Text messaging interventions to glycemic control in type 2 diabetes adults: systematic review

Mensajes de texto para el control glucémico en adultos con diabetes tipo 2: revisión sistemática

*Valles Ortiz, Patricia M **Miranda Felix, Patricia ***García Sosa, Elia S

*PhD in Nursing Sciences, Faculty of Nursing at the Universidad Autónoma de Nuevo León. E-mail: pvalles@uacj.mx  **Full time professor, Nursing Program at the Institute of Biomedical Sciences of the Universidad Autónoma de Ciudad Juárez. ***Professor at the Nursing School of the Universidad Autónoma de Sinaloa. México.

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Palabras Clave: diabetes tipo 2; hemoglobina glucosilada; mensajes de texto; teléfono móvil

ABSTRACT

Objective: The aim of this systematic review was to evaluate the effectiveness interventions that have used text messaging in the reduction of glycosylated hemoglobin levels in type 2 diabetes patients.

Methods: a systematic review of articles published in the MEDLINE database, Elsevier, Springer, DARE, CINAHL, Scopus, and Open Access, eight interventions studies that met the inclusion criteria, were identified.

Results: Intervention using short message services of cellular phones improved HbA1c levels and improved the metabolic control in T2D adults.

Conclusions: The use of text messaging in the management of T2D, is presented as a suitable, practical, and well accepted technology, it has strong potential for providing effective, ongoing support in the future. However the research studies, showed that the evidence is not yet conclusive to the improvement in glycemic control.

RESUMEN

Objetivo: Evaluar la evidencia disponible sobre la efectividad de las intervenciones que han utilizado mensajes de texto para la disminución de los niveles de hemoglobina glucosilada en el control glucémico en personas con DT2

Métodos: Se realizó una revisión sistemática en las bases de datos MEDLINE, Elsevier, Springer, DARE, CINAHL, Scopus, y Open Access, se identificaron ocho artículos que cumplieron con los criterios de elegibilidad para evaluar el uso de los mensajes de texto y los niveles de HbA1c.
Resultados: El envío de mensajes de texto a través de teléfono móvil mostró una disminución de los niveles de hemoglobina glucosilada en pacientes adultos con DT2

Conclusiones: La utilización de mensajes de texto en la atención de los pacientes con DT2, se presenta como una tecnología factible y bien aceptada sin embargo los estudios señalaron que la evidencia aún no es concluyente en la mejoría del control glucémico.

INTRODUCCIÓN

Diabetes has been identified as a health problem that affects high, middle and low income populations. The cost associated with its treatment and its complications represent the greatest burden not only to health services but also to patients and their families1. The World Health Organization (WHO) estimates that the number of people with diabetes in the world is 347 million and foresees that this figure will double by the year 2030. It also points out that 90% of cases belong to the category of type 2 diabetes (T2D). This data makes diabetes one of the greatest threats to public health in the 21st century2. In Mexico, T2D is considered the greatest health problem among the population. In the 2012 Survey of National Health3, 6.4 million people affirmed to have been diagnosed with diabetes. T2D is considered to be the primary cause of death and is the most frequent cause of premature impairment, blindness, terminal renal failure and non-traumatic amputations. Finally, it is a disease that is often not diagnosed until after its complications have appeared4,6.

Foremost, T2D is an illness that entails self-management, and its treatment is highly associated with behavior modification. Once diagnosed, people with T2D are responsible for managing their disease and, therefore, for carrying out both the pharmaceutical and the non-pharmaceutical actions prescribed in the therapeutic plan8. Performing these actions requires permanent support such as counseling and orientation from health professionals concerning diet, physical activity, medication oral intake, insulin injection and self-monitoring of capillary blood glucose in order to achieve optimum control of the disease and avoid or delay complications. Due to the long lasting nature of T2D, it is necessary to implement alternate strategies to ensure long term improvement7-9. Wireless phone service is one of the most widespread technologies throughout the world; thus, it is no surprise that it is considered for medical applications and those specific programs be developed to foster self-control of chronic diseases such as diabetes10-12.

