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A Diabetes Peer Support Intervention That Improved Glycemic Control: Mediators and Moderators of Intervention Effectiveness

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Abstract

Objective—In a randomized trial, a guided diabetes peer-support intervention improved glycemic control (A1c), with a difference in A1c change between groups of 0.58% ($P = 0.004$). The current study examined whether improvements in insulin uptake and perceived diabetes social support (DSS) mediated the intervention's impact on A1c. We also examined potential moderation by patients' health literacy, DSS, or diabetes distress.

Methods—We conducted secondary analyses for 212 type 2 diabetes patients participating in the trial using accepted methods for testing effect mediation and moderation.

Results—Roughly half (49%, 95% CI: 3%–80%) of the A1c effect was mediated by increased insulin use, while changes in DSS had a negligible impact. A1c impacts varied across subgroups defined by baseline DSS and functional health literacy (both $p < 0.01$). The intervention was particularly beneficial among patients with low baseline diabetes support or literacy levels. The intervention had a greater impact on A1c among patients with more frequent engagement in peer-support calls ($p < 0.01$).

Discussion—Patients receiving increased peer support had improved glycemic control largely due to their greater likelihood of initiating insulin. Greater intervention engagement was associated with stronger effects. The intervention had its greatest benefits among patients with low support or poorer health literacy.

Keywords

self-management; behavior change; peer-support

Introduction

Peer support is a potentially effective way to improve diabetes management, allowing for mutual exchange of information, joint problem-solving, and emotional support for the stressors of living with chronic disease. Peer-supporters may be especially effective when they receive training in communication skills for motivating behavior change and have “back-up” by health professionals to address complex medical problems.^{1,2} Information systems that can cue timely, systematic peer communication through telephone or computer

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contacts between face-to-face encounters may increase the intensity of peer-support, just as care management systems can improve outreach from patients' clinical team.

In a recent trial, we evaluated the impact on glycemic control of a guided diabetes peer support intervention compared to standard nurse care management.³ Patients in the peer support arm participated in an initial nurse-led group session to set diabetes-related behavioral goals, received brief training in Motivational Interviewing-based peer communication skills,⁴ and were paired with another age-matched participant. Paired peer partners were encouraged to talk weekly using a specially-designed telephone platform and were also offered patient-driven group sessions to share concerns, questions, strategies, and progress on goals. Participants in the comparison group participated in an initial session with nurse care managers to review their A1c values, discuss strategies to improve glycemic control, and to reinforce the importance of care management as a way of improving their glycemic control.

At the end of the six-month intervention, participants in the peer support intervention had significantly improved glycemic control compared to participants randomized to receive nurse care management alone (mean difference in A1c between groups: 0.58%, $p=0.004$). A larger number of intervention patients using only oral antihyperglycemic agents at baseline initiated insulin therapy compared to controls (15% versus 2%, $p=0.02$), and intervention patients at follow-up reported higher levels of diabetes social support ($p=0.01$).³

Particularly given that peer-support interventions have shown positive^{5,6} as well as negative⁷ results in prior studies, it is important to understand the mechanisms through which the intervention had its positive effect on glycemic control. For example, it is unclear whether improvements in A1c levels were driven primarily by changes in the subgroup of intervention participants who initiated insulin therapy. Diabetes-specific support can enhance self-management and improve outcomes;^{8,9} and in the current trial, it is unclear whether greater support among intervention patients was a driving factor mediating patients' improved glycemic control. The answers to these questions and exploration of other factors that may have contributed to the intervention's success in lowering mean A1c levels will help shape the design of other interventions seeking to improve risk factor control among diabetic adults.

To truly understand this intervention's impact, it also is important to identify what types of patients might have benefited the most. For example, patients with higher levels of diabetes-related social support at entry into the trial may have been able to leverage those resources synergistically with the additional resources provided by the intervention. Alternatively, the intervention may have been especially useful for patients with more limited support from their family and community contacts. Diabetes patients with health literacy deficits are at particularly high risk for poor glycemic control and complications,^{10,11} and it is unclear whether the intervention had a more muted effect among patients with lower baseline health literacy, or alternatively, whether the increased communication from a peer-partner helped to overcome those patients' challenges.

