Effect on Glycemic, Blood Pressure, and Lipid Control according to Education Types

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Background: Diabetes self-management education and reinforcement are important for effective management of the disease. We investigated the effectiveness of interactive small-group education on glycemic, blood pressure, and lipid levels.

Methods: For this study, 207 type 2 diabetes patients with suboptimal glycemic control (HbA1c levels >6.5%) were enrolled. The conventional education group received an existing education program from April to November in 2006, and the interactive education group received a new small-group education program from December 2006 to July 2007. The two groups were comparatively analyzed for changes in blood sugar, glycated hemoglobin, lipid, and blood pressure at baseline, 3, 6, and 12 months and the proportion of patients achieving target goals at 12 months.

Results: After 12 months of follow-up, HbA1c levels in the interactive education group were significantly lower than in the conventional education group (6.7% vs. 6.4%, \( P < 0.001 \)). Fasting and 2 hour postprandial glucose concentrations, total cholesterol, and low density lipoprotein cholesterol were significantly lower in the interactive education group than in the conventional education group. The proportion of patients that achieved target goals was significantly higher in the interactive education group.

Conclusion: The small-group educational method improved and re-established the existing group educational method. This finding suggests that the importance of education appears to be related to the method by which it is received rather than the education itself. Thus, the use of small-group educational methods to supplement existing educational methods established for diverse age levels should be considered in the future.

Keywords: Achievement; Diabetes mellitus; Education

INTRODUCTION

The current global prevalence of diabetes in adult population has been estimated to be 5.1% since 2003 and is expected to increase to approximately 6.3% by 2025 [1]. Diabetes is a major risk factor for leading causes of death such as cardiovascular and cerebrovascular disease and is accompanied by multiple complications, which have a negative effect on the family and society. Additionally, as the cost of treating diabetes and its complications have increased continuously, countries have made extensive efforts in preventing and managing diabetes [2].

In most cases, complete recovery after the onset of diabetes is difficult; thus, it is a chronic disease that requires continuous, lifelong therapy and self-management. In addition, several large-scale studies have proven that strict glycemic control and management of comorbidity such as hypertension, dyslipidemia can reduce the occurrence of diabetes complication and...
mortality rate [3-5]. Therefore, it is recommended that patients
start diabetic medication in conjunction with therapeutic life-
style modification as soon as possible. As known in the previ-
ous studies, it is more effective to motivate and educate patients
so that they can understand the disease itself and manage their
blood glucose level, instead of simply providing medication
[6-8]. Enhancing effective self-management skill is an impor-
tant part of diabetes management, thus, diabetes education is
necessary and required as the basis for diabetes care.

The Study Group on Diabetes Mellitus of the World Health
Organization (WHO) stated that “The foundation of diabetes
management is educating patients and their families on the
subject.” The American Diabetes Association’s mission state-
ment of education program is “Education is an ongoing pro-
cess with the ultimate goal of a positive behavioral change.”
Diabetes education is greatly beneficial in patients and furthermore, provides social and economic benefits to society as a
whole [9]. In other words, the most effective solution in terms
of preventing and controlling chronic diabetic complication is
patients’ active participation in diabetes management, both of
which can be possibly achieved through ongoing patient edu-
cation and training [10,11]. However, it is difficult to expect
effectiveness of the most diabetic education program with one
or two sessions conducted in this country [12].

Recently, various individual or group education programs
for patients have been offered in several hospitals, and have
shown improvement in HbA1c levels, self-management indi-
cators, patient satisfaction and knowledge, shortening of hos-
pitalization period, and reduction in leg amputation rates after
the application of these education programs [13,14]. However,
the majority of these studies assessed the short-term effects of
education on glucose control but not long-term effects after
education. In this study, we compared two programs between
the existing education program of unilateral information de-
ivery versus intensive, interactive education program for small
number of patients, regarding their effects on short- and long-
term improvement of diabetes maintenance indicators.

METHODS

Study population
This study is conducted on the patients who were not able to
achieve target HbA1c level according to the treatment guide-
line for diabetes from Korean Diabetes Association [15] (with
HbA1c levels ranging 6.5% to 9.0%) and who could be fol-
lowed for over one year. Patients were devided into two groups
based on the education methods. A total of 101 patients had
received conventional group education between April 2006
and November 2006, and 106 patients had received a new type
of small-group education between December 2006 and July
2007.

Measurement of covariates
We collected patient characteristics such as gender, age, height,
weight, duration of diabetes, and history of oral hypoglycemic
agents, anti-hyperlipidemic agents, or antihypertensive drugs,
or insulin therapy.

