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<LRH>**HADDAD ET AL.**

<RRH>**TEXT MESSAGING SUPPORT IN TYPE 2 DIABETES**

<SH>**ORIGINAL ARTICLE**

<CT>A Feasibility Study of Mobile Phone Text Messaging to Support Education and Management of Type 2 Diabetes in Iraq

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<ABSH>**Abstract**

<ABS>***Background:*** We undertook a feasibility study to evaluate feasibility and utility of short message services (SMSs) to support Iraqi adults with newly diagnosed type 2 diabetes.

Subjects and Methods: Fifty patients from a teaching hospital clinic in Basrah in the first year after diagnosis were recruited to receive weekly SMSs relating to diabetes self-management over 29 weeks. Numbers of messages received, acceptability, cost, effect on glycated hemoglobin (HbA1c), and diabetes knowledge were documented.

Results: Forty-two patients completed the study, receiving an average 22 of 28 messages. Mean knowledge score rose from 8.6 (SD 1.5) at baseline to 9.9 (SD 1.4) 6 months after receipt of SMSs ($P = 0.002$). Baseline and 6-month knowledge scores correlated ($r = 0.297$, $P = 0.049$). Mean baseline HbA1c was 79 mmol/mol (SD 14 mmol/mol) (9.3% [SD 1.3%]) and decreased to 70 mmol/mol (SD 13 mmol/mol) (8.6% [SD 1.2%]) ($P = 0.001$) 6 months after the SMS intervention. Baseline and 6-month values were correlated ($r = 0.898$, $P = 0.001$). Age, gender, and educational level showed no association with changes in HbA1c or knowledge score. Changes in knowledge score were correlated with postintervention HbA1c ($r = -0.341$, $P = 0.027$). All patients were satisfied with text messages and wished the service to be continued after the study. The cost of SMSs was €0.065 per message.

Conclusions: This study demonstrates SMSs are acceptable, cost-effective, and feasible in supporting diabetes care in the challenging, resource-poor environment of modern-day Iraq. This

study is the first in Iraq to demonstrate similar benefits of this technology on diabetes education and management to those seen from its use in better-resourced parts of the world. A randomized controlled trial is needed to assess precise benefits on self-care and knowledge.

<H1>**Introduction**

<CIC>DIABETES MELLITUS IS A COMMON disorder in many parts of the world, particularly the Middle East. Previous reports from Southern Iraq suggest an overall population prevalence of all forms of diabetes of 7.4%, with impaired fasting glycemia present in a further 2.0%.[1] The overall prevalence of undiagnosed diabetes in the general population of Iraq is 2.1%, with the highest prevalence of abnormal glucose homeostasis and diabetes being seen in the age range 40–59 years in both sexes.[1] Type 2 diabetes is the most frequent subtype of diabetes and requires treatment by life-style modification and/or oral medication with insulin therapy in some cases. Diabetes education is an integral component of clinical care and forms the basis for self-management. Lack of satisfactory patient education about diabetes and allied health subjects leads to fear, mistrust, and resentment.[2] In Iraq, unawareness of the long-term complications of diabetes is a problem in 30.7% of affected individuals, with 20.9% believing diabetes to be an untreatable disease.[3] Ongoing challenges to the health infrastructure in Iraq produce major difficulties in the provision of care and support to improve the health of people affected by type 2 diabetes.[3]

The potential of mobile phones to support health care is being increasingly recognized.[4] The short message service (SMS), otherwise known as "text messaging," is one of the oldest, simplest, and most commonly used features of mobile phones and provides a method of communicating with patients, irrespective of their location and time. Studies of the utility of the

SMS in diabetes healthcare contexts have been conducted in many different countries, including Austria, Japan, France, Korea, Norway, Spain, the United Kingdom, and the United States,[5] although few studies have been reported from resource-poor countries. SMSs have been used to provide patient reminders, psychological support, details of medical appointments, reports of critical medical events, laboratory results, and even surveys in other healthcare contexts.[6] In South Africa, SMSs have been used to transmit laboratory results to support the management of tuberculosis.[7] Elsewhere in resource-constrained environments, SMSs have been used to enhance human immunodeficiency virus/AIDS treatments.[8]