For literary revision, the study used Cooper’s seven step methodology13. All available evidence shows that information and communication technologies (ICTs) have enabled remote monitoring of results for different physiological variables, thus fostering better disease management in T2D patients and rendering additional benefits such as a decrease in the number of visits to the hospital while offering patients real-time support for their health condition. This technology makes it possible to send self-management-promoting reminders regarding their capillary glycaemia and levels of glycosylated hemoglobin (HbA1c), as well as motivation and educational messages conducive to self-care14,15. Although some studies show minor results concerning the utilization of information technologies to regulate T2D, message-based interventions oriented to promote patients’ self-control reported an improvement in HbA1c and highlighted the establishment or the improvement of communication between health professionals and patients as one additional benefit17,18.
The relative ease with which a text message or a short message service (SMS) can be sent turns the utilization of mobile phones into an ideal means to exchange information between T2D patients and health professionals. However, very few studies have been published so far which have examined whether mobile phone service is an effective tool to improve glycemic control or whether this kind of support offers enough advantages in self-management follow-up to enact its utilization. The use of remote monitoring systems, along with the intervention of health professionals, offers new opportunities for therapy adjustment in order to support T2D patients.

Consequently, the aim of the revision was to identify the evidence provided by the interventions which evaluated the effectiveness of mobile phone text messages in the actual improvement of HbA1C levels.

METHODS

The revision took place during the months of October and November of 2012. The work plan that the procedure would methodologically follow was outlined initially. The systematic revision was carried out with the utilization of Cooper’s seven step model:

1) Formulation of the problem, which stemmed from the research question: Are the messages sent through wireless mobile phone service useful in the glycemic control of T2D patients? 2) Search for literature, conducted according to selection criteria previously established. 3) Gathering of information in studies which were selected according to their pertinence to the stated purpose 4) Evaluation of the quality of the studies. 5) Analysis and interpretation of the studies’ results. 6) Interpretation of evidence. 7) Reporting of results.

The selection criteria established to conduct the search included the following: articles in English and Spanish published between 2002 and 2012 which described the use of text messages sent through mobile phone service to adults involved in self-management of T2D to maintain their glycemic control and report on their HbA1c.

In order to select information, an Internet search was conducted through the following data bases: Cochrane, CINAHL, Database of Abstracts of Reviews of Effectiveness (DARE), Academic Search Complete, MedicLatina, Open Access, MEDLINE, CENTRAL, ScienceDirect and Academic Google. The key terms used were those obtained in the Medical Subject Headings (MeSH). The search strategy applied was the cross reference of terms and key words with the use of Boolean operators AND, OR and NOT and the end truncation symbols * and “”.

The articles selected from among the data bases were those mentioning the established key terms in their titles and abstracts. In order to obtain a final selection of articles, the authors performed a critical reading of all abstracts, obtaining a total of 74 publications. After examining their titles, 19 articles were excluded, and after evaluating the abstracts, 35 more were disregarded. Of the 20 remaining studies, 12 articles were excluded: 5 of them because they dealt with another type of technology, 2 of them because of inconformity with the type of design, 2 because they observed protocols without results, 2 because their samples included school-age patients with Type 1 diabetes (T1D), and a pilot study which did not include HbA1c measurements. Finally, only eight studies were considered suitable for revision (Figure 1). To ensure the quality of such studies, the Critical Appraisal Skills Program guide for clinical trials in Spanish (CASPe) was used. Furthermore, to analyze information, a format in Microsoft Excel was developed, which recorded the following data: Author, journal,
year of publication, title of the article, aim or purpose of the study, study location, participants, description of the intervention, duration of the intervention, findings, main results and conclusions.

**Figure 1. Flow chart showing the selection process of articles to be revised systematically.**

**RESULTS**

In the final revision, eight studies were analyzed, which complied with previously established selection criteria. Such studies took place in the following locations: 1 in South Korea, 2 in the United States (USA), 1 in India, 2 in Iran and 2 in the United Kingdom (UK). Five of them were randomized clinical trials, two were clinical trials and two were pre-test/post-test studies. The articles were published in different medical journals specializing in the treatment of diabetes, remote medicine and remote care (Table 1).

