**Abstract**

**IMPORTANCE** Diabetes is a substantial public health issue. Peer mentoring is a low-cost intervention for improving glycemic control in patients with diabetes. However, long-term effects of peer mentoring and creation of sustainable models are not well studied.

**OBJECTIVE** Assess the effects of a peer support intervention for improving glycemic control in patients with diabetes and evaluate a model in which former mentees serve as mentors.

**DESIGN, SETTING, AND PARTICIPANTS** A randomized clinical trial was conducted from September 27, 2012, to March 21, 2018, at the Corporal Michael J. Crescenz Medical Center. US veterans with type 2 diabetes aged 30 to 75 years with hemoglobin A1C (HbA1c) greater than 8% received support over 6 months from peers with prior poor glycemic control but who had achieved HbA1c less than or equal to 7.5% (phase 1). Phase 1 mentees were then randomized to become a mentor or not to new randomly assigned participants in phase 2. Outcomes were assessed at 6 and 12 months. Data were analyzed from October 5, 2016, to September 4, 2018.

**INTERVENTIONS** Mentors who received an initial training session and monthly reinforcement training were assigned 1 mentee and given $20 for each month they contacted their mentee at least weekly.

**MAIN OUTCOMES AND MEASURES** Primary outcome was HbA1c change at 6 months. Secondary outcomes included HbA1c change at 12 months and change in low-density lipoprotein, blood pressure, diabetes quality of life, and depression symptoms at 6 and 12 months.

**RESULTS** The study enrolled 365 participants into phase 1 and 122 participants into phase 2. Most participants were Black (341 [66%]) and male (454 [96%]), with a mean (SD) age of 60 (7.5) years. Mean phase 1 HbA1c change at 6 months for usual care was −0.20% (95% CI, −0.46% to 0.06%) vs −0.52% (95% CI, −0.76% to −0.29%) for mentees (P = .06). Mean phase 2 HbA1c change at 6 months for usual care was −0.46% (95% CI, −1.02% to 0.10%) vs 0.08% (95% CI, −0.42% to 0.57%) for mentees (P = .16). There were no differences in secondary outcomes or HbA1c levels at 12 months. There was no benefit to past mentees who became mentors.

**CONCLUSIONS AND RELEVANCE** In this randomized clinical trial, a peer mentor intervention did not improve 6-month HbA1c levels and did not have sustained benefits.

**TRIAL REGISTRATION** ClinicalTrials.gov Identifier: NCT01651117

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**Key Points**

**Question** What are the effects of a peer support intervention in participants with poorly controlled type 2 diabetes?

**Findings** In phase 1 of this 2-phase randomized clinical trial involving 365 participants, a peer mentoring intervention did not improve hemoglobin A1c levels at 6 months and did not improve outcomes at 12 months. In phase 2 with 122 participants, receiving mentoring from a past mentee did not improve glycemic control and may have worsened mentees' control.

**Meaning** Future studies may be needed to determine optimal practices to create long-term, sustainable peer-mentoring models.
Introduction

Diabetes remains a major public health issue, affecting an estimated 9.4% of the US population.1 The prevalence of diabetes among veterans is higher at approximately 16%.2 Care for patients with diabetes represents a substantial portion of the use of Department of Veterans Affairs (VA) resources.3,4 Achieving good glycemic and other risk factor control through lifestyle changes and medication adherence requires substantial patient engagement in self-care.5-8 Yet, patients face many barriers to effective self-care.9-12

Diabetes self-care activities take place primarily outside of clinical encounters. Intensive clinic-based programs have been reported to be effective in improving self-care behaviors; however, they are often resource intensive, and participant engagement wanes over time.13,14 Peer support models that include peers with the same chronic illness and experiential knowledge may help augment patients’ existing social support structures and improve self-care.15-21 Models using peers, such as shared medical appointments and community health worker programs, have been shown to improve diabetes clinical outcomes.15-20

A more informal, flexible, and potentially inexpensive means of providing peer support is through volunteer peer coaches or mentors. Peer mentor programs have been shown to improve glycemic control and adherence to medications, diet, exercise, and blood glucose monitoring.22-26 The success of peer mentor programs is thought to be due in part to the reciprocity created through sharing of similar life experiences.21 Peer support may actually be just as beneficial to mentors as it is to mentees.25-27 A study by Heisler et al24 found that, compared with receiving nurse care management, veterans in a reciprocal peer support program experienced improved diabetes control. However, mentors in an obesity study experienced weight regain, and mentors’ weight changes were not associated with mentees’ success.28

A previous study23 showed the benefits of a telephone-based peer mentor model in which mentors with previously poorly controlled diabetes but with good control became a mentor; however, it is unclear if there are long-term benefits of this model. Given this lack of evidence regarding the long-term impact of peer mentoring, the limited evidence examining reciprocal peer support models, and inconclusive evidence about the clinical benefits to mentors in peer support models, this study builds on prior literature of telephone-based peer support to explore a potentially sustainable model in which former mentees serve as mentors.22-24 Our main hypotheses were (1) patients with diabetes and poor glycemic control would benefit from peer mentoring from peers with previously poor glycemic control but who had achieved good control, (2) patients with poor glycemic control would benefit from peer mentoring from former mentees who became mentors, and (3) becoming a mentor would provide additional benefit to those who had previously been mentees.