Using a conceptual framework for potential mediators and moderators of this intervention's impact developed prior to the trial,¹² the purpose of the current study was to examine the mediators and moderators of the service's effect on glycemic control. Specifically, we examined the two improved secondary outcomes as potential mediators: insulin initiation and perceived diabetes social support. We also examined potential effect moderation associated with patients' baseline diabetes social support, baseline diabetes distress, and functional health literacy. Finally, we examined whether the intervention was more impactful among patients with greater engagement as defined by more frequent telephone

peer support contacts. Understanding the mechanisms of effect in this trial is particularly important given that at least one other peer-support study found little evidence that such interventions improved diabetes clinical outcomes.⁷

Methods

Recruitment, Measures, and Randomization

The study was approved by the University of Michigan and Ann Arbor VA Healthcare System IRBs, and all patients completed written informed consent. Sampling, intervention characteristics, outcome measurement, and analytic methods for the trial were described in detail previously.³ Patients with type 2 diabetes and a recorded A1c > 7.5% in the prior six months receiving care at two Veterans Affairs (VA) facilities were identified from electronic medical records using a validated algorithm.¹³ Patients were excluded if they had an International Classification of Diseases (ICD-9) diagnosis of serious mental illness. After receiving provider approval, identified patients were contacted by telephone and screened for eligibility. We excluded patients who reported active substance abuse, severe depression, hearing loss, or a terminal illness such as advanced cancer.

Eligible and interested patients were scheduled for a face-to-face initial session in groups of 4 to 18. At that session, participants completed a self administered survey; as well as blood pressure and A1c tests with a Bayer DCA2000+ Analyzer.¹⁴ Participants were then randomized to the intervention or control groups. Patients, research staff, and care managers were blinded to randomization results until patients completed baseline surveys and physiologic measures.

Intervention and Control Group Services

Both intervention and control patients received care management. All care managers were nurses who completed a 4-hour training plus two one-hour booster sessions focused on Motivational Interviewing¹⁵ and Empowerment-based approaches¹⁶ to facilitate group discussion and encourage patients to identify self-care goals and action plans for attaining those goals.¹⁷ Care managers were encouraged to use these skills when counseling patients regardless of whether the patient was randomized to the peer-support intervention. All patients on insulin were given the same instructions about self-adjusting doses using recommended algorithms.¹⁸ All study participants received the results of their point-of-service A1c and blood pressure tests at baseline as well as their most recent cholesterol values recorded in their medical record. Each participant also received diabetes self-management educational materials.

Control group patients attended a 1.5 hour session led by a nurse care manager to review their laboratory and blood pressure results, ask questions about diabetes-related medications and other dimensions of self-care, and receive information on VA care management services. Control participants were provided contact information for their assigned care manager and were encouraged to schedule follow-up visits. All patients had access to their nurse care manager throughout the study.

Peer Support Intervention

After the baseline assessment, intervention group participants attended a 3-hour group session facilitated by a care manager and research associate that introduced the peer support program. During the session, laboratory and blood pressure results were reviewed and personal action planning was introduced. Participants received brief training in peer communication and motivation and were paired at random with another age-matched intervention participant in the same group. Peer partners were encouraged to call each other

at least once a week using an interactive voice response-facilitated telephone platform that: recorded call initiation, frequency, and duration; enabled partners to telephone without exchanging telephone numbers and to set time periods in which calls could be blocked; and generated automated reminders every 7 days if no peer calls were attempted. During a reminder call, participants could be transferred automatically to their peer-partner's number. The system also had functions enabling participants to leave voice messages for research staff or care managers. At the end of the initial session, intervention participants were given a DVD demonstrating peer communication skills and a diabetes self-management workbook that they could use to help guide their peer telephone calls. Peer support participants were offered three additional 1.5 hour group sessions at months 1, 3, and 6, in which participants were encouraged to share concerns, strategies, and progress on their action plans.

Measurement and Analysis

The full set of study outcomes is described elsewhere.³ The primary outcome for the trial was A1c measured at six months, controlling for baseline values. A1c at both time points was measured with a Bayer DCA 2000+ point-of-care analyzer.¹⁴ Insulin use was measured via self-report in the baseline and six-month follow-up survey and confirmed via medical record review. For mediator analyses presented here, we included a binary indicator for insulin initiation versus no-initiation. Perceived social support was measured using the Diabetes Support Scale (DSS).¹⁹ For the mediator analyses presented here, we included a measure of change in DSS scores between the baseline and 6 months (i.e., 6 month score – baseline score). Changes in other secondary outcomes of the trial, i.e., diabetes care self-efficacy,²⁰ self-reported diabetes self-management behaviors,²¹ diabetes distress,²² and autonomous motivation,²⁰ did not differ at the six-month follow-up between the two experimental arms. Therefore these variables were not examined as potential mediators of effects on A1c. We also examined the number of successfully completed peer-support calls among intervention patients as a potential mediator. For these analyses, we divided intervention patients into two roughly equivalent groups based on the number of calls completed (i.e., 8, N=56; 8+, N=50).

Based on the conceptual model,¹² the following baseline characteristics were examined as potential moderators of the intervention's impact on glycemic control: diabetes-specific distress measured using the Diabetes Distress Scale (DDS),²² DSS-measured diabetes social support,¹⁹ and health literacy. Health literacy was measured using a single validated item: "How often do you have problems understanding written materials?"²³ with five response options ranging from "Always" to "Never."