We measured the fasting plasma glucose, 2-hour postpran-
dial glucose, HbA1c, total cholesterol, triglycerides, high den-
sity lipoprotein cholesterol (HDL-C) and low density lipopro-
tein cholesterol (LDL-C), and blood pressure at baseline and 3,
6, and 12 months after education. During education, the pro-
portion of patients achieving targeted treatment goals was es-
timated by examining medical records. The medical records
were reviewed retrospectively.

Diabetes education methods
The two types of teaching methods are as follows.

Conventional education (CE)
Approximately 30 in-patients and out-patients were included
and group education was offered in two ways: diabetes educa-
tion executed by a doctor, and diabetes management executed
by a nurse for one and half hours followed by a one-on-one
nutritional session.

Interactive education (IE)
IE was consisted of approximately 10 people. A nurse, a dieti-
tian, and a physical therapist composed an education team
and offered 2.5-hour education sessions. Endocrine specialists
were responsible for the entire education system including
prescribing medicines and encouraging staffs. Nurses provid-
ed education for the patients to understand and manage dia-
betes, so patients could get overview of disease and verify exa-
namination levels, methods for managing and self-monitoring
of blood glucose, management of hypoglycemia, foot mainte-
nance, management for special days, and day-to-day activities
so as to maintain their daily lives by themselves. Nutritionists
emphasized the importance of diabetes-oriented diets and ed-
ucated patients on proper diet and clinical exercise specialist
thought how to exercise for diabetes. Written education aimed at developing a deeper understanding of the program and complementary education via Q & A were also given. After performing small group education and one-on-one private nutritional education, patients received primary and secondary sought management. Blood glucose examinations (HbA1c, blood lipid levels, and blood pressure measurements) were performed in the outpatient clinic at 3, 6, and 9 months after receiving education. Based on the above examination results, a diabetes management instructional flyer was sent out to those patients. Researchers/educators attempted to generate an interest in diabetes management indicators.

Statistical analysis
The crosstab method was used to estimate the proportion of patients who achieve the goals of diabetes management for both groups. The indicators for diabetes management were comparatively analyzed between the two groups at baseline and 3, 6, and 12 months after education. 

\[ P \text{ value } < 0.05 \] was considered to be statistically significant. All statistical analyses were conducted using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA).

RESULTS
The baseline characteristics of the two groups are shown in Table 1. There were no significant differences between two groups in sex, age, duration of diabetes, the rate of using insulin, oral hypoglycemic or antihypertensive agents. A greater percentage of patients in the IE group reported anti-hyperlipidemic agents use \( (P < 0.001) \) (Table 1). The mean age of the CE group and IE group was 56.5 ± 12.1, and 55.5 ± 10.6, respectively. The mean duration of diabetes for the CE group and IE group was 5.03 ± 2.3, and 5.1 ± 2.6, respectively and they were not significantly different.

Table 1. Baseline characteristics of participants by group

| Characteristic                        | CE (n=101) | IE (n=106) | P value |
|---------------------------------------|------------|------------|---------|
| Sex, M/F                              | 52/49 (52/48) | 64/42 (60/40) | 0.198 |
| Age, yr                               | 56.5 ± 12.1 | 55.5 ± 10.6 | 0.538 |
| Diabetes duration, yr                 | 5.03 ± 2.3 | 5.1 ± 2.6 | NS |
| Fasting plasma glucose, mg/dL         | 158.7 ± 49.5 | 144.2 ± 30.2 | 0.012 |
| Postprandial glucose, mg/dL           | 219.8 ± 74.5 | 212.1 ± 71.6 | 0.453 |
| HbA1c, %                              | 7.5 ± 0.7 | 7.5 ± 0.8 | 0.885 |
| Total cholesterol, mg/dL              | 199.5 ± 37.8 | 198.4 ± 41.2 | 0.844 |
| Triglyceride, mg/dL                   | 191.8 ± 114.5 | 188.5 ± 152.9 | 0.860 |
| HDL-C, mg/dL                          | 50.2 ± 11.1 | 44.3 ± 10.1 | 0.000 |
| LDL-C, mg/dL                          | 113.0 ± 30.8 | 123.1 ± 32.0 | 0.023 |
| SBP, mm Hg                            | 126.0 ± 17.7 | 128.6 ± 14.0 | 0.262 |
| DBP, mm Hg                            | 80.0 ± 11.2 | 80.7 ± 9.6 | 0.651 |
| No. of people treated with            |            |            |         |
| Diabetes and exercise only            | 3 (3) | 1 (0.9) | NS |
| Oral hypoglycemic agents              | 98 (97) | 105 (99.1) |         |
| Use of anti-hyperlipidemic agent       |            |            |         |
| No                                    | 43 (42.6) | 21 (19.8) | 0.000 |
| Yes                                   | 58 (57.4) | 85 (80.2) |         |
| Use of insulin                        |            |            |         |
| No                                    | 88 (87.1) | 95 (89.6) | NS |
| Yes                                   | 13 (12.9) | 11 (1.04) |         |
| Use of antihypertensive agent         |            |            |         |
| No                                    | 46 (45.5) | 35 (33) | NS |
| Yes                                   | 55 (54.5) | 71 (67) |         |