Methods

We conducted a randomized clinical trial in 2 phases. In phase 1, patients with diabetes and poor glycemic control were randomized to receive mentoring from peers with well-controlled diabetes whose diabetes was once in poor control or to usual care (phase 1 mentees vs usual care). In phase 2, different patients with poor glycemic control were randomized to receive mentoring from former mentees in phase 1 or to usual care (phase 2 mentoring from former mentee vs usual care). To assess whether becoming a mentor in phase 2 was associated with any benefit for phase 1 mentees, those patients were randomized to either become a mentor or not in phase 2 (phase 2 mentors vs nonmentors). A qualitative study examining the mentor-mentee relationship in-depth to explore factors associated with broader program implementation was also conducted.29 The study was conducted at the Corporal Michael J. Crescenz VA Medical Center. All aspects of the study were approved by the Corporal Michael J. Crescenz VA Medical Center Institutional Review Board.

Enrollment began on September 27, 2012, to March 21, 2018, and follow-up was completed by October 2018. Data were analyzed from October 5, 2016, to September 4, 2018. The trial protocol is
Participants
Participants were identified through the electronic medical records. Patients with a diagnosis of diabetes were eligible to be a phase 1 or 2 mentee if they received their primary care from a Philadelphia or Camden VA facility and had a hemoglobin A1c (HbA1c) level greater than 8% on at least 2 occasions in the 24 months prior to enrollment, 1 of which was within the 3 months prior to enrollment. The HbA1c is a measure of the % of hemoglobin which is glycated. An HbA1c greater than 8% is considered poor control.30 We did not distinguish where the HbA1c was drawn. Potentially eligible participants were sent a letter notifying them about the study, followed within 2 weeks by a telephone call. Phase 1 mentors had to have at least 1 HbA1c less than or equal to 7.5% in the 3 months prior to enrollment but have at least 1 HbA1c greater than 8% in the 3 years prior to enrollment. Former mentees who became mentors in phase 2 were not required to have achieved HbA1c levels less than or equal to 7.5% to become mentors. Additional inclusion criteria included age 30-75 years, type 2 diabetes, access to a telephone for contact with mentor or mentee, and ability to understand English. Veterans (mentees and mentors) who agreed to participate completed a written consent form during their first in-person visit. All participants received $50 for each visit requiring a blood draw and survey (baseline, 6 months, and 12 months).

Randomization and Intervention
Randomization was performed using permuted blocks with varying block size using SAS Proc Plan (SAS Institute Inc) generated by the study statistician (A.C.). We produced 3 randomization lists: (1) phase 1 veterans with poor glycemic control who received mentoring from a mentor who was once in poor control and now in good control vs usual care, (2) phase 2 veterans with poor glycemic control who received mentoring from a former mentee from phase 1 vs usual care, and (3) phase 2 former mentees who became mentors vs nonmentors. For the first 6 months, potential participants were only enrolled into phase 1. After that, participants were enrolled into phase 2 if there was a former mentee who had been randomized to be a mentor waiting to be matched. Study participants and staff were not blinded to group assignment. However, both participants and staff learned of the group assignment only after randomization, which occurred after completing the consent and baseline survey. Study investigators and analysts were blinded until follow-up analyses were performed.

Peer mentors participated in a 1-hour, 1-on-1 training session consisting of (1) instruction designed to help learn the mentee's story, understand their motivations, help set a realistic plan for goal achievement, assess and support progress, and deal with failure in an accepting manner; (2) role-playing exercises; and (3) review of sample questions for potential mentee encounters. Each peer mentor was then matched with a mentee based on age (plus or minus 10 years), self-reported race/ethnicity, sex, and insulin use (with or without experience with insulin) and introduced to their mentees by research staff via telephone. If an appropriate mentor was not found within 2 weeks, matching criteria were loosened except for experience with insulin. Mentors were given $20 for each month they contacted or attempted to contact their mentee via telephone at least weekly. Research staff contacted mentors once per month to provide training reinforcement and ask about interactions. Mentees who became mentors in phase 2 received the same training, support, and incentive.

Outcomes and Follow-up
The prespecified primary outcome was change in HbA1c, level from baseline to 6 months. Prespecified secondary outcomes included change in HbA1c, level from baseline to 12 months and change from baseline to 6 and 12 months in direct low-density lipoprotein (LDL), systolic blood pressure (BP), diabetes quality of life (measured by the Diabetes Distress Scale; respondents rated on a 5-point
scale [with 1 indicating no distress and 5 indicating serious distress] the degree to which the following caused distress: [1] feeling overwhelmed by the demands of living with diabetes and [2] feeling that I am failing with my diabetes regimen; scores were the average of the 2 items31), and depression symptoms (measured by the Patient Health Questionnaire-2 scale; respondents rated on a 4-point scale [with 0 indicating not at all and 3 indicating nearly every day] the degree to which they had the following symptoms: [1] little interest or pleasure in doing things and [2] feeling down, depressed, or hopeless; scores were the sum of the 2 items32). All participants had a baseline visit during which BP, weight, and height were measured and surveys were administered. On the same day, participants underwent bloodwork for the collection of baseline HbA1c level and LDL level. In-person data were collected at baseline, 6 months, and 12 months.

Adverse events (AEs) were reported to the Data Safety Monitoring Board biannually. Deaths and events requiring hospitalization were considered serious adverse events (SAEs). Any event that required an ambulance, outpatient surgery, or emergency department visit was considered an AE. Minor and major hypoglycemic events were also collected. Data Safety Monitoring Board members were blinded to study arm.

