Review of the Effect of Internet Therapeutic Intervention in Patients With Type 1 and Type 2 Diabetes

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The use of the Internet has changed the way health care professionals manage diabetes, with platforms now available allowing patients to upload self-monitoring of blood glucose data and share with their health care provider (1). Previous studies have established the efficacy of Internet blood glucose monitoring systems (1–3).

It is now our standard of care to offer an Internet blood glucose monitoring system to patients. We currently have 1,100 patients enrolled and have outcome data on the first 409 patients. Of the 409 patients, 388 had HbA1c at baseline and at least one subsequent HbA1c determination within 9 months. HbA1c values from 3–9 months were averaged to generate follow-up data. The relationship of reporting frequency and HbA1c change was determined by dividing patients into frequent reporters, who reported more than once per month, and infrequent reporters.

Patients were instructed to upload self-monitoring of blood glucose readings every 2 weeks through their choice of platform including CareLink (Medtronic), meters equipped with report-generating software (Contour USB, Bayer; FreeStyle InsuLinx, Abbott; iBGStar, Sanofi), and a customized spreadsheet (Excel, Microsoft). All platforms generated reports presenting the mean, SD, and range of glucose values according to time of day. The patient’s endocrinologist reviewed the readings and sent feedback to the patient via e-mail. Recommendations included changes in therapy, testing frequency, and lifestyle or encouragement to continue with no changes.

Key results are summarized in Table 1. HbA1c in all type 2 diabetic patients declined from 8.36 ± 1.35% to 7.91 ± 0.98% (P < 0.001). For type 2 diabetic patients treated with insulin, HbA1c declined from 8.53 ± 0.82 to 8.12 ± 0.91% (P < 0.001). Type 2 diabetic patients exclusively on oral hypoglycemic agents (OHAs) declined from 8.15 ± 0.98 to 7.67 ± 1.29% (P < 0.001).

At baseline for type 2 diabetic patients, there was no statistically significant difference in HbA1c values for the groups whether they were frequent or infrequent reporters. At follow-up, it was found that HbA1c in frequent reporters were significantly lower than in infrequent reporters, regardless of treatment (P < 0.05).

It was found that type 1 diabetic patients who had “ideal” HbA1c showed little decrement in HbA1c values. When excluding patients with HbA1c < 6.9 (n = 17), type 1 diabetic patients showed a decline of 8.12 ± 1.38% to 7.93 ± 1.17% (P < 0.01).

We observed a trend of less frequent reporting among type 1 diabetic patients with lower HbA1c values. When we excluded patients with HbA1c < 7.4 (n = 26), we found frequent reporters had lower follow-up HbA1c than infrequent reporters (P < 0.05).

Regardless of type of diabetes or treatment, all patients improved significantly. Additionally, when separated into frequent versus infrequent reporters, we found no differences at baseline. At follow-up, frequent reporters had consistently lower HbA1c values.

Previously, there has been a lack of data to fully demonstrate the efficacy of Internet interventions on type 1 diabetic patients, with most available studies conducted on much smaller sample sizes (4,5). We found Internet intervention to be effective across all groups, including type 1 diabetic patients. The lowering of HbA1c

Hugh D. Tildesley,1,2 Mary Ellen Conway,3 Stuart A. Ross,4 Augustine M. Lee,2 Jeremy H.M. Chan,3 Adel B. Mazanderani,6 Hamish G. Tildesley,7 and Adam S. White1,2

1Department of Endocrinology and Metabolism, St. Paul’s Hospital, Vancouver, British Columbia, Canada
2Department of Endocrinology and Metabolism, University of British Columbia, Vancouver, British Columbia, Canada
3Department of Medicine, McMaster University, Hamilton, Ontario, Canada
4Department of Medicine, University of Calgary, Calgary, Alberta, Canada
5Department of Medicine, Vanderbilt University, Nashville, TN
6Department of Medicine, Saint George’s University, Grenada, West Indies
7Department of Psychological and Brain Sciences, Dartmouth College, Hanover, NH

Corresponding author: Hugh D. Tildesley, hdtildesley@gmail.com.

