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Original Research

The Effectiveness of Internet Intervention on 926 Patients with Diabetes Mellitus for Up to 30 Months



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ABSTRACT

Objective: To assess the long-term effect of an Internet blood glucose monitoring system (IBGMS) on patients with type 1 diabetes mellitus and patients with type 2 diabetes.

Methods: In all, 1200 patients were offered to be taught to communicate with their endocrinologists using standardized glucose level reports by e-mail, and received feedback within 24 hours. The first 926 patients enrolled were reviewed consecutively from March 2011 to October 2013. Seventy-seven of these patients were excluded owing to lack of glycated hemoglobin (A1C) data. The remaining 849 patients consisted of 295 patients with type 1 diabetes and 554 patients with type 2 diabetes. Nonreporters are patients with no record of reporting (n=167), whereas the reporters had reported at least once (n=682). The A1C values were obtained at registration; follow-up values at 3-month intervals were recommended.

Results: Reporter A1C decreased from 8.13%±1.34% to 7.74%±1.11% (p<0.0001). Reporters with type 1 diabetes dropped from 8.04%±1.23% to 7.72%±1.03% (n=238; p<0.0001). Reporters with type 2 diabetes dropped from 8.18%±1.40% to 7.75%±1.14% (n=444; p<0.0001) and were subdivided based on treatment: those on oral hypoglycemic agents declined from 7.96%±1.38% to 7.49%±1.03% (p<0.0001), and those on insulin with or without oral hypoglycemic agents declined from 8.40%±1.39% to 8.02%±1.20% (p<0.0001). The nonreporters did not show a significant change in A1C.

Conclusions: Initial and prolonged improvement was found in A1C levels for all reporters. The data support that numerous patients can be followed up effectively using the Internet for as long as 30 months.

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R É S U M É

Objectif : Évaluer l'effet à long terme d'un système de surveillance de la glycémie par internet (SSGI) des patients souffrant du diabète sucré de type 1 et des patients souffrant du diabète de type 2.

Méthodes : En tout, 1200 patients étaient invités à apprendre à communiquer par courriel avec leur endocrinologue au moyen des rapports standardisés de la concentration en glucose, et recevaient une réponse dans les 24 heures. Les 926 premiers patients inscrits étaient passés en revue de manière consécutive de mars 2011 à octobre 2013. Parmi ces derniers, 77 patients étaient exclus en raison du manque de données sur l'hémoglobine glyquée (A1c). Les 849 patients restants comptaient 295 patients souffrant du diabète de type 1 et 554 patients souffrant du diabète de type 2. Les non-participants étaient les patients n'ayant pas d'enregistrement de rapports (n=167), tandis que les participants avaient

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transmis le rapport au moins une fois (n=682). Les valeurs d'A1c étaient obtenues à l'inscription; les valeurs de suivi étaient recommandées tous les 3 mois.

Résultats : L'A1c des participants a diminué de 8,13 % ± 1,34 % à 7,74 % ± 1,11 % (p < 0,0001). Les participants souffrant du diabète de type 1 ont montré a diminué de 8,04 % ± 1,23 % à 7,72 % ± 1,03 % (n=238; p < 0,0001). Les participants souffrant du diabète de type 2 ont montré a diminué de 8,18 % ± 1,40 % à 7,75 % ± 1,14 % (n=444; p < 0,0001) et ont été subdivisés selon le traitement: ceux sous agents hypoglycémiques ont montré a diminué de 7,96 % ± 1,38 % à 7,49 % ± 1,03 % (p < 0,0001) et ceux sous insuline combinée ou non aux agents hypoglycémiques oraux ont montré a diminué de 8,40 % ± 1,39 % à 8,02 % ± 1,20 % (p < 0,0001). Les non-participants n'ont pas montré de changement significatif de l'A1c.

Conclusions : Une amélioration initiale et prolongée a été observée dans les concentrations d'A1c de tous les participants. Les données soutiennent que de nombreux patients peuvent être suivis de manière efficace en ligne jusqu'à 30 mois.

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Introduction

Self-monitoring of blood glucose (SMBG) has been performed as an adjunct to glycosylated hemoglobin (A1C) measurements in diabetes mellitus management (1–8). The emergence of new technologies has revolutionized the way patients and healthcare professionals approach diabetes management; various Internet platforms are now available that allow patients to upload SMBG data and share this information with their healthcare providers, who assess the data and decide whether treatment and lifestyle modifications are necessary (4). Previous randomized controlled trials have demonstrated that an Internet blood glucose monitoring system (IBGMS) is more effective than routine care in lowering A1C levels, with the majority of studies involving patients with type 2 diabetes (9–13).

