One-year efficacy and safety of Web-based follow-up using cellular phone in type 1 diabetic patients under insulin pump therapy: the PumpNet study


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Abstract

Aim. – Conventional follow-up of type 1 diabetic patients treated with continuous subcutaneous insulin infusion (CSII) was compared with intensive coaching using the Web and the cellular phone network for retrospective data transmission and short message service (SMS).

Methods. – Thirty poorly controlled patients (HbA1c 7.5–10%) were enrolled in a bicenter, open-label, randomized, 12-month, two-period, crossover study. After a 1-month run-in period, 15 patients were randomly assigned to receive weekly medical support through SMS based upon weekly review of glucose values, while 15 patients continued to download self-monitored blood glucose (SMBG) values on a weekly basis without receiving SMS. After 6 months, patients crossed over to the alternate sequence for 6 additional months. Visits at the clinic were maintained every 3 months.

Results. – Patients with long-standing inadequately controlled diabetes (24 ± 13 years) were included. A non-significant trend to reduction in HbA1c (−0.25 ± 0.94%, P < 0.10) and mean glucose values (−9.2 ± 25 mg/dl, P = 0.06) during the 6-month SMS sequence was observed as compared with the no-SMS period. No safety issue (hypoglycemia, glucose variability) was reported. Adherence to SMBG was not affected by the trial. Quality of life analysis suggests a significant improvement in DQOL global score, as well as the DQOL satisfaction with life subscale, during the SMS sequence.

Conclusions. – Long-term telemedical follow-up of insulin pump-treated patients using a cellular phone-, SMS- and Web-based platform is feasible, safe, does not alter quality of life and associated with a trend toward improved metabolic control.

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1. Introduction

The frequency of self-monitoring of blood glucose (SMBG) is a major determinant of the quality of metabolic control among patients with type 1 diabetes mellitus [1]. Moreover, the efficacy of providing adequate education and coaching was well established in the DCCT trial [1]. However, the implementation of these principles has proven difficult in real life [2]. Patients may not perform SMBG, not use information appropriately, not report values on a diary, not bring their diary. Doctors may not provide enough availability and schedules of appointments often are not relevant with real care needs. New technologies of information and communication have acquired a state of reliability and popularity that led to many recent trials. Most systems rely upon the transmission of retrospective clinical and metabolic data, whereas some experimental systems are also able to predict future glucose levels. Yet time is still to demonstrate that these technologies are both efficient and safe in helping diabetic patients to reach therapeutic targets consistently.

We conducted a randomized trial in order to assess the relevance of telecare in adult patients with type 1 diabetes under continuous subcutaneous insulin infusion (CSII). For cost-effectiveness purposes, the telecare device relied on two broadly used technologies, cellular phone for transmission of retrospective data and short message service (SMS) for immediate medical feedback. The specific aims of this study were the assessment of metabolic efficacy, safety and quality of life.

2. Research design and methods

This was a bicenter, open-label, randomized, two-period, crossover, 12-month study in which coaching patients through the GlucoNet system using SMS was compared with a conventional follow-up in two 6-month treatment periods. During both periods, the same intensive SMBG and glucose targets were required.

Subjects entered the study based on the following criteria: age ≥18 years, type 1 diabetes, treated with CSII with an external pump for a minimum duration of 3 months, and with insufficient control as based upon HbA1c level between 7.5% (≥) and 10% (≤). Patients with threatening retinopathy, women with ongoing or planned pregnancy, patients unable to use the GlucoNet hardware, living out of reach of the cellular phone network, or unwilling to comply with a minimum of four self-measured blood glucose (SMBG) tests per day were excluded.

