEE International

WoWMoM Workshop on Interdisciplinary Research on E-Health Services and Systems. Kos, Greece, 15-19 June 2009.

Wagner EH. "Chronic Disease Management: What will it take to improve care for chronic illness?" In the journal for *Effective Clinical Practice*. Volume 1, Issue 1, pp. 2-4. August-September 1998.

World Health Organization (WHO). 2008. Diabetes Fact Sheet N°312. November 2008. Accessed at: <http://www.who.int/mediacentre/factsheets/fs312/en/>.

World Health Organization (WHO). 2002. Diabetes Fact Sheet N°172. October 2002. Accessed at: <http://www.who.int/mediacentre/factsheets/fs172/en/index.html>.

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