Cost-Benefit Analysis of Internet Therapeutic Intervention on Patients With Diabetes

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Background: With the emergence of IBGMS for allowing for patients to communicate their self-monitored blood glucose (SMBG) readings with their health care providers, their impact on the management of diabetes is becoming well-supported with regards to clinical benefits. Their impact on healthcare costs, however, has yet to be investigated. This study aims to determine the cost-benefits of such interventions in comparison to routine care.

Objectives: To analyze the cost-benefit of an Internet Blood Glucose Monitoring Service (IBGMS) in comparison to routine diabetes care.

Patients and Methods: 200 patients were surveyed to assess the cost associated with doctor appointments in the past 12 months. Annual number of visits to medical services for diabetes and costs of transportation, parking, and time taken off work for visits were surveyed. Self-reported frequency of SMBG and most recent A1C were also surveyed. We compared 100 patients who used the IBGMS with 100 patients who only used routine care.

Results: There is a trend of lowered total cost in the intervention group compared to the control group. The control group spent $210.89 per year on visits to physicians; the intervention group spent $131.26 (P = 0.128). Patients in control group visited their endocrinologist 1.76 times per year, those in intervention group visited their endocrinologist 1.36 times per year, significantly less frequently than the control group (P = 0.014). Number of visits to other medical services is similar between the groups. Average A1C in intervention group is 7.57%, in control group is 7.69% (P = 0.309).

Conclusions: We have demonstrated that IBGMS, while not reaching statistical significance, may be associated with slightly reduced A1C and cost due to visiting physicians.

Keywords: Diabetes Mellitus; Internet; Economics; Online Systems; Blood Glucose Self-Monitoring; Telemedicine; Cost-Benefit Analysis

1. Background

Self-monitoring of blood glucose (SMBG) has been performed as an adjunct to glycated hemoglobin (A1C) measurements in diabetes management (1-8). Various Internet platforms are now available which allow patients to upload SMBG data and share this information with their health care providers, who assess the data and decide whether treatment and lifestyle modifications are necessary (8).

The Canadian Diabetes Association has published guidelines regarding internet-based therapy (9), and it is now our standard of care to offer an Internet Blood Glucose Monitoring Service (IBGMS) in our clinic in British Columbia, Canada. Patients enrolled in IBGMS were recommended to upload SMBG readings every two weeks through their choice of platform. Available platforms included Carelink (Medtronic), report-generating meters (Bayer Contour USB, Abbott Freestyle Insulinx, Sanofi iBG

Star), a customized spreadsheet (Microsoft Excel), and an online-reporting platform (Western Canadian Insulin Pump Centers). Typically, patients chose platforms based on computer literacy and computer compatibility. All platforms generated reports presenting results in tabular and/or graphical formats according to time of day, with automatic calculations showing the mean, standard deviation and range of blood glucose values. The patients' endocrinologists reviewed the reports and sent feedback directly to the patients via email. Recommendations included: medication adjustments, suggestions on testing frequency and lifestyle modifications, or encouragement to continue with no changes.

In this study, we explored the cost-effectiveness of IBGMS. Previous randomized controlled trials have demonstrated that telemedicine use has the potential to reduce the number of routine follow-up appointments. Taking

into account travel time and time off work, Biermann et al. calculated a savings of €650 (~900 USD) for patients who were followed up by phone every 2-4 weeks, compared to control patients who made monthly in-person visits (10). Jansa et al. estimated the cost savings of teleconferences instead of in-person visits at €396 (~548 USD) over 12 months (11). In that study, the intervention group attended nine teleconferences and three hospital appointments vs. 12 hospital appointments in the control group. In reality, for the purpose of managing diabetes, patients rarely see their endocrinologist as frequently as 12 times per year.

2. Objectives

This retrospective study aims to provide evidence for the cost-effectiveness of IBGMS from a different perspective. We compared 100 patients who used the IBGMS to report to their endocrinologist online with 100 patients who only used routine care. Patients were surveyed to assess the costs associated with doctor appointments in the past 12 months.

3. Patients and Methods

This study was approved by University of British Columbia – Providence Health Care Research Institute.

3.1. Survey Administration

We designed a survey composed of 15 questions. Patients were asked the annual number of visits to general practitioners, endocrinologists, laboratories, and other specialists for reasons relevant to diabetes. Moreover, the cost associated with each office visit was determined. Patients were asked to provide the cost of transportation to and from physician offices, parking costs, and if they have taken time off work for these visits. Finally, patients were asked to recall the frequency of SMBG and their most recent A1C. In total, 200 patients completed the survey. This includes 100 consecutively consenting patients with diabetes who had never reported blood glucose readings to their physician over the Internet, the control group, and another 100 consecutively consenting patients using IBGMS, the intervention group.

The survey was administered at two locations: the diabetes center at St. Paul's Hospital from January 9th 2014 to February 6th 2014, and the Endocrine Research Society from January 14th 2014 to April 14th 2014. 75 patients completed the survey at the diabetes center of St. Paul's Hospital, and 125 patients completed the survey at Endocrine Research Society. 4 out of the 75 participants from the diabetes center were reporters who reported glucose readings to their physician online (5.3%), the remaining 71 participants were non-reporters who used routine care only (94.7%). 96 out of the 125 participants from the Endocrine Research Society were reporters (76.8%), the remaining 29 were non-reporters (23.2%).