Values are presented as mean ± standard deviation or number (%). CE, conventional education group; IE, interactive education group; NS, not significant; HbA1c, hemoglobin A1c; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Improvements of management indicators from educational methods
Analytical results of diabetes management indicators in the CE group and the IE group at baseline and 12 months after education are shown in Table 2. Over the 1-year follow up period, the fasting plasma glucose levels significantly dropped from 144.2 ± 30.2 mg/dL to 122.8 ± 19.2 mg/dL in the CE group and from 158.7 ± 49.5 mg/dL to 129.2 ± 25 mg/dL in the IE group, significantly. Comparing two groups, the IE group showed a significantly greater improvement over the CE group \( (P = 0.040) \). The 2-hour postprandial glucose level for both the CE group and the IE group decreased significantly from 219.8 ± 74.5 mg/dL at baseline to 175.6 ± 48.8 mg/dL and from 212.1 ± 71.6 mg/dL to 159.3 ± 42.1 mg/dL, respectively, one year after education received. Comparing drops of 2-hour postprandial glucose levels between the two groups showed that the IE group had a significantly greater improvement than the CE group \( (P = 0.013) \).
Effect on diabetes control according to education types

The HbA1c levels of the CE group decreased significantly from 7.5±0.7% to 6.7±0.8% and 6.6±0.6%, 3 and 6 months after education, respectively. However, after 12 months, the HbA1c levels were slightly increased to 6.8±0.6%. The HbA1c levels of the IE group showed a steady decrease, from 7.5±0.8% at baseline to 6.6±0.7%, 6.5±0.8%, and 6.5±0.5% at 3, 6, and 12 months after education received, respectively. The IE group showed greater improvement compared to the CE group ($P<0.001$) (Fig. 1).

The lipid concentration between the two groups showed no significant differences for HDL-C and triglycerides. However, total cholesterol prior to education were similar as 199.5±37.8 mg/dL and 198.4±41.2 mg/dL, respectively, whereas total cholesterol levels at 12 months after education were significantly different between two groups (168.5±34.7 mg/dL for CE and 157.1±38.2 mg/dL for IE; $P=0.026$). The LDL-C concentration in the CE group prior to education was 113.3±30.8 mg/dL and decreased to 102.9±31.7 mg/dL at 12 months after education. The LDL-C concentration in the IE group prior to education was 123.1±32.0 mg/dL and decreased to 85.6±28.0 mg/dL one year after education. After one year, there was a significant difference in LDL-C levels between the two groups ($P<0.001$). The percentage of patients in the IE group taking cholesterol medication was significantly higher than that in the CE group.

Achievement of target goals

According to the American Diabetes Association [16] and the International Diabetes Federation [17] criteria, the primary and secondary (final) target goals were defined and the proportion of patients achieving diabetes management goals are shown in Table 3. One year after education, the proportion of patients that achieve primarily targeted fasting plasma glucose level was increasing in both groups, but there was no significant difference between the groups. Although there was a significant decreasing trend in blood pressure for both groups, there was no significant difference between the groups.

Table 2. Changes in biochemical parameters by group

| Parameter                | CE ($n=101$) | IE ($n=106$) | $P$ value | $P$ value |
|--------------------------|--------------|--------------|-----------|-----------|
| Fasting plasma glucose, mg/dL | 158.7±49.5  | 129.2±25.0   | 0.000$^a$ | 144.2±30.2 | 0.040$^a$ |
| 2-hr postprandial glucose, mg/dL | 219.8±74.5  | 175.6±48.8   | 0.000$^a$ | 212.2±71.6 | 0.012$^a$ |
| HbA1c, %                 | 7.5±0.7      | 6.8±0.6      | 0.000$^a$ | 7.5±0.8    | 0.000$^a$ |
| Total cholesterol, mg/dL | 199.5±37.8   | 168.5±34.7   | 0.000$^a$ | 198.4±41.2 | 0.026$^a$ |
| Triglyceride, mg/dL      | 191.8±114.5  | 160.6±100.0  | 0.002$^a$ | 188.5±152.9 | 0.167 |
| HDL-C, mg/dL             | 50.2±11.1    | 47.2±12.0    | 0.015$^a$ | 44.3±10.1  | 0.491 |
| LDL-C, mg/dL             | 113.0±30.8   | 102.9±31.7   | 0.010$^a$ | 123.1±32.0 | 0.000$^a$ |
| SBP, mm Hg               | 126.0±17.7   | 125.7±14.3   | 0.832     | 128.6±14.0 | 0.061 |
| DBP, mm Hg               | 80.0±11.2    | 77.4±8.4     | 0.071$^a$ | 80.7±9.6   | 0.984 |

Values are presented as mean±standard deviation.

