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Optimizing HgA1C and glucose monitoring frequency in patients with Type 2 diabetes

Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

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Summary

Background:

The primary objective of our study is to compare HgA1C to self monitoring frequency in diabetes subjects. A secondary objective is to evaluate the influence of family support and gender on glucose monitoring frequency and HgA1C.

Material/Methods:

We studied the glucose monitoring frequency and HgA1c outcome of 67 subjects treated with diet alone, 350 subjects treated with tablets, 155 subjects treated with insulin, and 228 subjects treated with both tablets and insulin.

Results:

Eleven percent of the subjects monitoring 4–7 times per week produced a positive significant coefficient ($p < .05$). Self monitoring less than 4 times per week showed no statistical significance and self monitoring more than 8 times per week showed no statistical significance. Forty-eight percent of subjects treating with insulin alone and tablet plus insulin produced positive significant coefficients ($p < .05$). The percentage lowering of HgA1C of tablet plus insulin is 15.64% as the mean HgA1C at the first visit was 9.35 compared to 7.89. The percentage lowering of HgA1C for insulin alone was 12.24% as the mean HgA1C at the first visit was 9.37 compared to 8.23 at the later visit.

Conclusions:

We conclude that (1) frequency of self monitoring should be based on individualized goals and willingness to participate, (2) both insulin alone and tablet plus insulin levels of medication are effective at lowering HgA1C levels; however, using the tablet and insulin combined produced lower HgA1C levels than using insulin alone; (3) family support and gender have no effect on glucose monitoring frequency and lowering HgA1C levels.

key words:

hemoglobin A1C • glucose monitoring frequency • self management diabetes education • Type 2 diabetes • self monitoring • Shared Medical Appointment

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BACKGROUND

Individuals with diabetes do not realize the consequences of poorly controlled blood sugars until injury occur [1–4]. The Diabetes Control and Complications Trial (DCCT) showed that glycemic control delays the onset of microvascular and macrovascular complications [5]. Glucose monitoring allows individuals with diabetes the opportunity to establish targets they should achieve for glucose control [6,7]. In the United Kingdom Prospective Diabetes Study (UKPDS), patients with new onset type 2 diabetes showed benefits in achieving glucose control evidenced by reductions in microvascular and neuropathic complications [8]. Self monitoring glucose is an important tool used to provide education and self management instructions to achieve optimal glucose levels [9]. There are multiple barriers that exist between the transfer and application of theoretical knowledge to patients [10,11]. For example, recent studies have focused on specific aspects of diabetes education in patients with cognitive impairment to a specific education program for insulin management and suggest that education should focus on specific needs expressed by the older population [12–15]. Diabetes education is a key aspect in diabetes management and is a collaborative process allowing the patient with diabetes to receive knowledge and skills needed to change behavior and successfully manage the disease [16,17]. A formal diabetes education program is a comprehensive program that is designed to enrich a patient's knowledge in diabetes management skills to problem solve unanticipated situations of hyperglycemia and hypoglycemia and sick-days, reduce risks associated with diabetes, and help with the healthy coping of day to day challenges of living with the disease [18–20]. Goals of diabetes therapy are to achieve optimal glucose and lipid values, improve quality of life and reduce health care costs [21].

MATERIAL AND METHODS

It is a cross sectional study done after an institutional review board approval. The study looked at 67 subjects with type 2 diabetes treated with diet alone, 350 subjects treated with tablets, 155 subjects treated with insulin, and 228 subjects treated with both tablets and insulin. Subjects had an average of 6 co-morbidities and 9 prescription medications respectively. Subjects were followed in a Shared Medical Appointment (SMA) as part of a Diabetes Self Management Education (DSME) program in the primary care setting in three intervals over 28 months. Exclusion criteria include subjects with limited physical abilities who were unable to participate in group diabetes self management education. Participants may have had prior individualized diabetes & carbohydrate counting education [22,23]. The study utilized the facility's Computerized Patient Record System (CPRS) upon entry and again at the third visit to collect hemoglobin HgA1C and frequency of reported glucose tests. Specific instructions for home glucose monitoring are given at routine office visits and at DSME visits. All subjects with a diagnosis of diabetes are given precise instructions to monitor glucose and interpret results. Formal DSME is provided by interdisciplinary staff instructors and re-enforced in three group visits before discharge to the Primary Physician. The curriculum content used is structured according to the National Standards for Diabetes Self Management

Education, tailored to match individual's needs and adapted as necessary for age, type of diabetes, cultural influences, health literacy and other co-morbidities. SPSS version 19 is used to regress the dependent variable, drop in hemoglobin HgA1C level, on the independent categorical variables through linear regression.