**Statistical Analysis**

Our prespecified basic model for all analyses was an analysis of covariance comparing change in outcome (HbA1c level) from baseline to 6 months by treatment group, adjusting for baseline HbA1c level. To also assess change from baseline to 12 months, we used a mixed-effects model and included a time fixed effect and a patient random effect to account for correlation between time periods.

Preliminary complete-case analysis was accompanied by evaluation of complete cases compared with those missing 6-month HbA1c follow-up. Every attempt was made to avoid missing outcomes, including abstracting HbA1c measures from the electronic medical records when patients missed follow-up visits if it was within 30 days. To perform intent-to-treat analysis, we used multiple imputation using Markov chain Monte Carlo methods with 25 iterations and achieved a relative efficiency of more than 99%. Analyses were conducted on each iteration, and results were combined using the Rubin formula.34

Our final primary intent-to-treat analyses were conducted with multiple imputation by using analysis of covariance, adjusting for baseline and including a time fixed effect and a patient random effect. Additional analyses, not prespecified, were also performed. We used logistic regression to evaluate the outcome HbA1c improvement greater than or equal to 1% (yes/no). We selected a 1% cutoff because this marker is a clinically meaningful decrease associated with an approximately 40% decrease in diabetic microvascular complications.35 We performed a nonprespecified exploratory subset analysis including only those with a baseline HbA1c level greater than 8% (baseline was assessed after enrollment, and some patients who were recruited as having poorly controlled diabetes based on the electronic medical records showed good control at baseline). We also compared change in HbA1c level in phase 2 by whether the mentor had improved their control in phase 1. Analyses were conducted using SAS, version 9.4 (SAS Institute Inc).

To achieve 80% power to detect a 0.8% change in HbA1c level (with a standard error of 1.6) between phase 2 mentors and nonmentors, a sample of 64 patients per arm was required. To protect against attrition, we inflated that number by 10% to arrive at 72 participants per arm. Working backward to determine how many patients with poor glycemic control would be needed in phase 1, we started with 144 (72 for each arm of phase 2) and inflated again by 10% to arrive at 160 (to allow for attrition between phase 1 and 2). We thus intended to recruit 320 patients with poor control and randomize 1:1 to obtain 160 mentees and 160 usual care patients. However, mid-study evaluation revealed that attrition between phase 1 and phase 2 was higher than expected. As a result, we recruited additional patients with poor glycemic control to phase 1 to have sufficient phase 2 mentors. This process led to resources being wasted on an overly large usual care group in phase 1, and randomization was changed to 2:1. For the same reasons, we decided it was not necessary to maintain a 1:1 randomization in phase 2 and changed the enrollment target to 56 for usual care.
Power for 72 vs 56 was 79.5%. All methodological changes were approved by the institutional review board.

Results

Most participants were Black (341 [66%]) and male (454 [96%]), with a mean (SD) age of 60 (7.5) years (Table 1 and Table 2). We assessed 4501 patients for eligibility; 2524 were unable to be contacted or had other reasons to decline, 1131 patients contacted were eligible, 644 declined to participate, and 487 eligible participants were enrolled (Figure): 365 patients into phase 1 and 122 patients into phase 2. Of those who were mentees in phase 1, 142 were randomized to the phase 2 mentor vs nonmentor group (Figure). For the primary outcomes evaluating change in HbA1c level at 6 months, we had follow-up HbA1c data on more than 87% of participants. We imputed the following data: phase 1, 30 of 202 in the mentee arm and 16 of 154 in the usual care arm; phase 2, 10 of 68 mentoring from a former mentee arm and 3 of 47 in the usual care arm.

### Table 1. Baseline Characteristics for Phase 1 Participants

| Variable                          | No. (%) | Usual care (n = 154) | Mentee (n = 202) |
|-----------------------------------|---------|----------------------|------------------|
| Age, mean (SD), y                 |         | 60.6 (7.4)           | 59.6 (7.9)       |
| Male                              | 146 (94.8) | 195 (96.5)          |
| Race/ethnicity, self-reported     |         |                      |                  |
| White                             | 40 (26.0) | 50 (24.8)           |
| Black                             | 93 (60.4) | 136 (67.3)          |
| Other<sup>b</sup>                 | 21 (13.6) | 16 (7.9)            |
| Hispanic                          | 11 (7.1)  | 11 (5.5)            |
| Education                         |         |                      |                  |
| <High school                      | 6 (3.9)  | 12 (5.9)            |
| High school                       | 46 (29.9) | 65 (32.2)          |
| Some college                      | 77 (50.0) | 93 (46.0)          |
| ≥College                          | 25 (16.2) | 32 (15.9)          |
| Partnered                         | 78 (50.7) | 95 (47.3)          |
| Lives alone                       | 39 (25.5) | 68 (33.7)          |
| Income, tertile                   |         |                      |                  |
| Low (<$15 000/y)                  | 35 (22.7) | 51 (25.3)         |
| Mid ($15 000 to <$40 000/y)       | 48 (31.2) | 55 (27.2)         |
| High (>=$40 000/y)                | 43 (27.9) | 67 (33.2)         |
| Unreported (do not know or refused) | 28 (18.2) | 29 (14.4)         |
| BMI, mean (SD)                    | 32.7 (6.7) | 33.1 (6.6)        |
| General health history, mean (SD) | 3.2 (0.9) | 3.3 (0.9)         |
| Duration of diabetes, mean (SD), y | 14.2 (8.0) | 13.8 (9.1)       |
| Antihyperglycemic medications     |         |                      |                  |
| Oral medications only             | 32 (20.8) | 52 (25.7)        |
| Insulin only                      | 48 (31.2) | 50 (24.8)         |
| Insulin + oral medications        | 73 (47.4) | 100 (49.5)        |
| Clinical measures, mean (SD)      |         |                      |                  |
| HbA<sub>1c</sub>                  | 9.8 (1.6) | 9.3 (1.6)          |
| LDL                               | 99.5 (39.0) | 92.3 (32.1)       |
| SBP                               | 135.5 (18.4) | 138.8 (18.3)    |
| DBP                               | 79.1 (13.4) | 80.6 (13.3)       |
| DDS2, mean (SD)<sup>d</sup>       | 2.4 (1.1)  | 2.5 (1.2)          |
| PHQ-2, mean (SD)<sup>e</sup>      | 1.3 (1.6)  | 1.6 (1.8)         |