CE, conventional education group; IE, interactive education group; HbA1c, hemoglobin A1c; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

$^aP<0.05$.

Fig. 1. Changes in A1c levels over 12 months. CE, conventional education group; IE, interactive education group. $^aP<0.05$.
mission is insufficient to motivate them. Because this education system is not personalized, even after patients received education, they have difficulties in practicing guidelines for diabetes management and has been failing to reach the target glycemic goal and, therefore, to prevent diabetes complications [19,20]. Thus, developing new educational programs is required.

In this study, we attempted to make changes to the traditional teaching system, to configure a new training program and to evaluate improvements of diabetes management indicators after applying these new educational methods. Although we could not find significant short-term effects of IE (3 and 6 months after receiving education), we identified long-term improvements (12 months after receiving education) on fasting plasma glucose, 2-hour postprandial glucose, HbA1c levels, total cholesterol, and LDL-C.

**DISCUSSION**

In the previous study, it has been demonstrated that the effects of diabetes education was favorable on compliance with medications, exercise programs, regular checkups, as well as on significant decreases in 2-hour postprandial glucose levels [18]. However, these promising results were produced using effective education and studies showing the long-term effects of education were limited. The current diabetes education conducted in the most hospitals is being implemented to inpatients, outpatients, and guardians, using instructor-led training for a large group of patients regardless of their different educational levels. Although this education system help increase patients’ knowledge about the disease, simple knowledge trans-

### Table 3. Proportion of patients achieving target goals

| Target goal                      | CE, % | IE, % |
|----------------------------------|-------|-------|
| Fasting plasma glucose, mg/dL    | <130  | 36.6  | 33.0  |
|                                  | <110  | 8.9   | 10.4  |
| 2-hr postprandial glucose, mg/dL | <180  | 34.7  | 38.6  |
|                                  | <145  | 14.9  | 14.9  |
| HbA1c, %                         | <7    | 27.7  | 30.2  |
|                                  | <6.5  | 1.0   | 4.9   |
| Total cholesterol, mg/dL         | <200  | 49.0  | 50.0  |
| Triglyceride, mg/dL              | <150  | 46.5  | 54.9  |
| HDL-C, mg/dL                     | M>40, | 54.5  | 47.2  |
|                                 | F>50  | 56.4  | 51.9  |
| LDL-C, mg/dL                     | <100  | 34.7  | 19.8  |

**Fig. 2.** Proportion of patients achieved target goal for fasting plasma glucose (FPG) and 2-hr postprandial glucose (PP2). CE, conventional education group; IE, interactive education group. *P<0.05.

**Fig. 3.** Proportion of patients achieving target goal for HbA1c. CE, conventional education group; IE, interactive education group. *P<0.05.
It is considered to be important education factor to check patients’ own laboratory results (e.g., blood glucose, HbA1c levels, and lipid levels) in the result table provided for IE group, and to recognize the differences between targeted goals and their own levels. Additionally, sending out the result tables at 3, 6, and 9 months after receiving education gives the meaning of re-education; recognizing the need for continuous management.

At 3 and 6 months after receiving education, HbA1c levels for both groups showed the decreasing trends. However, after 12 months, HbA1c levels in the CE group showed an increasing trend, while the IE group continued to show a decreasing trend. Thus, for the improvement of long-term maintenance indicators, intervention with sustained, intensive diabetes education is considered necessary.

Although the proportion of patients who achieved their goal of HbA1c <7.0% were similar between two groups, more patients in IE group achieved their targeted goal of HbA1c <6.5%, as result of strict blood glucose control, than those in CE group (48.1% and 30.7%, respectively). In other words, this new education method yielded significant improvements in strict and long-term glycemic control.

Diabetes education in Korea is currently taking place in clinics and public health centers. The insurance policies and fees for health care service are unrealistic, so forming a dedicated education unit and developing a qualified education program are difficult. Most provide perfunctory and one-time education with one-way communication, and it does not guarantee effectiveness of education.

The weaknesses of this study are: 1) it was retrospective study using the medical records of patients; 2) comparison of the degrees of fulfillment of self-management between both groups and changes in the treatment regimen were not investigated one year after receiving education; 3) including only patients who completed the one year follow-up limited generalization of our study findings. Based on this study, a long-term follow-up survey could be planned to determine the prolonged effects of this intensive education program and to evaluate self-management. Furthermore, experiences in diabetes educators and the effects of this education can be shared and this education can be used as a basic material in developing new educational programs in the future.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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