It is now our standard of care to offer an IBGMS to patients. Since March 2011, 1200 patients have been to the clinic and offered enrolment in the system. Here, we report data from the first 926 patients registered. Demographic information is summarized in Table 1. The effect of IBGMS on A1C level was evaluated for patients with type 1 diabetes, patients with type 2 diabetes exclusively receiving oral hypoglycemic agents (OHAs) and patients with type 2 diabetes on a regimen of insulin with or without OHAs. As a secondary outcome, the relationship between reporting frequency and extent of A1C improvement was analyzed.

Methods

Patients enrolled in IBGMS were instructed to upload SMBG readings every 2 weeks through their choice of platform. Available platforms included Carelink (Medtronic), report-generating meters (Bayer Contour USB, Abbott Freestyle Insulinx, Sanofi iBG Star) and a customized spreadsheet (Microsoft Excel). Typically, patients chose platforms based on computer literacy and computer compatibility. All platforms generated reports presenting results in tabular or graphical formats according to time of day, with automatic calculations showing the mean, SD and range of blood glucose values. (Figure 1 shows a sample report generated using

Microsoft Excel.) The patients' endocrinologists reviewed the reports and sent feedback directly to the patients by e-mail. Recommendations included medication adjustments, suggestions on testing frequency and lifestyle modifications or encouragement to continue with no changes.

The A1C laboratory examinations at 3-month intervals were recommended for all patients. A single A1C value from up to 3 months before registration was used as the baseline A1C value. If patients had more than 1 A1C values during this 3-month period, an average baseline A1C value was calculated. The A1C values obtained after enrolment were used to generate a follow-up average A1C value for each patient. Of the 926 patients, 77 lacked baseline and at least 1 follow-up A1C value and were excluded from data analysis. The remaining 849 patients consisted of 295 patients with type 1 diabetes and 554 patients with type 2 diabetes. The 849 patients formed 2 groups: those who had no record of reporting to their endocrinologists since registration, the "nonreporters" (n=167), and those who had reported at least once since registration, the "reporters" (n=682). Both reporters and nonreporters were analyzed in 3 defined groups: patients with type 1 diabetes, patients with type 2 patients exclusively on OHAs and patients with type 2 diabetes on insulin with or without OHAs. All 3 groups of reporting patients were further subdivided into frequent reporters, who reported at least once per month on average since registration, and infrequent reporters, who reported less than once per month.

Within all groups of reporters and nonreporters, average follow-up A1C values were compared with baseline A1C values using paired sample *t* tests to detect changes in A1C over time. In all groups of reporters, A1C values of frequent and infrequent reporters were compared at baseline using independent *t* tests and again at follow up. In addition, for reporting patients with type 1 diabetes, the differences in A1C change from baseline level were compared between frequent and nonfrequent reporters.

To visualize the trend of A1C change in reporters and nonreporters, a series of average A1C values was generated at 6-month intervals for the 2 groups and plotted. Differences in A1C change from baseline level were compared between reporters and nonreporters.

Results

Reporters vs. nonreporters

The ratio of patients with either type of diabetes is similar in reporter and nonreporter groups (Table 1). Overall, A1C values of reporters declined from 8.13%±1.34% to 7.74%±1.11% at follow up (p<0.0001) (Table 2). The initial drop in A1C level took place as early as 3 months after enrolment in the IBGMS, and the average follow up A1C value stabilized at a consistently lower level for as long as 30 months (Figure 2A). Overall, no significant change in A1C values

Table 1

Demographic distribution of the first 926 patients enrolled in an Internet blood glucose monitoring system

Characteristics	Reporters n=682	Nonreporters n=167
Gender, n (%) ^a		
Male	388 (56.9)	108 (64.7)
Female	294 (43.1)	59 (35.3)
Age, years (SD)	59.1 (14.5)	59.1 (15.7)
Baseline A1C,% (SD)	8.13 (1.34)	7.95 (1.40)
Type of diabetes, n (%)		
Type 1	238 (34.9)	57 (34.1)
Type 2	444 (65.1)	110 (65.9)

A1C, glycosylated hemoglobin.

^a p<0.05 for reporter group vs. nonreporter group.

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