The study was performed among outpatients attending the diabetology clinic of Grenoble University Hospital and Toulouse Rangueil University Hospital, France. Duration of the screening period was fixed at 6 months following approval by regulatory board. Patients fulfilling the inclusion criteria were provided with an Accucheck Active® glucose meter (Roche Diagnostics, Meylan, France) (Visit 1, screening) and asked to maintain their usual treatment, aiming at a preprandial glucose target of 70–120 mg/dl and a postprandial glucose target of 100–160 mg/dl, until the next visit. Randomization occurred after a period of 4 weeks, and determined the order of treatment sequence: communication through SMS for 6 months followed by a 6-month period without SMS communication (SMS to no-SMS group), or the reverse sequence (no-SMS to SMS group). Baseline analytical assessments, including HbA1c, were acquired at this visit (Visit 2, randomization). Patients were provided with and taught to use a cellular phone capable of infra-red communication and GPRS data transmission (Siemens S45i) and a personal digital assistant (PDA Palm m515®, Palm OS 4.1) preloaded with the GlucoNet® software (France Telecom R&D, Meylan, France) and the quality of life DQOL questionnaire software (Avalis Telemedicine, Basel, Switzerland). Whatever the treatment sequence order, patients were requested to download their blood glucose values at weekly intervals during 1 year, and to download the quality of life questionnaire every 3 months, within 1 week before of after the visit at the clinic. In the Grenoble (P.Y.B., R.B.) and Toulouse (V.M., S.B.L.) centers, investigators were engaged to acknowledge reception of glucose data and to send therapeutic advice through SMS, according to the group, at weekly intervals, i.e. half of the cohort would receive SMS during the first 6 months, and the other half during the last 6 months.

Four other visits at the clinic were scheduled at 3-month intervals, for the collection of HbA1c and other analytical data (Visit 3, Visit 5, Visit 6) or for activating patients’ crossover to the alternate sequence (e.g. SMS to no-SMS) (Visit 4). This mid-protocol fourth visit also allowed the investigator to set a safety switch on the GlucoNet® software, in order to activate or to block SMS transmission capabilities.
The GlucoNet® software consists of a module capable of retrieving date-stamped glucose values from the memory of the glucose meter and sending them as GPRS data. In the current trial, this module equipped a Palm PDA able to communicate with the glucose meter through infrared transmission. The patient was able to use the PDA in order to comment glucose values, either with predetermined comments displayed in scrolling menus, or with manual entry. The PDA would then communicate with the cellular phone through infrared transmission. The second GlucoNet® module allowed the investigator to create and manage patients’ files on a database using an Internet browser, to display glucose values and comments on a graphic interface, and to send SMS. Noteworthy, SMS transmission was unidirectional, from the investigator to the patient, without instant reply feature. The database was not implemented with any system allowing automatic prediction of glucose changes, thus only retrospective SMBG data were available to the investigator.

The study was reviewed and approved by the institutional review board (Person Protection Committee CPP of Grenoble University Hospital), and all subjects provided written informed consent. A data safety monitoring board (Clinical Research Board DRC) reviewed the progress of the study. A computerized database was managed by the Clinical Investigation Center (CIC INSERM, Grenoble University Hospital) and was implemented with a powerful safety feature allowing preventing or date-stamp any modification of the data following their validation.

3. Efficacy assessments

HbA1c measurements were performed at 3-month intervals from Visit 2 through Visit 6, at either Grenoble or Toulouse University Hospital Laboratory, using a high-performance liquid chromatography method, both certified by the National Glycohemoglobin Standardization Program.

Capillary blood glucose data transmitted by the patients to the server were used to compute an average glycemic value reflecting the 1-month (V2) or 3-month period (V3–V6) preceding each visit.

Quality of life was determined using the Diabetes Quality of Life (DQOL) questionnaire, as implemented during the DCCT trial [3] and validated in French [4]. The DQOL questionnaire was analyzed in five different subscales: satisfaction with life, impact of diabetes, social/vocational worry, diabetes-related worry, and health perception [3]. It is a multiple-choice tool with 59 items allowing to compute a score on the scale of 0–100, with higher scores indicating higher quality of life. This questionnaire was self-administered by the patients using user-friendly software installed in the PDA, so that their answers could be easily transmitted using the cellular phone to an Internet secured server (Avalis). The server automatically performed calculation of the five components of the DQOL score.

An independent investigator conducted a 19-item satisfaction survey after completion of the trial, to gather further informations regarding technical background of the patient, ergonomy of the device, impact of the trial on diabetes management and cost-related issues.

Adherence was determined from the server as the average number of blood glucose tests performed by the patients during the week preceding each visit. As this period may induce a greater adherence, frequency of SMBG was also compared during the 30 days preceding V2, V4 and V6.

4. Safety assessments

Low blood glucose was arbitrarily defined as a capillary blood glucose value < 70 mg/dl. Severe hypoglycemia was defined as any episode requiring help from a third party. Frequency of hypoglycemic episodes was computed from the data transmitted by the patients, at the time intervals described above. Occurrence of severe hypoglycemia, ketosis or intercurrent illnesses was retrospectively determined by the investigator during the visits at the clinic, so as body weight, and basal and bolus insulin requirements.