Statistical Analysis

Mediation by the two candidate mediators (insulin starts and improvements in DSS) was assessed by testing the change in the magnitude of the coefficient associated with the intervention before and after adjustment of those mediators.²⁴ The base model included only the intervention group indicator and A1c at baseline as predictors. The `xtmixed` command in STATA, version 12, which fits multilevel mixed-effects linear regression models, was used to assess the change in mean HbA1c level, with clustering by assigned pairs.²⁵ We then introduced into the model measures of insulin starts and improvement in DSS-measured social support. The proportion of the overall intervention effect mediated by insulin starts and improvements in DSS was evaluated using the method recommended by MacKinnon and Dwyer,²⁶ operationalized for use with binary mediators (e.g. insulin starts) in Stata. Bootstrapping with 1000 replications was used to produce confidence intervals for estimates of mediation in the path analysis of direct and indirect intervention effects.²⁷ Mean six month A1c test results also were examined using ANOVA and paired t-tests comparing

patients in the control group with intervention patients who completed 8 and 8+ peer telephone calls (i.e., a test of dose-response).

To evaluate effect moderation, we first fit a model including the main effect for intervention group as well as an interaction term between the intervention and each potential moderator (i.e., baseline DSS, diabetes distress, and health literacy). The main effect of each moderator was also included in the models. Both DSS and health literacy were found to interact significantly with the intervention in these models. We then constructed graphical displays presenting trends in intervention effects across levels of DSS and health literacy. We used multivariate fractional polynomial interaction (MFPI) to assess various potential functional forms for the two interactions.²⁸ Specifically, we used the MFPI procedure in STATA version 12 to assess linear and higher degrees of fractional polynomial functional forms for the interactions, and found that linear interaction models were the best fit for both moderators, according to the Akaike information criterion. Variations in intervention effects across levels of each moderator are presented graphically using two-way plots. Ninety-five percent confidence bands were computed using the delta method as employed in Stata 12.²⁹

Results

Description of the Sample

As noted previously,³ 244 participants were randomized into the trial, 216 (89%) provided A1c assessments at six months, and 231 (95%) completed six-month surveys. Analyses for the current study focus on the 212 patients with both complete A1c and survey data. Those patients had a mean age of 62, 100% were men (by design), 83% were Caucasian, and 29% had at most a high school education. Almost half (46%) of patients were using only oral antihyperglycemic agents at enrollment, and 19% reported living alone. Baseline DSS scores ranged from 0–100, and baseline scores were roughly normally distributed with a mean of 54 (SD: 24) and median of 60. Compared to trial participants without complete data on all outcomes (N=32), those included in the current analyses were no different in terms of age, health literacy or baseline values for DSS and insulin use.

Results of Mediator Analyses

In tests of mediation (Table 1), insulin starts were an independent predictor of improvements in A1c, although changes in DSS scores were not (Models 1 and 2). When both insulin starts and DSS improvement were entered into the model simultaneously (Model 3), insulin starts remained a significant predictor, while the impact of DSS improvement remained non-significant ($p=.27$). Analyses of direct and indirect intervention effects showed that 46% of the total intervention effect on A1c (95% CI: 3% to 76%) was mediated by insulin starts. The intervention main effect remained statistically significant regardless of which potential mediators were included as covariates (i.e., there was a significant intervention-control difference in Model 1, 2, and 3), confirming partial mediation with 54% of the overall intervention impact unexplained by the two covariates.

Compared to the mean endpoint A1c value among control patients (8.2%), we observed a significant dose-response ($p<0.01$) associated with intervention group patients who had 8 peer support calls (7.9%), and 8+ calls (7.6%). Control-group mean A1c values at follow-up were marginally higher than patients with 8 calls ($p=0.09$) and significantly higher than patients with 8+ calls ($p=0.003$).

Results of Moderator Analyses

A global test of interaction between baseline DSS and intervention group was statistically significant (interaction term $p<.001$). The intervention had a significant impact among

patients who at baseline reported lower levels of diabetes support (DSS < 60) while no significant effect was found among patients with higher baseline support levels (DSS ≥ 60; Figure 1).

The global test for interaction between baseline health literacy and intervention was statistically significant (interaction term $p=.04$). Patients with lower baseline health literacy levels were particularly likely to benefit (Figure 2). Significant decreases in A1c were observed among patients who reported at baseline ever experiencing literacy problems (always, often, sometimes, rarely). On average, there was no difference between intervention and control groups' endpoint A1c's among patients with a high health literacy level at baseline.