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); DBP, diastolic blood pressure; DDS, Diabetes Distress Scale; HbA<sub>1c</sub>, hemoglobin A<sub>c</sub>; LDL, low-density lipoprotein; PHQ, Patient Health Questionnaire; SBP, systolic blood pressure.

<sup>a</sup> The number in each group represents the number of participants analyzed.

<sup>b</sup> Other is a convenience category that includes multiple races (checked more than 1 box), Asian, Native Hawaiian or Pacific Islander, Alaskan Native or American Indian, other (could be written in if desired but coded as other), and missing.

<sup>c</sup> Self-rated health was assessed through the Short Form Health Survey, question 1 (SF-1): “In general, would you say your health is Excellent, Very Good, Good, Fair, Poor.” Scores range from 1 indicating excellent to 5 indicating poor.

<sup>d</sup> Diabetes distress was assessed using a 2-item screening instrument (DDS2) asking respondents to rate on a 5-point scale (1 = no distress and 5 = serious distress) the degree to which the following caused distress: (1) feeling overwhelmed by the demands of living with diabetes and (2) feeling that I am failing with my diabetes regimen. Scores were the average of the 2 items.<sup>31</sup>

<sup>e</sup> Depression symptoms were assessed using a 2-item screening instrument (PHQ-2) asking respondents to rate on a 4-point scale (0 = not at all and 3 = nearly every day) the degree to which they had the following symptoms: (1) little interest or pleasure in doing things and (2) feeling down, depressed, or hopeless. Scores were the sum of the 2 items. <sup>34</sup>
mentees randomized to become mentors and nonmentors, we imputed 9 of 70 and 11 of 69, respectively.

In phase 1, compared with the intervention group, the usual care group had a greater mean baseline HbA1c (9.8% vs 9.3%). The mean baseline HbA1c was not different by arm in phase 2 or among phase 1 participants randomized to become a mentor or nonmentor. Demographic data and baseline LDL and BP levels were similar between treatment and control groups for all 3 analysis cohorts.

**Phase 1 Mentees vs Usual Care**

At 6 months, the mean change in HbA1c was −0.20% (95% CI, −0.46% to 0.06%) in the usual care arm and −0.52% (95% CI, −0.76% to −0.29%) for the intervention arm (\(P=0.06\)) (Table 3). There was no difference in HbA1c between arms at 12 months. The intervention did not affect BP, LDL, diabetes distress, or depressive symptoms. On enrollment, 58 people had an HbA1c measurement...
Figure. Participant Flow Diagram

A Phase 1 and 2 mentees

4501 Participants assessed for eligibility

4014 Excluded
846 Not meeting inclusion criteria
2524 Other reasons and unable to contact

487 Participants with poorly controlled diabetes enrolled

365 Randomized to Phase 1

158 Allocated to usual care
158 Received allocated intervention
0 Did not receive allocated intervention
3 Discontinued intervention
2 Deceased
1 Withdraw

207 Allocated to mentor
201 Received allocated intervention
6 Did not receive allocated intervention (never matched)

122 Randomized to Phase 2

49 Allocated to usual care
49 Received allocated intervention
0 Did not receive allocated intervention

72 Allocated to being a mentor
69 Received allocated intervention
3 Did not receive allocated intervention

22 Lost to follow-up
22 Unable to contact
3 Discontinued intervention
2 Deceased
1 Withdraw

42 Lost to follow-up
42 Unable to contact
10 Discontinued intervention
3 Deceased
1 Withdraw
6 Stopped intervention but willing to be followed

154 Analyzed
4 Excluded from analysis
2 Duplicate enrolment
2 Deceased

202 Analyzed
5 Excluded from analysis
2 Duplicate enrolment
3 Deceased

47 Analyzed
4 Excluded from analysis
2 Deceased

68 Analyzed
5 Excluded from analysis
3 Duplicate enrolment
2 Deceased

B Phase 2 mentors (former mentees)

207 Participants assessed for eligibility

65 Excluded
10 Pilot cases
3 Administrative withdrawal
2 Deceased
1 Withdraw
6 Never matched as a mentee
42 Unable to contact

142 Randomized

70 Allocated to usual care
70 Received allocated intervention
0 Did not receive allocated intervention

72 Allocated to being a mentor
69 Received allocated intervention
3 Did not receive allocated intervention

12 Lost to follow-up
12 Unable to contact

13 Lost to follow-up
13 Unable to contact
1 Discontinued intervention
2 Deceased

70 Analyzed
2 Excluded from analysis
2 Deceased

Multiple imputation was used to include people in the final analysis even if they were lost to follow-up. Only those who were unintentionally enrolled more than once and those who died were excluded.
less than or equal to 8%. Of these, 15 were in the usual care arm and 43 were in the intervention arm.
In nonprespecified analyses, when we limited the analysis to those with a baseline HbA1c greater than 8%, the mean change in HbA1c was −0.32% (95% CI, −0.60% to −0.05%) for usual care and −0.75% (95% CI, −1.01% to −0.48%) for the intervention arm (P = .03). For the mentee arm compared with usual care, the odds of decreasing HbA1c by 1% was 1.70 (95% CI, 1.01-2.86; P = .05).