**Table 1. Articles selected for analysis during revision**

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Country</th>
<th>Design</th>
<th>Sampling</th>
<th>Journal’s Impact Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. 2012</td>
<td>United States</td>
<td>Randomized Clinical Trial</td>
<td>Non-Probability Sampling</td>
<td>0.8</td>
</tr>
<tr>
<td>Goodarzi et al. 2012</td>
<td>Iran</td>
<td>Randomized Clinical Trial</td>
<td>Probability Sampling</td>
<td>4.39</td>
</tr>
<tr>
<td>Istepanian et al. 2009</td>
<td>United Kingdom</td>
<td>Randomized Clinical Trial</td>
<td>Non-Probability Sampling</td>
<td>1.467</td>
</tr>
<tr>
<td>Quinn et al. 2009</td>
<td>United States</td>
<td>Randomized Clinical Trial</td>
<td>Non-Probability Sampling</td>
<td>1.93</td>
</tr>
<tr>
<td>Shetty et al. 2011</td>
<td>India</td>
<td>Clinical Trial</td>
<td>Non-Probability Sampling</td>
<td>0.296</td>
</tr>
<tr>
<td>Turner et al. 2009</td>
<td>United Kingdom</td>
<td>Clinical Trial</td>
<td>Non-Probability Sampling</td>
<td>0.503</td>
</tr>
<tr>
<td>Yoon et al. 2008</td>
<td>South Korea</td>
<td>Pre-test/Post-test Study</td>
<td>Non-Probability Sampling</td>
<td>2.61</td>
</tr>
<tr>
<td>Zolfaghari et al. 2012</td>
<td>Iran</td>
<td>Pre-test/Post-test Study</td>
<td>Non-Probability Sampling</td>
<td>4.39</td>
</tr>
</tbody>
</table>
Intervention duration lasted between three and twelve months, and sample size varied between 23 and 215 participants. The revision excluded intervention studies which used the sending of text messages with information concerning self-care, management of prescribed therapeutics, clarification of doubts and surveillance of blood glucose levels, among other messages, to patients with T2D. Control groups received habitual attention given by the doctor, a specialized nurse of diabetes, or both, whether in the doctor’s office, in the Health Care Center or in the Clinic for Diabetes according to the medical system of each country.

Turner and collaborators\textsuperscript{15} consider that the greatest achievement in self-management was that patients received educational messages in real time in response to the values of blood glucose reported. Quinn and collaborators\textsuperscript{17}, in turn, highlighted that patients benefitted from the information concerning diabetes, medication, habits and lifestyle that was sent via messages to their mobile phones. In addition, both Yoon and Kim\textsuperscript{19} and Bell and collaborators mentioned that intervention using this technology is easy to implement and maintain, considering this a successful preventive factor in self-care in order to achieve glycemic control. Goodarzi and collaborators’ findings\textsuperscript{22} demonstrated the effectiveness of intervention using mobile phone SMS in T2D management, drawing attention to the use of mobile phone service to provide remote education to these patients. Istepanian and collaborators\textsuperscript{16} did not find differences in the levels of HbA1c between intervention and control groups, explaining that sending SMS does not provide an advantage in habitual care; however, intervention did show a favorable 0.64\% (\( P=0.06 \)) difference in HbA1c. Shetty and collaborators’ study\textsuperscript{14} showed that communication through SMS is well accepted by T2D patients and contributed to improving health results. Zolfaghari and collaborators\textsuperscript{23} underlined that using SMS through cell phones improved HbA1c levels as well as the adherence to prescribed treatment in patients with T2D (Table 2.)