An extensive literature review of mobile phone use to support diabetes management[5] suggests that SMSs are effective in type 2 diabetes, although few studies have been reported from the Gulf Region and none from Iraq. One Gulf study conducted in Yazd, Iran has explored the potential of SMSs to support education of patients with diabetes.[9] Another study in type 2 diabetes in Bahrain in which SMSs were used to facilitate communication with patients showed that this technology is acceptable to patients as a way of transmitting information and led to a reduction in glycosylated hemoglobin.[10] Two studies have measured outcomes from SMS support related to knowledge and skills as measured by the Diabetes Knowledge Test from the Michigan Diabetes Research and Training Center (Ann Arbor, MI).[11]

In Iraq, provision of diabetes education to ensure adequate knowledge about self-care and to prevent many misconceptions represents a major challenge in diabetes care. SMSs have the potential to address this challenge in a modern-day Iraqi context given their relatively low cost, minimal requirement for infrastructure, the increasingly widespread use of mobile phones, and their easy accessibility, unlike Internet resources, which remain relatively limited. The

acceptability and potential of SMSs as a means of delivering health care in Iraq are, however, unknown.

Our aim therefore, was to undertake a feasibility study to explore the feasibility, acceptability, and cost of SMSs in adults living in Iraq with type 2 diabetes. In addition the opportunity was taken to collect data on the potential effect of this intervention on knowledge, glycemic control, and clinic attendance, to inform planning for future studies of the effectiveness of SMSs in this context.

<H1>**Subjects and Methods**

The effectiveness of SMSs was evaluated in a feasibility study in 50 patients with type 2 diabetes recruited from the outpatient clinic in Al-Sadr Teaching Hospital, Basrah, Iran. All patients were in the first year (mean, 6 months) following diagnosis with type 2 diabetes, regardless of microvascular complications and were treated with diet and metformin, with some receiving glimepiride or glibenclamide. Inclusion criteria included possession of a mobile phone device, a minimum intermediate school level of education, or access to assistance in reading SMSs. Explanation of the study was provided to all participants, and oral consent was obtained as is the standard for clinical research studies in Iraq. Ethical approval for this study was granted by Basrah Medical College.

Each patient provided a mobile phone number for a phone on which they were happy to receive SMSs designed to enhance their diabetes-related knowledge. One text message was sent weekly to each patient using the website www.bulksms.com [Celerity Systems (Pty) Ltd., Century City, South Africa). Patients' mobile numbers were uploaded onto the system, and each text message was sent to each patient at the same time participants preferred weekly (most

commonly Friday afternoons), with SMSs delivered from March 2011 to October 2011. SMSs were limited to 70 characters in unicode form, allowing messages to be sent in Arabic.

The feasibility of delivering SMSs was evaluated by collecting data from patients regarding the numbers of messages received and summary data relating to failed delivery of messages from the website. Patients were asked to complete a questionnaire that explored the acceptability of the SMS intervention. Costs were calculated and expressed adjusted for the numbers of SMSs delivered.

The text messages were categorized into five education-related themes relating to diet, treatment, complication awareness, blood glucose monitoring, and enhancement of clinic attendance. These messages were largely reminders about aspects of management, and examples are shown in Table 1<T1>. In total, 1,316 messages were transmitted at weekly intervals over a period of 7 months using the sequence shown in Figure 1<F1>.

All participants were asked to complete a baseline questionnaire evaluating their knowledge level. This questionnaire was adapted from the Diabetes Knowledge Test from which 14 general questions were used after translation into Arabic.[12] Each question contributed one mark to a potential total of 14 marks. Glycemic control was monitored by measurement of glycated hemoglobin (HbA1c) using the enzymatic method supplied by Diazyme Laboratories (Poway, CA) and was measured at baseline and 6 months. Also after 6 months, the Diabetes Knowledge Test score was reassessed, and marks were compared with baseline marks to evaluate change in knowledge level as the primary outcome.

Statistical analyses in the form of paired-samples *t* tests and correlations using SPSS version 15.0 software for Windows 7 (SPSS, inc., Chicago, IL) were performed to compare the Diabetes Knowledge Test scores and HbA1c at baseline and 6 months. Linear regression was

done to evaluate the effect of age, gender, and educational level, and findings were considered statistically significant when $P < 0.05$.