Blood glucose variability was assessed by two different indicators, computed at the same time intervals as described above, according to the literature: mean amplitude glycemic excursion (MAGE index) [5], and low blood glucose index (LBGI) [6].

5. Power calculations and statistical analyses

The trial was powered to detect a 0.5% difference in HbA1c between the two groups according to a crossover setting, with a power of 0.90 and an α risk of 0.05. A sample size of 31 patients was thus calculated. We intended to include 40 patients, anticipating the loss of patients during follow-up.

Per protocol analyses were performed using SPSS software (SPSS, Chicago, IL). Results are presented as means ± S.D., or as differences with 95% confidence intervals. All analyses were preceded by a preliminary test in order to rule out an effect of the randomization sequence order. Comparisons between groups were made with paired t-test if data were normally distributed, or with Wilcoxon test otherwise. A P value ≤ 0.05 was interpreted as statistically significant.

6. Results

We intended to enroll 40 patients, yet at the end of the 6-month inclusion period, 31 patients had been included and followed-up according to the trial design. Upon analysis, one patient did not fulfill the inclusion criteria, as the initial HbA1c value was < 7.5%, so this patient was secondarily excluded from the analysis. The following data are per protocol analyses involving 30 patients, among which, 15 had been included by the Grenoble center and 15 by the Toulouse center. Statistical analysis first ruled out an effect of the order of enrollment in the treatment sequences during this crossover trial, such an effect was not observed in any of the variables. Enrolled patients were 15 men and 15 women, aged 41.3 ± 11.3 years [20–62], with type 1 diabetes for 24 ± 13 years [2–47], body
mass index $24.1 \pm 2 \text{ kg/m}^2 \ [20.6–28.4]$, and daily insulin needs of $36.4 \pm 10.4 \text{ IU}$. HbA$_{1c}$ at V2 was $8.31 \pm 0.67\% \ [7.5–10.10]$ and was similar in both treatment sequences, $8.31 \pm 0.65$ in the SMS to no-SMS group and $8.22 \pm 0.72$ in the no-SMS to SMS group ($P = 0.51$), as were demographic and other metabolic variables (data not shown). All patients used programmable pumps allowing multiple hourly flow rates, and all patients used fast-acting insulin analogs. Daily insulin doses at V2 were $36.4 \pm 10.4 \text{ IU} \ [19–56]$, basal rate insulin doses were $21.6 \pm 6.2 \text{ IU} \ [9.5–31.4]$ and bolus insulin doses were $15.4 \pm 6.9 \text{ IU} \ [15–30]$. The rate of study completion was excellent, with only two patients interrupting data transmission between the 10th and the 12th months during the no-SMS phase for unknown reasons. All other patients but one transmitted glucose data on time as requested by the protocol, without any intervention from the investigator. One patient interrupted transmission for a 3-week period during the no-SMS phase because of neglect. During this 1-year trial, patients were not enrolled in any educational of diabetes-relevant intervention, and diabetes care was limited to the SMS and scheduled visits. SMS recommendations did not lead to extra-communication between patients and investigators, for clarification nor for validation.

The cumulative connection time of the investigators to the server was measured in one center at 3341 minutes throughout the whole trial duration, leading to extrapolate that each investigator requested 4.5 minute/week to monitor each of the 15 patients. Training to use the communication material occurred during V2, and did not exceed 30 minutes. From the satisfaction survey, 81% of patients judged the device as very easy or moderately easy, 19% as moderately complex, none as very complex. Technical errors occurred in rare occasions, related with incidental clock unsynchronization between the glucose meter and the PDA, needing technical intervention (<10 occurrences).

A total of 729 SMS were actually sent throughout the trial. Contents of the SMS were proactively classified by the investigator through the software into three categories: good control, no modification needed (42%)—intermediate control, improvements are needed (52%)—severe disturbances, urgent action has to be taken (6%). Further analysis of the SMS content and its impact on patients’ behavior was not performed.