**Phase 2 Mentoring From a Former Mentee vs Usual Care**

The mean change in HbA1c was −0.46% (95% CI, −1.02% to 0.10%) in the usual care arm and 0.08% (95% CI, −0.42% to 0.57%) for the mentoring from a former mentee arm (P = .16) (Table 4). At 6 months, compared with usual care participants, mentees who received mentoring from a former mentee showed statistically significant improvement in the Diabetes Distress Scale score of 0.10 points; 95% CI, −0.20 to 0.41 for the usual care arm vs −0.41 points; 95% CI, −0.68 to −0.14 for the intervention arm; P = .02). Similar to phase 1, effects did not persist. No other outcomes showed statistically significant differences.

In nonprespecified analyses, when we compared the change in HbA1c between those whose mentor had successfully decreased their HbA1c by greater than or equal to 1% in phase 1 to those who had not, those mentored by a past successful mentee dropped their HbA1c by 0.28% (95% CI, −0.89% to 0.34%) compared with an increase in HbA1c of 0.76% (95% CI, −0.05% to 1.57%) in those who received mentoring from a past unsuccessful mentee (P = .05).

**Phase 2 Mentors vs Nonmentors**

Becoming a mentor in phase 2 did not prove beneficial to former mentees. Six months after being randomized to become a mentor or not, both those randomized to being a mentor and nonmentors had increases in HbA1c (0.1% and 0.3%, respectively, P = .54).

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**Table 3. Changes in Phase 1 Outcomes From Baseline to 6 and 12 Months**

| Outcome                  | Usual care (n = 154) | Mentee (n = 202) | P value |
|--------------------------|----------------------|------------------|---------|
| **Primary outcome**      |                      |                  |         |
| HbA1c (95% CI)           |                      |                  |         |
| Baseline to 6 mo         | −0.20 (−0.46 to 0.06)| −0.52 (−0.76 to −0.29) | .06     |
| Baseline to 12 mo        | −0.26 (−0.53 to −0.01)| −0.28 (−0.53 to −0.03) | .92     |
| HbA1c, baseline >8% (95% CI) |                      |                  |         |
| Baseline to 6 mo         | −0.32 (−0.60 to −0.05)| −0.75 (−1.01 to −0.48) | .03     |
| Baseline to 12 mo        | −0.39 (−0.67 to −0.12)| −0.48 (−0.76 to −0.19) | .68     |
| **Secondary outcome**    |                      |                  |         |
| LDL (95% CI)             |                      |                  |         |
| Baseline to 6 mo         | −2.08 (−6.58 to 2.42)| −4.31 (−8.31 to −0.31) | .46     |
| Baseline to 12 mo        | −7.17 (−11.77 to −2.57)| −7.86 (−12.40 to −3.31) | .83     |
| SBP (95% CI)             |                      |                  |         |
| Baseline to 6 mo         | −3.45 (−6.23 to −0.66)| −0.87 (−3.48 to 1.74)| .18     |
| Baseline to 12 mo        | −3.75 (−6.60 to −0.91)| −2.33 (−4.92 to 0.27)| .47     |
| DBP (95% CI)             |                      |                  |         |
| Baseline to 6 mo         | −1.72 (−3.39 to −0.06)| −0.82 (−2.37 to 0.72)| .43     |
| Baseline to 12 mo        | −2.56 (−4.26 to −0.85)| −2.41 (−3.97 to −0.85)| .90     |
| DDS2 (95% CI)            |                      |                  |         |
| Baseline to 6 mo         | 0.02 (−0.14 to 0.18)| −0.04 (−0.20 to 0.13)| .65     |
| Baseline to 12 mo        | −0.12 (−0.28 to 0.04)| −0.18 (−0.34 to −0.02)| .62     |
| PHQ-2 (95% CI)           |                      |                  |         |
| Baseline to 6 mo         | −0.05 (−0.28 to 0.18)| −0.04 (−0.26 to 0.18)| .94     |
| Baseline to 12 mo        | −0.12 (−0.35 to 0.11)| −0.17 (−0.39 to 0.04)| .72     |

Abbreviations: DBP, diastolic blood pressure; DDS, Diabetes Distress Scale; HbA1c, hemoglobin A1c; LDL, low-density lipoprotein; PHQ, Patient Health Questionnaire; SBP, systolic blood pressure.

SI conversion factors: To convert LDL to mmol/L, multiply by 0.0259; HbA1c to proportion of total hemoglobin, multiply by 0.01.

* Adjusted for baseline value and patient random effects.

Based on a subset analysis including patients with baseline HbA1c greater than 8% (baseline was assessed after enrollment, and some patients who were recruited as poorly controlled based on prior medical records showed good control at baseline). This analysis included 139 and 159 patients in the usual care and mentee group, respectively.
Adverse Events

No SAEs or AEs were deemed to be related to the study. No participant was removed from the study as a result of an SAE or AE. The Data Safety Monitoring Board did not request that any additional analyses be performed to evaluate hypoglycemic events.