**Table 2. Results of Intervention on HbA1c Levels**

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Results on HbA1c Levels</th>
<th>Before</th>
<th>After</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2012)</td>
<td>GI 9.6 – 1.5 DE</td>
<td>9.0 – 0.90 DE</td>
<td>-1.2</td>
<td>-1.0</td>
</tr>
<tr>
<td>Goodarzi et al. (2012)</td>
<td>GI 7.91 – 1.24 DE</td>
<td>GC 7.83 – 1.12 DE</td>
<td>7.02 – 1.02 DE</td>
<td>7.8 – 1.26 DE</td>
</tr>
<tr>
<td>Istepanian et al. (2009)</td>
<td>GI 7.9 - 1.5</td>
<td>GC 8.1 - 1.6</td>
<td>7.76</td>
<td>8.40</td>
</tr>
<tr>
<td>Quinn et al. (2009)</td>
<td>GI 9.2 ± 1.7</td>
<td>9.3 ± 1.8</td>
<td>9.0 ± 1.8</td>
<td>9.9 ± 2.1</td>
</tr>
<tr>
<td>Shetty et al. (2011)</td>
<td>GI - &gt; 8 NS</td>
<td>GC - &gt; 8 NS</td>
<td>8.9 ± 1.4</td>
<td>9.1 ± 1.3</td>
</tr>
<tr>
<td>Turner et al. (2009)</td>
<td>9.5 – 2.2</td>
<td>8.9</td>
<td>Hb1Ac improves after three months by 0.52% (0.91)</td>
<td></td>
</tr>
<tr>
<td>Yoon, (2008)</td>
<td>GI 8.09 ± 1.72</td>
<td>GC 7.59 ± 1.09</td>
<td>6.77 ± 0.77</td>
<td>8.40 ± 1.04</td>
</tr>
</tbody>
</table>
Six of the eight studies analyzed maintained contact exclusively through text messages. In one study, one weekly phone call was made by the patient’s health provider if he had not received information about the patient three days after the date appointed to communicate results while another study compared the use of SMS with phone calls made to land lines\textsuperscript{23}. (Table 3)

**Table 3. Characteristics of Interventions of Selected Studies**

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Population, Age, Sampling</th>
<th>Years diagnosed with DM</th>
<th>Intervention duration</th>
<th>Intervention Characteristics</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belle et al. (2012)</td>
<td>Adults 58 years old, 54% men n-65</td>
<td>13 months</td>
<td>12 months</td>
<td>SMS sending of videos, self-care and reminders</td>
<td>Advice and recommendations concerning care of diabetes, lifestyle support</td>
</tr>
<tr>
<td>Goodarzi et al. (2012)</td>
<td>Adults 53.8 years old, 77% women n-81</td>
<td>Over a year</td>
<td>3 months</td>
<td>4 educational messages per week</td>
<td>Symptoms of Hypoglycemia, Motivation; healthy eating visit to the doctor every 2 months</td>
</tr>
<tr>
<td>Istepanian et al. (2009)</td>
<td>Adults 58.5 years old, n-137</td>
<td>12.5 months</td>
<td>9 months</td>
<td>Sending of capillary glucose results</td>
<td>Received recommendations concerning treatment and details about results</td>
</tr>
<tr>
<td>Quinn et al. (2009)</td>
<td>Adults 53 years old, 50% women n-163</td>
<td>7.9 months</td>
<td>12 months</td>
<td>Motivational SMS One monthly phone call on average</td>
<td>Attention from the center for diabetes or from local doctor</td>
</tr>
<tr>
<td>Shetty et al. (2011)</td>
<td>Adults 50.5 years old, n-215</td>
<td>5 months</td>
<td>12 months</td>
<td>2 educational messages per week concerning healthy habits</td>
<td>Directions concerning medical and nutritional therapy, physical activity, reminders for follow-up of medication treatment</td>
</tr>
<tr>
<td>Turner et al. (2009)</td>
<td>Adults 57.6 years old, 78% men n-23</td>
<td>6.4 months</td>
<td>12 months</td>
<td>Alerts and reminders</td>
<td>Decision making support</td>
</tr>
<tr>
<td>Yoon (2008)</td>
<td>Adults 47 years old, 57% women n-51</td>
<td>6.6 months</td>
<td>12 months</td>
<td>52 SMS average per patient Messages with motivational information</td>
<td>Orientation from health team</td>
</tr>
<tr>
<td>Zolfaghari et al. (2012)</td>
<td>Adults 52.7 years old, 53% women n-77</td>
<td>7.1 months</td>
<td>3 months</td>
<td>At least 4 educational and motivational SMS a week</td>
<td>Counseling concerning the disease, risk factors and importance of keeping glucose level within normal ranges</td>
</tr>
</tbody>
</table>
DISCUSSION