### Table 1
Metabolic parameters before and at the end of each treatment sequence

<table>
<thead>
<tr>
<th>Treatment sequence</th>
<th>$HbA_{1c}$ (%)</th>
<th>$HbA_{1c}$ at baseline</th>
<th>$HbA_{1c}$ at 6 months</th>
<th>Difference [IC 95%]</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS</td>
<td>30</td>
<td>8.31 ± 0.65</td>
<td>8.18 ± 0.59</td>
<td>–0.14 [-0.33–0.06]</td>
<td>0.166</td>
</tr>
<tr>
<td>No-SMS</td>
<td>30</td>
<td>8.22 ± 0.72</td>
<td>8.34 ± 0.67</td>
<td>0.12 [-0.13–0.36]</td>
<td>0.333</td>
</tr>
<tr>
<td>Paired difference between the treatment sequences</td>
<td>30</td>
<td>–0.14 ± 0.53</td>
<td>0.12 ± 0.65</td>
<td>0.25 [-0.10–0.60]</td>
<td>0.097</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment sequence</th>
<th>Glycemia (mg/dl)</th>
<th>Glycemia at baseline</th>
<th>Glycemia at 6 months</th>
<th>Difference [IC 95%]</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS</td>
<td>29</td>
<td>166 ± 23</td>
<td>160 ± 20</td>
<td>–6 [-12–1]</td>
<td>0.098</td>
</tr>
<tr>
<td>No-SMS</td>
<td>28</td>
<td>162 ± 22</td>
<td>167 ± 21</td>
<td>5 [-2–12]</td>
<td>0.176</td>
</tr>
<tr>
<td>Paired difference between the treatment sequences</td>
<td>27</td>
<td>–5 ± 17</td>
<td>4 ± 18</td>
<td>9 [-1–19]</td>
<td>0.064</td>
</tr>
</tbody>
</table>

### 7. Efficacy

#### 7.1. Metabolism

Overall, patients enrolled in the SMS sequence tended to improve glycemic control compared to patients without SMS communication, as measured by HbA$_{1c}$ and average cumulative capillary blood glucose values (Table 1), however the differences between the two treatment sequences failed to reach statistical significance. HbA$_{1c}$ was reduced by $–0.14 \pm 0.53\%$ during the 6-month period with SMS communication, whereas it was increased by $0.12 \pm 0.65\%$ during the semester without SMS transmission ($P = 0.097$, Table 1). The number of patients who succeeded in lowering HbA$_{1c}$ by 0.5% or more (as the threshold for the trial power calculation) was 8/30 (26.7%, CI 95% 14.2–44.5) during the SMS sequence and 5/30 (16.7%, CI 95% 7.3; 33.6) ($P = \text{NS}$) during the no-SMS sequence. No patient was able to reach the HbA$_{1c}$ ADA target of $< 7.0\%$ in the no-SMS sequence, while one patient succeeded in doing so during the SMS sequence.

#### 7.2. Quality of life

All patients at V2 filled the questionnaire. However, several patients neglected to answer the questionnaires at 3-month intervals and were not reminded to do so in the absence of an adequate procedure, the DQOL database is being left unchecked until the completion of the trial. Therefore, the DQOL questionnaires were completed throughout the trial, thus allowing comparisons for a given patient by paired t-test, in 17 patients during the SMS sequence and in 22 patients during the no-SMS sequence. A comparison of DQOL scores in the combined subjects at baseline and at the end of the 12-month trial was possible in 18 patients. The 12-patients group who failed to complete all questionnaires did not differ at baseline regarding DQOL scores, and did not behave differently during the trial regarding metabolic or adherence outcomes.

The two treatment sequence groups did not significantly differ at baseline for any of the DQOL subscales, and the combined study population got similar scores between the onset and the end of the 12-month trial. However, the analysis according to the treatment sequence revealed that patients
going through the SMS period significantly improved the overall DQOL score by 5.6% after the 6-month period; DQOL global score increased from 65.6 ± 6.4 to 69.3 ± 9.4 during the SMS period (P = 0.05) and remained stable during the no-SMS period (68.8 ± 8.4 vs. 68.8 ± 9.3, P = NS). Satisfaction with life significantly increased during this SMS period from 64.8 ± 11.2 to 72.9 ± 13.4 (P = 0.01), whereas no significant change was evidenced during the no-SMS period (72.6 ± 14.7 vs. 72.5 ± 14.4, P = NS). However, regarding satisfaction, a non-significant trend toward an order effect was observed (P = 0.059), leading to interpret this putative beneficial effect of the SMS period with caution. The other components of the DQOL score were not significantly modified, whatever the study period (data not shown). Interestingly, from the satisfaction survey, 76% of patients felt that the quality of their medical care improved due do the device, none declared a deterioration of care.