Discussion

This randomized clinical trial found that, compared with usual care, veterans with diabetes and poor glycemic control receiving mentoring from a veteran whose diabetes was once in poor control but now in good control marginally improved HbA1c after the 6-month intervention. This finding was not statistically significant at $P < .05$. Gains were not sustained at 1 year. In addition, receiving mentoring from a former mentee did not lead to improvements in HbA1c and may have even led to worsening of glycemic control if the “mentor” had not improved their own control when a mentee themselves.

Compared with former mentees who did not themselves become mentors, serving as a mentor also did not lead to improvements in HbA1c. The intervention had no further benefits on BP, lipids, diabetes distress, or depression symptoms. To our knowledge, this is the first study to evaluate benefits of peer mentor models beyond 6 months and to assess a potentially more sustainable model in which previous mentees serve as mentors.

Our study differed from other peer mentor studies because of the lower-touch hour-long mentor training curriculum. Mentors in our study received a 1-time, 1-hour training session with monthly reinforcement sessions from research staff. Heisler et al24 provided a 3-hour training session plus optional group sessions, and Thom et al22 had mentors attend 36 hours of training and take an exam. While the intervention was purposefully designed this way to make it easier to implement, a higher-touch intervention may have led to improved diabetes-related outcomes.

Table 4. Changes in Phase 2 Outcomes From Baseline to 6 and 12 Months

| Outcome | Usual care (n = 47) | Mentoring from a former mentee (n = 68) | $P$ value |
|---------|-------------------|----------------------------------------|-----------|
| Primary outcome* |                     |                                        |           |
| HbA1c (95% CI) |                   |                                        |           |
| Baseline to 6 mo | −0.46 (−1.02 to 0.10) | 0.08 (−0.42 to 0.57) | .16       |
| Baseline to 12 mo | −0.27 (−0.89 to 0.36) | −0.16 (−0.65 to 0.33) | .80       |
| HbA1c baseline >8% (95% CI)*b |               |                                        |           |
| Baseline to 6 mo | −0.67 (−1.30 to −0.04) | 0.32 (−0.91 to 0.28) | .42       |
| Baseline to 12 mo | −0.61 (−1.32 to 0.09) | −0.47 (−1.07 to 0.13) | .76       |
| Secondary outcome* |                     |                                        |           |
| LDL (95% CI) |                     |                                        |           |
| Baseline to 6 mo | 7.91 (−0.70 to 16.52) | −1.62 (−9.25 to 6.00) | .11       |
| Baseline to 12 mo | 5.04 (−4.10 to 14.18) | −4.91 (−12.81 to 2.99) | .11       |
| SBP (95% CI) |                     |                                        |           |
| Baseline to 6 mo | 1.47 (−3.53 to 6.47) | 0.19 (−4.05 to 4.42) | .70       |
| Baseline to 12 mo | −1.69 (−6.88 to 3.51) | 1.39 (−2.77 to 5.55) | .37       |
| DBP (95% CI) |                     |                                        |           |
| Baseline to 6 mo | 0.23 (−2.81 to 3.26) | −1.37 (−3.93 to 1.18) | .43       |
| Baseline to 12 mo | −1.09 (−4.20 to 2.03) | −1.76 (−4.28 to 0.76) | .74       |
| DDS2 (95% CI) |                     |                                        |           |
| Baseline to 6 mo | 0.10 (−0.20 to 0.41) | −0.41 (−0.68 to −0.14) | .02       |
| Baseline to 12 mo | −0.13 (−0.45 to 0.19) | −0.02 (−0.31 to 0.26) | .62       |
| PHQ-2 (95% CI) |                     |                                        |           |
| Baseline to 6 mo | −0.32 (−0.77 to 0.14) | −0.26 (−0.67 to 0.15) | .86       |
| Baseline to 12 mo | −0.46 (−0.94 to 0.02) | −0.09 (−0.52 to 0.34) | .25       |

Abbreviations: DBP, diastolic blood pressure; DDS, Diabetes Distress Scale; HbA1c, hemoglobin A1c; LDL, low-density lipoprotein; PHQ, Patient Health Questionnaire; SBP, systolic blood pressure.

SI conversion factors: To convert LDL to mmol/L, multiply by 0.0259; HbA1c to proportion of total hemoglobin, multiply by 0.01.

* Adjusted for baseline value and patient random effects.

b Based on a subset analysis including patients with baseline HbA1c greater than 8% (baseline was assessed after enrollment, and some patients who were recruited as poorly controlled based on prior medical records showed good control at baseline). This analysis included 39 and 50 patients in the usual care and former mentee group, respectively.
The marginal effects seen at 6 months did not persist at 1 year regardless of starting HbA1c. This outcome is comparable with other programs that address behavior change, such as diabetes self-management education, which show a diminishing effect after the intervention ends. One possible explanation for the lack of sustained effects on glycemic control is the loss of support for peer pairs to stay in touch. Our peer mentor model, like others, supported mentors with financial incentives and monthly phone calls from research staff. The financial incentive of $20 a month to call the mentee weekly plus the monthly training enforcement and contact from the study staff did not continue after 6 months. Future peer mentor interventions may benefit from supporting longer-term interactions.