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improves long-term diabetes outcome and lowers costs. The efficacy of this intervention warrants consideration of coverage for this service by insurance plans.

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**Author Contributions.** H.D.T. designed the study, developed the protocol, collected and interpreted data, wrote the manuscript, and reviewed and edited the manuscript. M.E.C., J.H.M.C., and A.B.M. collected the data. S.A.R. contributed to study design and protocol development and reviewed and edited the manuscript. A.M.L. and H.G.T. analyzed data, wrote the manuscript, and reviewed and edited the manuscript. A.S.W. contributed to study design and protocol development, interpreted data, and reviewed and edited the manuscript. All authors read and approved the final manuscript. H.D.T. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**References**


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**Table 1—Baseline and follow-up HbA1c in frequent and infrequent reporting patients**

<table>
<thead>
<tr>
<th>Type of diabetes</th>
<th>$n$</th>
<th>Baseline HbA1c (SD)*</th>
<th>Follow-up HbA1c (SD)†</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NGSP, % IFCC, mmol/mol</td>
<td>NGSP, % IFCC, mmol/mol</td>
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<tr>
<td>Type 1†</td>
<td>115</td>
<td>8.12 (1.38) 65 (15.1)</td>
<td>7.93 (1.17) 63 (12.8)</td>
<td>&lt;0.01</td>
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<td>Frequent reporters§</td>
<td>44</td>
<td>8.07 (0.84) 65 (9.2)</td>
<td>7.85 (1.02) 62 (11.1)</td>
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<tr>
<td>Infrequent reporters§</td>
<td>71</td>
<td>8.14 (1.15) 65 (12.6)</td>
<td>7.98 (1.00) 64 (10.9)</td>
<td></td>
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<tr>
<td>Type 2 OHA</td>
<td>116</td>
<td>8.15 (0.98) 66 (10.7)</td>
<td>7.67 (1.29) 60 (14.1)</td>
<td>&lt;0.001</td>
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<td>Frequent reporters</td>
<td>35</td>
<td>8.03 (1.25) 64 (13.7)</td>
<td>7.48 (0.85) 58 (9.3)</td>
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<td>Infrequent reporters</td>
<td>81</td>
<td>8.21 (1.42) 66 (15.5)</td>
<td>7.75 (1.27) 61 (13.9)</td>
<td></td>
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<tr>
<td>Type 2 insulin+/− OHA</td>
<td>140</td>
<td>8.53 (0.82) 68 (9.0)</td>
<td>8.12 (0.91) 65 (9.9)</td>
<td>&lt;0.001</td>
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<td>Frequent reporters</td>
<td>41</td>
<td>8.42 (1.40) 69 (15.3)</td>
<td>7.86 (1.39) 62 (15.2)</td>
<td></td>
</tr>
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<td>Infrequent reporters</td>
<td>99</td>
<td>8.57 (1.42) 70 (15.5)</td>
<td>8.22 (1.08) 66 (11.8)</td>
<td></td>
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<tr>
<td>Type 2</td>
<td>256</td>
<td>8.36 (1.35) 68 (14.8)</td>
<td>7.91 (0.98) 63 (10.7)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Baseline HbA1c values were compared with follow-up averages using paired samples t tests. Frequent and infrequent reporters were compared at baseline across all defined groups using independent t tests and again at follow-up. IFCC, International Federation of Clinical Chemistry and Laboratory Medicine. *$P = NS$ for frequent reporters compared with infrequent reporters for each type of diabetes. †$P = 0.05$ for frequent reporters compared with infrequent reporters for each type of diabetes. §Excluding patient HbA1c <6.9 ($n = 17$). §Excluding patient HbA1c <7.4 ($n = 26$).