3.2. Data Analysis

The cost of transportation and the amount money lost from taking time off work were calculated for each patient and summed as the total cost per patient. The amount of money lost from taking time off work was calculated by multiplying the fraction of a day taken off work with average daily income ($176). Total cost, as well as the component costs of transportation and the losses due to taking time off work was compared across control and intervention groups using independent t-tests.

4. Results

Overall, there is a trend of lowered total cost in the intervention group compared to the control group. The total cost, cost of transportation and amount of money lost from taking time off work are summarized in Table 1. The control group spent $210.89 per year on visits to doctors; the intervention group spent $131.26 (P = 0.128). The cost of transportation including parking costs was $31.70 per year in the control group; that in the intervention group was $24.78 (P = 0.289). The amount of money lost from taking time off work is $179.19 per year in the control group, and $106.48 in the intervention group (P = 0.294).

These costs include visits to general practitioners, endocrinologists, laboratory exams, cardiologists, nephrologists, podiatrists, ophthalmologists, and vascular doctors. The average number of annual visits to each medical service is outlined in Table 2. Patients in control group visited their endocrinologist 1.76 times per year, those in intervention group visited their endocrinologist 1.36 times per year, significantly less frequently than the control group (P = 0.014). Number of visits to other medical services is similar between the two groups. When looking at visits to endocrinologists in isolation, no significant difference in transportation cost, amount of money lost from taking time off work or total cost was detected (Data not shown).

In terms of SMBG frequency, patients in control group tested 1.83 times daily, significantly less frequently than patients in intervention group, who tested 3.06 times per day (P < 0.001). 85 patients in control group were able to recall their most recent A1C, the average value was 7.69%. 99 patients in intervention group were able to recall their most recent A1C, the average value was slightly lowered at 7.57% (P = 0.309).

Table 1. Cost Comparison of Control and Intervention Groups

	Cost/Person		
	Control	**Intervention**	**P Value**
Total Cost	210.89 [a]	131.26	0.128
Cost of Transportation	31.70	24.78	0.289
Cost of Missed Work	179.19	106.48	0.294

[a] US Dollar.

Table 2. Number of Annual Visits to Different Medical Services

	Number of visits per year		
	Control	Intervention	P Value
General Practitioner	5.65	5.14	0.486
Endocrinologist	1.76	1.36	0.014 [a]
Laboratory Exam	4.10	4.61	0.297
Cardiologist	0.41	0.24	0.149
Nephrologist	0.47	0.39	0.681
Podiatrist	0.52	0.56	0.854
Ophthalmologist	1.31	1.40	0.688
Vascular Doctor	0.07	0.00	0.156
Total Visits	14.3	13.7	0.643

[a] $P < 0.05$.

5. Discussion

Overall, we observed a trend of lowered cost of seeing doctors in the intervention group as compared to the control group, but the difference was not statistically significant. Both the cost of transportation and amount of money lost from taking time off work are slightly reduced in the intervention group. Proper utilization of the Internet blood glucose monitoring system (IBGMS) also reduced the number of office visits to endocrinologists. Moreover, patients in the intervention group had a slightly lowered A1C. Recent studies have demonstrated that patients who frequently report blood glucose readings to their physician online attain significantly lower follow-up A1C levels compared to those who report infrequently (7). Data from this study further support the A1C-lowering effect of Internet intervention on patients with diabetes.

Although no significant difference in cost of seeing doctors was observed between control and intervention groups, one should keep in mind that various factors can contribute to cost, such as socio-economic status, which might in turn determine transportation cost and amount of money lost from taking time off work. These factors were not analyzed in the present study. Patients in the intervention group on average administered SMBG 3.06 times per day, significantly more frequently than those in the control group who tested 1.83 times per day. One can argue that those in the reporter group might be more diligent with diabetes management overall, and therefore also attained lower A1C levels. This is one possible explanation. However, in previous studies, we have shown that A1C of patients randomized to the IBGMS group reverted to baseline A1C values after removal of Internet intervention, suggesting that sustained utilization of IBGMS is necessary for improving A1C (12).

This study suffers from a few limitations. Some patients needed to come to their doctor's appointments from out of town, the cost of ferry and flights were not included in analysis to avoid skewing data. Finer classification of patient groups can be accomplished if the number of patients in each group is reasonably large. Patients were not classified by type of diabetes; therefore it is difficult to analyze the cost-effectiveness of IBGMS specifically for patients with type 1 diabetes and those with type 2 diabetes. There is no baseline A1C data for the control and intervention groups, thus it cannot be determined if reporting had a direct effect on A1C, only that there is a potential correlation of lower A1C with reporting. As all data from the survey was self-reported, the most recent A1C values, parking costs and time taken off work for each doctor appointment may be affected by recall biases. Lastly, the cost-benefit analysis has been done for a group of patients in British Columbia, Canada.

Proper utilization of IBGMS is effective and efficient because it may result in lower A1C and reduce the number of office visits to endocrinologists. In the long run, patients enrolled in the IBGMS can potentially benefit from optimal glycemic control and experience reduced number of complications with diabetes, which can in turn improve quality of life and save a substantial amount of resources for the health care system. Longitudinal studies that span a few years can better evaluate these parameters.

In this study we have demonstrated that Internet intervention via IBGMS, while not statistically significant, may show a trend in decreased costs due to visits to physicians with a possible slight reduction in A1C.

Acknowledgements

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