The revision of intervention studies based on the use of SMS through cell phone showed a significant reduction in HbA1c levels; however, it cannot be affirmed that these data are a result of the exclusive use of text messages for self-management. It must be taken into consideration that while a significant reduction in HbA1c levels was observed in six of the eight studies, the period of duration of interventions was not the same for all studies. Glycemic control was determined by the HbA1c levels, and comparisons were drawn at the beginning and end of the intervention in both experimental and control groups. It was noted that participants in the intervention group in all eight studies obtained lower figures for their HbA1c levels at the end of the studies when compared to the control group. Istepanian and collaborators\textsuperscript{16} pointed out that no significant differences in HbA1c levels were found between the experimental and the control groups. Such data coincided with the results of other studies with a different type of intervention conducted in the United Kingdom such as the one by Farmer and collaborators in which they show that there is no convincing evidence to incorporate their findings into the self-care of T2D patients nor of the fact that providing greater intensive support or mere habitual care may have an effect on the improvement of glycemic control in well controlled T2D patients. Two of the studies provided support through phone calls\textsuperscript{17,23}; another study utilized a video of care methods\textsuperscript{18} and the remaining five mention sending messages with educational and motivational content. From all this information it can be inferred that there was no uniformity among interventions to demonstrate that sending SMS exclusively is an effective strategy for maintaining T2D patients’ glycemic control, since glycosylated hemoglobin levels were maintained or reduced to figures lower than 7%.

It is also noteworthy that the doctors and nursing staff using this technology for the first time shared the opinion that it does have the potential to improve patient care\textsuperscript{23}. This opposes Turner and collaborators’ reports showing concern from the medical staff of patients becoming dependent on orientation and guidance outside of the health care facilities\textsuperscript{15}.

The rapid advance in information and communication technologies opens new possibilities for T2D self-management. The main findings demonstrated that intervention through counseling and/or orientation based on the use of mobile phone service through SMS actually improves HbA1c levels. It is also worth mentioning that it is necessary to conduct more studies on this option before generalizing its utilization by most people with T2D. However, it is undeniable that SMS through cell phones are associated with improvement in glycemic control, which is of particular interest due to the fact that the index of access to mobile phone service is quite high\textsuperscript{12,17}.

Reliable information and efficient communication are both crucial elements in health care, and the use of proper technology may indeed increase the quality and outreach of both elements. On one hand, information is the basis for the knowledge that allows people to maintain their own health, and, on the other, social organizations help people reach a healthy state through health care systems\textsuperscript{25}.

CONCLUSION

It was concluded that SMS represent a new communication technology which enables a person with a mobile phone to send a text message to another mobile phone. SMS
are sent almost instantaneously to the destined cellular phone and can be read virtually anywhere, which is highly convenient for the receiver.

This service is also inexpensive, efficient, comfortable and less intrusive in comparison to a phone call. Currently, it is widely available, and more and more widely used throughout the world. Finally, the relative ease with which an SMS can be sent fosters both information exchange and ongoing communication between T2D patients and their medical staff.

During recent years, several applications of information technology based mainly on mobile phone service have been developed in order to help patients manage chronic conditions, such as T2D, outside clinics. However, the scarce number of existing articles was considered a limitation to this revision as no greater contribution of evidence was found to point out more conclusive results concerning glycemic control through this information technology.

REFERENCES


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