7.3. Adherence

Counting the number of capillary blood glucose values transmitted to the server assessed the adherence of patients in performing SMBG. When measured during the week preceding each visit, this number was not affected by the enrollment in the trial or by the treatment sequence. In the SMS to no-SMS group, initial SMBG value was 4.79 ± 1.74 tests per day and final value 4.63 ± 1.21 at 6 months, whereas in the no-SMS to SMS group, initial value was 4.85 ± 1.34 and final value 4.74 ± 1.05 at 6 months. When measured during the 30 days preceding V2, V4 and V6, no statistical difference was observed in either group, although a trend was noticed in the SMS to no-SMS group between V2 and V4, where SMBG frequency increased from 3.96 ± 1.60 to 4.93 ± 1.26 tests per day (difference 0.97, IC95 [−1.96–0.02], P = 0.054). Frequency of SMBG did not correlate with HbA1c outcome.

7.4. Safety

The number of low blood glucose episodes (< 70 mg/dl) checked on the server database, did not differ between the two treatment sequences: 4149 episodes during the trial, including 2214 during the SMS period and 1935 during the no-SMS period, i.e. 79.1 ± 58 episodes per patient in the SMS period [6–259] vs. 69.1 ± 47.3 episodes per patient in the no-SMS period [2–187] (P = 0.345). No severe hypoglycemia, nor diabetic ketoacidosis, was reported throughout the trial. No significant difference between the two treatment sequences was observed in any of the two blood glucose variability indices, MAGE and LBGI, at baseline and throughout the trial (data not shown).

8. Discussion

Several telecare trials have been recently reported using various technologies in both types of diabetes, aiming at improving metabolic control through telemonitoring, or intensive tele-coaching. Whether a telemedical approach of diabetes care is efficient, safe, cost-effective and realistic is still a matter of debate.

The main contributions of the PumpNet trial are as follows:

- the GlucoNet® platform is based upon a popular technology, GSM cellular phone, that is broadly spread among diabetic patients, thus not requiring the purchase of costly materials;
- it is the first controlled trial using SMS as communication means, with clear advantages as SMS is fast, direct and efficient, user-friendly, and traceable;
- PumpNet was a long-term, 1-year trial, with a crossover design;
- this trial suggests that a weekly monitoring of patients with SMS is safe, does not alter patients’ satisfaction and quality of life, and tends to improve metabolic control.

Indeed, some previous telecare studies used modern transmission through wired phone lines and vocal feedback from the physician, needing to provide the patient with the appropriate material and connector, to train him, and to set appointments for telephone calls [7,8]. Other studies used the Web and SMS for data and questions submission from the patient and feedback from the health care provider, which proved to be efficient in the short run (3 months), but may not be realistic in the long term, requiring the patient to voluntarily connect to the Internet [9,10]. The newest generations of cellular phones, marketed after the completion of our study, are enabled to run various user-friendly software allowing to communicate with a glucose meter, to add comments about glucose values and to send data on the Internet, without requiring an additional PDA, the main limitation being the current lack of a universal connector compatible with the different marketed glucose meters [11]. One strength of our study is that we asked all patients to transmit their glucose levels on a weekly basis throughout the whole trial period, thus controlling for the phone transmission per se. Therefore we were able to isolate the effect of physician feedback by SMS. During a recent and similarly designed study, a slight reduction in HbA1c was observed among patients receiving immediate feedback by phone calls upon modem transmission of SMBG [12]. In that study, one explanation for the more efficient metabolic outcome was the longer time spent by endocrinologists and nurses to assist telecare patients (on average 3.4 h per patient during 6 months) [12]. More appropriate and persuasive advice may be provided when SMBG are assorted with comments, which may be provided by the patient on the cell phone terminal, or alternatively by voice communication with the health care professional [11,12]. A first advantage of the GlucoNet® platform is to directly capture data from the glucose meter, avoiding the time-consuming step of transcribing data into the diary. A second advantage of this platform, and of any electronic diary with communication capabilities, is to desynchronize the transmission of data by the patient, and the feedback of the health care provider, allowing a more flexible schedule for care for
both actors. The current drawback is the absence of real-time feedback on the ongoing insulin regimen, when patients neglect to add comments to the transmitted glucose values. Current technology allows to overcome this limitation in the case of insulin pump treatment, as the latest pump models feature communication capabilities, but smart insulin injection devices would be needed in order to automatically download insulin doses to an electronic diary for patients on multiple daily injections regimen. Therefore, we suggest that the ideal telecare device in the current state of technology would combine, on the patient side; an electronic diary implemented into a smart phone, able to communicate wirelessly with the glucose meter and the pump, and on the health professional side, SMS and voice communication. Noteworthy, glucose prediction softwares, able to predict future glucose values, based upon retrospective SMBG values and life-style parameters [13], were not available in the GlucoNet platform during our trial, but could be valuable in future telemedicine platforms.