Heisler et al found that a reciprocal peer support intervention improved HbA1c. Given these results, we anticipated seeing benefits on glycemic control in participants who became mentors. Not only did we not observe benefits, having a mentor who did not improve their own control in phase I was associated with worsening control for their mentees. Use of the term mentor may have been detrimental because, anecdotally, some phase 2 mentees noted that their own control was better than that of their mentors. Transitioning former mentees to mentors is 1 way of maintaining sustainability of peer support models; however, using former mentees who improved glycemic control may be the best approach to obtain optimal outcomes.

We did not find any further effects of our peer mentor intervention on BP, lipids, diabetes distress, or depression symptoms. Our results reinforce the findings from other studies, which also found no significant changes in these outcomes. Of note, the study was not powered to detect differences in BP or lipids, and participants' baseline values were fairly well controlled. In addition, mentors were not specifically skilled or trained to address mentees' diabetes distress or depression symptoms. Our qualitative analysis of mentor-mentee pairs indicated that multiple comorbidities, especially poor mental health, hindered the mentor-mentee relationship. A peer mentor model may not be appropriate for patients also dealing with severe mental health issues.

Limitations
This study has limitations. First, we conducted the study at 1 VA medical center in a mostly Black male population. The findings may not be generalizable outside of the VA community. A peer mentor study conducted in public health clinics with a more varied patient population did show improvements in glycemic control. Second, we did not succeed at only enrolling veterans with very poor control; however, effects did not persist even for those with an HbA1c level greater than 8% at baseline. Third, the training of mentors by design was short and limited, and we did little to select naturally inclined mentors. Our qualitative results indicate that providing additional mentor training to build structure into mentor-mentee interactions, choosing mentors who are inherently good at providing coaching, and not targeting mentees struggling with challenging comorbidities could potentially enhance the impact of the program.

Conclusions
In this randomized clinical trial, there was no difference between a peer support intervention vs usual care for improving glycemic control in patients with diabetes. Initial gains were marginal and not maintained. However, several findings from ad hoc analyses indicated that initial gains were more pronounced in patients with starting HbA1c levels above 8% and that mentoring from a former mentee who did not improve while a mentee could lead to worse outcomes. Future studies to determine how best to facilitate mentor and mentee engagement and optimal practices to create long-term sustainable peer-mentoring models may be warranted.
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Author Contributions: Dr Long had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Long, Dicks, Heisler, Marcus.

Acquisition, analysis, or interpretation of data: Long, Ganetsky, Canamucio, Dicks, Marcus.

Drafting of the manuscript: Long, Ganetsky, Canamucio, Dicks.

Critical revision of the manuscript for important intellectual content: Long, Canamucio, Heisler, Marcus.

Statistical analysis: Long, Canamucio, Heisler, Marcus.

Obtained funding: Long.

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REFERENCES

1. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017: Estimates of Diabetes and Its Burden in the United States. Centers for Disease Control and Prevention, U.S. Dept of Health and Human Services; 2017. Accessed November 7, 2019. https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf

2. Reiber GE, Koepsell TD, Maynard C, Haas LB, Boyko EJ. Diabetes in nonveterans, veterans, and veterans receiving Department of Veterans Affairs health care. Diabetes Care. 2004;27(suppl 2):B3-B9. doi:10.2337/diacare.27.suppl_2.B3

3. Weinstock RS, Hawley G, Reple D, Feuerstein BL, Sawin CT, Pogach LM. Pharmacy costs and glycemic control in the Department of Veterans Affairs. Diabetes Care. 2004;27(suppl 2):B74-B81. doi:10.2337/diacare.27.suppl_2.B74

4. Maciejewski ML, Maynard C. Diabetes-related utilization and costs for inpatient and outpatient services in the Veterans Administration. Diabetes Care. 2004;27(suppl 2):B69-B73. doi:10.2337/diacare.27.suppl_2.B69

5. Chiu CJ, Wray LA. Factors predicting glycemic control in middle-aged and older adults with type 2 diabetes. Prev Chronic Dis. 2010;7(1):A08.
6. Ho PM, Rumsfeld JS, Masoudi FA, et al. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. Arch Intern Med. 2006;166(17):1836-1841. doi:10.1001/archinte.166.17.1836

7. Rhee MK, Slocum W, Ziemer DC, et al. Patient adherence improves glycemic control. Diabetes Educ. 2005;31(2):240-250. doi:10.1177/0145721705274927

8. Pladevall M, Williams HK, Potts LA, Divine G, Xi H, Lafata JE. Clinical outcomes and adherence to medications measured by claims data in patients with diabetes. Diabetes Care. 2004;27(12):2800-2805. doi:10.2337/diabetes.27.12.2800

9. Shacter HE, Shea JA, Akhabue E, Sablani N, Long JA. A qualitative evaluation of racial disparities in glucose control. Ethn Dis. 2009;19(2):121-127.