<H1>**Results**

Forty-two of the 50 patients with type 2 diabetes who were recruited from the outpatient clinic in Al-Sadr Teaching Hospital completed the study (Fig. 2<F2>). Three patients were lost to follow-up because they provided the wrong mobile number during registration for the study, another four patients failed to attend clinic to complete the post-test questionnaire, and one patient transferred his clinical care to the private sector. The mean age of those completing the study was 51.4 (SD 10.3) years, and 12 (28.6%) were male. Fifty percent of the participants had received higher (secondary school and college or university) education.

After an account had been created, a total of 4,500 credits was purchased over four time periods at a total cost of around €147.40 (€1.0 = USD1.4), resulting in a cost of €0.065/message (two credits were required to generate one text message). On average, patients received 22 of the 28 intended messages. The main reasons for undelivered messages were interference from the telecommunications vendor in an attempt to stop sender ID, the patient changing the SIM card or traveling, or the SMS hanging in an upstream position when the patient was beyond the reach of the mobile network.

The mean knowledge score prior to the intervention was 8.6 (SD 1.5), which rose to 9.9 (SD 1.4) afterward. This increase (mean [SE], 1.29 [0.265]) was shown to be significant using the paired-samples *t* test ($P = 0.002$). Linear regression demonstrated that age, gender, and educational level were not related to increased knowledge. Knowledge scores before and after the SMS intervention were correlated ($r = 0.297$, $P = 0.049$).

Mean baseline HbA1c was 79 mmol/mol (SD 14 mmol/mol) (9.3% [SD 1.3%]) and decreased to 70 mmol/mol (SD 13 mmol/mol) (8.6% [SD 1.2%]) after the SMS intervention (mean [SE] decrease 8.5[1] mmol/mol). A paired-samples *t* test showed this change to be significant ($P = 0.001$). Linear regression showed that age, gender, and educational level were not associated with changes in HbA1c level, although baseline and 6-month HbA1c values were correlated ($r = 0.898$, $P = 0.001$). Changes in knowledge scores were correlated with post-SMS intervention HbA1c ($r = –0.341$, $P = 0.027$) (Fig. 3<F3>), although changes in HbA1c and changes in knowledge scores were not correlated ($r = 0.149$, $P = 0.345$).

The questionnaire survey showed that all patients were satisfied with text messages and wished the service to be continued after the study. They also reported that they had received messages at appropriate times, and 90.5% of the patients found the messages understandable. Thirty-eight percent of patients tried to reply to the SMSs.

<H1>**Discussion**

This feasibility study, which is the first of its kind in Iraq, demonstrates that SMS is a feasible and acceptable way of promoting knowledge of diabetes in affected individuals living in Iraq and reflects the generally positive outcomes of studies that have evaluated the effectiveness of SMSs in various aspects of diabetes care in other parts of the world.[5] Initial experience in message development and transmission suggests that this may offer a cost-effective means of providing ongoing healthcare support to patients given the increasingly widespread use of mobile phones in Iraq and their widespread accessibility, much unlike Internet resources. Provision of education through SMSs represents an easy way to provide knowledge for patients with type 2 diabetes in Iraq, 90.5% of whom found the messages understandable and wished the service to

continue. The fact that 38.1% of patients tried to reply to the message despite instruction at the start that this would not prove possible shows that clear guidance regarding the limitations of the service is important when such services are introduced. The main limitations to this approach were the interference from the telecommunications provider, which attempted to stop some of SMSs, and the loss of some SMS messages when the recipient was located beyond network reach.

Initial experience in message development and transmission suggests that this method of communication can also offer a cost-effective method of providing ongoing healthcare support to patients given the increasingly widespread use of mobile phones in Iraq. The total text messaging cost was around €147.40, resulting in a cost of €0.065 per message.

It has been shown that sending educational text messages via mobile phones is an effective way of increasing recipients' knowledge. Our participants' level of knowledge increased significantly after the intervention which is consistent with the findings of Fatehi<AQ2> et al.,[9] who found SMSs were an effective means of conveying information to patients in an Iranian context. Although we observed an increase of just over one correct answer for each participant, it is difficult to comment on whether this increase or the absolute level of knowledge gained is clinically sufficient. In a Middle Eastern population in the United Arab Emirates, diabetes knowledge scores have been subdivided into three categories for the larger 23-point questionnaire[13]: a score of 19–23 was defined as "good knowledge," a score of 15–18 as "moderate knowledge," and 0–14 as "poor knowledge." Extrapolating to the short form we have used, good knowledge could be defined as the equivalent score of 12–14, moderate as 10–11, and poor as 0–9. There is clearly therefore a need to facilitate further improvements in knowledge in our population to support optimal clinical outcomes. A limitation of our feasibility