We observed a non-significant trend to metabolic improvement during the SMS phase of the trial. Based upon the cross-over design of our trial, and the enforcement of weekly data transmission, our interpretation is that this improvement is independent from a trial effect, but could be credited to the impact of SMS content, or to a coaching and motivation effect of weekly SMS, or both. This coaching effect is suggested by a trend to an increase in SMBG frequency during the SMS period. The absence of statistical significance may be due to a too small cohort. The use of a glucose prediction engine could have improved the impact of the SMS phase, although experienced diabetologists were in charge of reviewing SMBG values. Alternatively, we recruited patients with long disease duration, some of them with long-term and regular follow-up in the investigation centers, and failure of experienced diabetologists to obtain satisfactory HbA1c levels may have led investigators to inappropiate expectations towards telecare. Indeed, it is likely that patients with long-standing diabetes and chronically poor metabolic outcome, despite appropriate management, are the most resistant to improvement. In future trials, it may be more relevant to compare conventional care and telecare among patients with higher HbA1c levels and without regular follow-up with a diabetologist [14]. Nevertheless, our metabolic results are consistent with those obtained through a recent meta-analysis of available literature on telecare among adult patients with type 1 diabetes [12]. This analysis showed a small significant effect of telecare on diabetes control among adult patients, but ruled out a larger effect (delta HbA1c ≥ 1%). A more recent study using real-time data transmission with a cellular phone and intensive phone-based feedback with a diabetes specialist nurse did not evidence improvement in HbA1c [11]. Our explanation is that so far studies failed in identifying the appropriate metabolic, social and psychological profile of the population that would be most susceptible to favorably respond to telecare. We suggest that telecare limited to data transmission and SMS feedback could be proposed to well-controlled patients with adequate self-management skills. This would free up resources and time in order to focus on patients with inappropriate diabetes control, and provide them with face-to-face visits as well as with telecare including voice feedback. Besides, our study was designed in order to test the effect of an SMS-based weekly intervention supplementing but not replacing conventional face-to-face visits. This design may not be appropriate for a cost-effectiveness study of this telecare approach [15]. Longer studies (> 1 year) with larger cohorts are still needed to provide relevant information to policy makers regarding telecare in adult patients with type 1 diabetes.

There was concern that giving weekly advice to patients without actually talking with them might affect glucose variability and hypoglycemic risk. Yet no severe hypoglycemia, or diabetic ketoacidosis occurred during the trial, and no significant difference between the two treatment sequences was observed regarding frequency of hypoglycemic episodes, or blood glucose variability indices. Besides, the improvement in quality of life and satisfaction with life, observed during the SMS period, seems to be independent of a trial effect or a “high-tech” effect, but rather to the positive impact of health care professional feedback that could restore self-confidence through a regular and appropriate SMS communication. This coaching effect was highlighted by a trial where type 2 diabetic patients were telephoned by a call center with a frequency proportional to the last HbA1c level [16]. This is also in agreement with a survey recently conducted among patients with type 2 diabetes enrolled in a Web-based disease management program based on an interactive electronic medical record, that included access to their electronic medical record, secure email, ability to upload blood glucose readings, an education site, and an interactive online diary for entering exercise, diet, and medication [17]. Three themes emerged as important to the design and evaluation of Web-based care programs: feeling that non-acute concerns are uniquely valued; enhanced sense of security about health and health care; frustration with unmet expectations [17]. It is remarkable that the GlucoNet® platform, though mostly focused on glucose data analysis, already reached significant results regarding quality of life. This platform could be further improved, by adding educational modules. Indeed, cellular phone-based “game” have been recently proposed as a way to encourage, motivate, and boost the confidence of young type 1 diabetic patients [18].

In summary, teletransmission of glucose values using a cellular phone, combined with SMS feedback, is safe, does not alter quality of life, and tends to improve metabolic control non-significantly, without requiring excessive connection time. The debate is still open regarding the adequate use of telecare among type 1 diabetic patients.

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