Discussion

The current study sheds light on mechanisms of effect for diabetes peer-support interventions and could inform efforts to target these services to patients who may be more likely to benefit. We found that improvements in A1c in this trial of guided peer support were largely mediated by insulin starts while improvements in patients' diabetes-related social support did not significantly mediate changes in A1c. In moderator analyses, we found that patients with lower baseline levels of perceived diabetes support or lower health literacy levels were especially likely to benefit from this peer support intervention.

Insulin starts accounted for almost half of the improvement in average A1c levels, with the remaining intervention effect unexplained by available covariates. Questions remain about other potential pathways through which this program improved patients' glycemic control. As reported in the main trial results,³ the intervention did not affect some other candidate mediators, such as self-reported diabetes-related distress or reported medication adherence. Peer support may have improved self-management behaviors that were not measured reliably in this study. In addition, while care management was available to both intervention and control groups, intervention patients may have been more effective communicators with their care manager and physicians, and/or care managers may have been more proactive in addressing intervention patients' self-management needs. Unfortunately, the current study design cannot tease apart the components of this guided peer support intervention (i.e., peer communication, enhanced nurse case management, and the supporting materials including a DVD on effective communication).

As suggested by our theoretical model,¹² participants with low baseline diabetes-specific social support and patients with low baseline health literacy levels were especially likely to make significant improvements in their glycemic control in the peer support arm compared to the nurse care management arm. Both of these risk factors have been associated in multiple observational studies with worse clinical outcomes, so it is especially encouraging that both were significant moderators of peer support intervention effects. These findings reinforce evidence from prior trials about the importance of targeted interventions providing more intensive diabetes self-management support for patients with low health literacy.^{30,31} There have been few trials testing the moderating role of social support, but observational studies have found an association between baseline diabetes social support and success in other diabetes self-management interventions that do not specifically seek to improve patients' social support.³²

Analyses suggest that intervention effects were significantly stronger among patients completing more peer-support calls. Measurable and unmeasurable difference in patients' propensity to reach out for peer support may have contributed both to increased intervention engagement and greater intervention effect. However these data do suggest that there may

be a dose response relationship, and future studies should seek to identify the factors determining greater engagement. Greater attention to usability testing techniques such as think-aloud protocols and Rapid Iterative Testing and Evaluation may promote both greater engagement and long-term sustainability of these interventions.^{33,34}

One of the most important caveats for this study stems from limits in our ability to measure key constructs such as social support, medication adherence, or other factors potentially related to intervention effects. The limited mediation shown in Table 1 may reflect limited reliability in measures of insulin initiation or diabetes-related social support, and other possible mediators such as medication adherence or intensification may have been missed due to error in those measures. In addition, the current study excluded 13% of participants in the overall trial who did not have complete data on baseline and follow-up A1c, and this decreased the study's statistical power to identify potential mediators and moderators. Also, the study was limited to male, primarily Caucasian Veterans, and the intervention may have different impacts on social support or other potential outcomes if it were delivered within samples including women, racial/ethnic minorities, or patients with a different level of access to health care.

In summary, the current study suggests that the overall positive effects of this peer-support intervention on patients' glycemic control likely reflected multiple improvements in patients' diabetes management and self-care. While increases in insulin use played a major role, other yet-to-be-identified factors also explained the clinically important improvements in A1c. Patients with the poorest baseline diabetes support and those with lower levels of functional health literacy were especially likely to benefit. We conclude that peer-support interventions for diabetes can improve glycemic control through multiple channels and may be especially relevant for patients who are vulnerable to complications due to poor support or health literacy deficits.

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Figure 1. Moderator Analysis: Variation in Intervention Effects by Baseline Diabetes Social Support

Note: Lower Diabetes Support Scale values indicate less baseline social support. Grey bands indicate 95% confidence intervals.

Figure 2. Moderator Analysis: Variation in Intervention Effects by Baseline Health Literacy
Note: Grey bands indicate 95% confidence intervals.

Table 1

Summary of Mediator Analyses

	Base Model	Model 1	Model 2	Model 3
Intervention^(a)	-0.50 (p=0.00)	-0.40 (p=0.02)	-0.51 (p=0.01)	-0.42 (p=0.02)
Insulin Start^(b)		-1.62 (p<.001)		-1.53 (p=0.01)
DM Social Support^(c)			-0.004 (p=0.11)	-.003 (p=0.27)
R-squared	0.34	0.38	0.35	0.39

Notes: Each column includes coefficients from a separate regression model with changes in A1c from baseline to the six-month follow-up as the outcome.

^(a) negative coefficients indicate improvements in A1c among intervention patients relative to controls.

^(b) 1= insulin initiate; 0 = no insulin initiation.

^(c) DSS scores range from 0–100 with higher numbers indicating greater support.