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study is that it did not have a control group. We cannot therefore exclude the possibility that knowledge scores would have increased anyway during this time period, relatively early after diagnosis when education may have been provided as part of routine clinical care in addition to that provided through participation in the study. Text messaging has been found to be a suitable method for providing information to individual patients as well as larger groups of people. Ferrer-Roca et al.[14] suggested that SMSs may provide a simple, fast, efficient, and particularly suitable adjunct to the management of diabetes. SMSs may be particularly useful for targeting teenagers,[4] an age group that is known to have particular difficulties in controlling their diabetes. Although mean glycemic control in our cohort failed to achieve the ideal target of an HbA1c concentration less than 7.0% (53 mmol/mol), HbA1c concentrations decreased from baseline levels, a finding consistent with that reported by Liang et al.[15] However, it is not possible to attribute this effect to our intervention in the absence of a control group.

Mobile phone technology has made a recent and rapid appearance in low- and middle-income nations.[16] Education and awareness programs within the mobile health field have recognized the potential of SMSs for transmitting information about various subjects on a large scale, including testing and treatment methods, availability of health services, and disease management. Formal studies and evidence demonstrate that SMSs have a measurable impact on and greater ability to influence behavior than radio and television campaigns.[17] Additionally, SMSs have the potential to reach remote, rural areas with limited access to public health information and education and health clinics and where there are few healthcare workers. Studies in developing countries have shown that patients who received SMS support have significantly improved adherence to antiretroviral therapy with improved rates of viral suppression compared with controls.[18] A 2007 Thai study showed that patients with tuberculosis who received daily

text message medication reminders improved adherence to over 90%.[19] Mobile phones therefore, seem to provide an effective tool to improve patient outcomes in resource-limited settings. In postconflict regions like Iraq, the need for such technology to deliver care especially in underserved and remote areas is urgent and timely.

In conclusion, our study demonstrates that, in a modern-day Iraqi healthcare context with the particular challenges that have arisen following the recent conflicts and associated degradation of the healthcare infrastructure,[20] SMSs are an acceptable and feasible way of potentially improving diabetes knowledge. The value of this intervention in Iraq now needs to be tested in a randomized controlled trial to quantify the precise benefits and to resolve some minor practical problems encountered in delivering the intervention. The success of this pilot study suggests that investment should be made in Iraq in a mobile health infrastructure to support future trials aimed at facilitating healthcare delivery, particularly in a diabetes context.

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<H1>**Author Disclosure Statement**

J.W.G. declares receipt of fees for attending an Advisory Board for Bayer and speaker's fees from Pfizer. N.S.H., R.I., N.P., F.A.K.K., T.A.H., T.P., and N.A. declare no competing financial interests exist.

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<TN>TABLE 1.<TH>EXAMPLES OF THE CONTENT OF TEXT MESSAGES SENT TO PATIENTS

Topic of SMS	*Example*
Diet	"Honey and dates cannot be eaten freely as they can disturb diabetes control."
Treatment	"If you remember an hour or two late that you have forgotten a tablet, take it then. If it is longer since you missed the dose then take your next tablet at the usual time."
Complications	"Take care of your feet. Feet problems can occur if you have diabetes, however your diabetes is treated."
Blood glucose monitoring	"Check your blood sugar four hours after meals and not immediately after eating."
Clinic attendance	"Visit us at the Diabetes Center to check your Hemoglobin A1c."

<TFN>SMS, short message service.

<FGN>**FIG. 1.**<FGCAP>Sequence of text messages sent to patients. SMS, short message service.

<FGN>**FIG. 2.**<FGCAP>Study design and patient sample selected.

<FGN>**FIG. 3.**<FGCAP>Correlation between knowledge score change and glycated hemoglobin (HbA1c) (in mmol.mmol) after 6 months.

<AQ1>Give correct academic degrees for all authors. MD/PhD added as placeholders.

<AQ2>Changed to match reference list.

<AQ3>Give first names or initials of all person being acknowledged.

<AQ4>Give all authors and not et al.

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