RESULTS

Using the enter method of linear regression the full model including medication type, medication level, gender, and family support indicates overall model significance ($p < .01$) and $R^2 = .056$. The medication levels, insulin and tablet plus insulin produce positive significant coefficients ($p < .05$). The positive coefficient indicates that both variables produce a mean difference value greater than that of no medication used, lowering the HgA1C level by a larger amount. Under the glucose monitoring category, monitoring 4–7 times per week produces a positive significant coefficient ($p < .05$). None of the other monitoring levels were significant. Gender and family support were found to be insignificant in the analysis. A second model was estimated using the enter method of linear regression without gender and family support indicating overall model significance ($p < .01$) and $R^2 = .054$, finding the same conclusions as previously stated. A third model using the enter method of linear regression was used to assess the significance of medication level. The overall model is significant ($p < .01$) and $R^2 = .050$. The combined model finds significance ($p < .05$) for the computed variable combining insulin and tablet plus insulin. Further analysis comparing the combined model to the reduced model indicates that taking both the tablet and insulin is more effective at lowering HgA1C levels than taking insulin alone at the 0.10 level of significance. As a matter of fact, the raw data indicates that the percentage lowering of HgA1C of tablet plus insulin is 15.64% as the mean HgA1C at the first visit was 9.35 compared to 7.89 at the later visit whereas the percentage lowering of HgA1C for insulin was 12.24% as the mean HgA1C at the first visit was 9.37 compared to 8.23 at the later visit.

DISCUSSION

We tested the hypothesis that achieving optimal HgA1C results is directly correlated to the frequency of self monitoring in subjects with type 2 diabetes. We found that at the time of diagnosis, many patients with type 2 diabetes were motivated to test frequently as was prescribed, and problem solve towards successful outcome [24–26]. The National Standards for Diabetes Self Management Education guide was used to formulate the education and match individual's needs, and adapt as necessary for age, the type of diabetes, cultural influences, health literacy and other co-morbidities. Utilization of print, audio, and models to deliver the education was also used. However, after 5mos, many subjects were less inclined to test glucoses, report results, and maintain focus. When this behavior was observed, our intervention was to engage each subject individually by offering 1:1 appointments with DSME staff to discuss obstacles [8,11]. We found that coaching subjects towards glucose monitoring and problem solving lead to preventable hospitalizations. Contacting telephonically was highly accepted and successfully integrated into treatment plan.



Table 1. Estimation results of full linear regression model.

Full Model p<0.01 R²=.056			
	Coefficient	Significance	95% C.I.
Intercept	-.265	.568	-1.177-.647
Family	.467	.255	-.339-1.273
Gender	-.163	.662	-.895-.569
Tablet	.404	.126	-.113-.921
Insulin	.624	.027*	.071-1.177
Tablet + Insulin	.979	.001*	.434-1.523
1-3 times per week	.279	.137	-.089-.647
4-7 times per week	.760	.013*	.160-1.359
8 or more Times per week	.294	.260	-.218-.806

* p<.05.

Table 2. Estimation results of reduced linear regression model.

Reduced Model p<0.01 R²=.054			
	Coefficient	Significance	95% C.I.
Intercept	.186	.439	-.286-.658
Family	NA	NA	NA
Gender	NA	NA	NA
Tablet	.395	.134	-.122-.911
Insulin	.617	.029*	.064-1.170
Tablet + Insulin	.967	.001*	.423-1.511
1-3 times per week	.284	.130	.084-.651
4-7 times per week	.770	.012*	.171-1.369
8 or more Times per week	.311	.232	-.200-.822

* p<.05.

Table 3. Estimation results of combined linear regression model.

Combined Model p<0.01 R²=.050			
	Coefficient	Significance	95% C.I.
Intercept	.170	.480	-.302-.642
Family	NA	NA	NA
Gender	NA	NA	NA
Tablet	.408	.122	-.109-.925
Insulin	.805	.002*	.286-1.324
Tablet + Insulin	.805	.002*	.286-1.324
1-3 times per week	.287	.126	-.081-.656
4-7 times per week	.815	.008*	.217-1.413
8 or more Times per week	.351	.178	-.159-.860

* p<.05.

Table 4. Descriptive statistics.

	Medication Level			
	None	Tablet	Insulin	Both
Mean (S.D.)	.38 (1.31)	.79 (1.55)	1.18 (2.21)	1.57 (1.85)
# in Sample	67	350	155	228
	Glucose monitoring			
	None	1–3 Times/Wk	4–7 Times/Wk	8+ Times/Wk
Mean (S.D.)	.52 (1.59)	.90 (1.57)	1.73 (2.02)	1.27 (1.96)
# in Sample	145	289	86	280
	Gender		Family support	
	Male	Female	Yes	No
Mean (S.D.)	1.05 (1.81)	1.00 (1.36)	.47 (1.28)	1.06 (1.81)
# in Sample	777	23	781	19

Mean (S.D.).

Furthermore, the present study has shown that empowering the subject with diabetes to practice self care management is imperative to reaching HgA1C targets. However, the subject with the diagnosis, ultimately decides the glucose monitoring frequency needed to successfully achieve glucose targets.

CONCLUSIONS

Tables 1–3 represent each of the estimated models, the unstandardized coefficients, corresponding significance levels, and the ninety five percent confidence intervals. Thus, the following conclusions were made: (1) frequency of self monitoring should be based on individualized goals and willingness to participate, as seen in this study the best frequency for glucose monitoring is between 4 and 7 times per week; (2) both insulin alone and tablet plus insulin levels of medication are effective at lowering HgA1C levels in patients, however, using the tablet and insulin combined produced lower HgA1C levels than using insulin alone; (3) family support and gender have no effect on lowering HGA1C levels in patients. (Descriptive statistics of the analyzed data are depicted in Table 4).

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