10. Anderson RM, Barr PA, Edwards GJ, Funnell MM, Fitzgerald JT, Wisdom K. Using focus groups to identify psychosocial issues of urban Black individuals with diabetes. Diabetes Educ. 1996;22(1):28-33. doi:10.1177/014572179602200104

11. Samuel-Hodge CD, Headen SW, Skelly AH, et al. Influences on day-to-day self-management of type 2 diabetes among African-American women: spirituality, the multi-caregiver role, and other social context factors. Diabetes Care. 2000;23(7):928-933. doi:10.2337/diabetes.23.7.928

12. Egede LE, Bonadonna RJ. Diabetes self-management in African Americans: an exploration of the role of fatalism. Diabetes Educ. 2003;29(1):105-115. doi:10.1177/014572170302900115

13. Aubert RE, Herman WH, Waters J, et al. Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization: a randomized, controlled trial. Ann Intern Med. 1998;129(8):605-612. doi:10.7326/0003-4819-129-8-199810150-00004

14. Phillips CO, Wright SM, Kern DE, Singa RM, Shepperd S, Rubin HR. Comprehensive discharge planning with postdischarge support for older patients with congestive heart failure: a meta-analysis. JAMA. 2004;291(11):1358-1367. doi:10.1001/jama.291.11.1358

15. Clancy DE, Cope DW, Magruder KM, Huang P, Wolfman TE. Evaluating concordance to American Diabetes Association standards of care for type 2 diabetes through group visits in an uninsured or inadequately insured patient population. Diabetes Care. 2003;26(7):2032-2036. doi:10.2337/diabetes.26.7.2032

16. Kirsh S, Watts S, Pascuzzi K, et al. Shared medical appointments based on the chronic care model: a quality improvement project to address the challenges of patients with diabetes with high cardiovascular risk. Qual Saf Health Care. 2007;16(5):349-353. doi:10.1136/qshc.2006.019158

17. Trento M, Passera P, Bajardi M, et al. Lifestyle intervention by group care prevents deterioration of type II diabetes: a 4-year randomized controlled clinical trial. Diabetologia. 2002;45(9):1231-1239. doi:10.1007/s00125-002-0904-8

18. Norris SL, Chowdhry FM, Van Le K, et al. Effectiveness of community health workers in the care of persons with diabetes. Diabet Med. 2006;23(9):544-556. doi:10.1111/j.1464-5491.2006.01845.x

19. Edelman D, Fredrickson SK, Melnyk SD, et al. Medical clinics versus usual care for patients with both diabetes and hypertension: a randomized trial. Ann Intern Med. 2010;152(11):689-696. doi:10.7326/0003-4819-152-11-201006010-00001

20. Jaber R, Braksmajer A, Trilling JS. Group visits: a qualitative review of current research. J Am Board Fam Med. 2006;19(3):276-290. doi:10.3122/jabfm.19.3.276

21. Heisler M. Overview of peer support models to improve diabetes self-management and clinical outcomes. Diabetes Spectrum. 2007;20(4):214-221. doi:10.2337/diaspect.20.4.214

22. Thom DH, Ghorob A, Hessler D, De Vore D, Chen E, Bodenheimer TA. Impact of peer health coaching on glycemic control in low-income patients with diabetes: a randomized controlled trial. Ann Fam Med. 2013;11(2):137-144. doi:10.1370/afm.h143

23. Long JA, Jahnle EC, Richardson DM, Loewenstein G, Volpp KG. Peer mentoring and financial incentives to improve glucose control in African American veterans: a randomized trial. Ann Intern Med. 2012;156(6):416-424. doi:10.7326/0003-4819-156-6-201206200-00004

24. Heisler M, Vijan S, Makki F, Piette JD. Diabetes control with reciprocal peer support versus nurse care management: a randomized trial. Ann Intern Med. 2010;153(8):507-515. doi:10.7326/0003-4819-153-8-20100190-00007

25. Krause N, Herzog AR, Baker E. Providing support to others and well-being in later life. J Gerontol. 1992;47(5):300-311. doi:10.1093/geront/47.5.P300

26. Matthews BA, Baker F, Hann DM, Denniston M, Smith TG. Health status and life satisfaction among breast cancer survivor peer support volunteers. Psychooncology. 2002;11(3):199-211. doi:10.1002/po.550
27. Schwartz CE, Sendor M. Helping others helps oneself: response shift effects in peer support. Soc Sci Med. 1999;48(11):1563-1575. doi:10.1016/S0277-9536(99)00049-0

28. Leahey TM, Wing RR. A randomized controlled pilot study testing three types of health coaches for obesity treatment: professional, peer, and mentor. Obesity (Silver Spring). 2013;21(5):928-934. doi:10.1002/oby.20271

29. Lott BD, Dicks TN, Keddem S, Ganetsky VS, Shea JA, Long JA. Insight into veterans' perspectives on a peer support program for glycemic management. Diabetes Educ. 2019;45(6):607-615. doi:10.1177/0145721719879417

30. American Diabetes Association. Older adults. In: Standards of Medical Care in Diabetes—2019. Diabetes Care. 2019;42(suppl 1):S139-S147. doi:10.2337/dc19-S012

31. Joseph DH, Griffin M, Hall RF, Sullivan ED. Peer coaching: an intervention for individuals struggling with diabetes. Diabetes Educ. 2001;27(5):703-710. doi:10.1177/014572170102700511

32. Kroenke K, Spitzer RL, Williams JBW. The Patient Health Questionnaire-2: validity of a two-item depression screener. Med Care. 2003;41(11):1284-1292. doi:10.1097/01.MLR.0000093487.78766.43

33. Fisher L, Glasgow RE, Mullan JT, Skaff MM, Polonsky WH. Development of a brief diabetes distress screening instrument. Ann Fam Med. 2008;6(3):246-252. doi:10.1370/afm.842

34. Rubin DB. Multiple Imputation for Nonresponse in Surveys. Vol 81. John Wiley & Sons; 2004.

35. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000;321(7258):405-412. doi:10.1136/bmj.321.7258.405

36. Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. Diabetes Care. 2002;25(7):1159-1171. doi:10.2337/diacare.25.7.1159

**SUPPLEMENT 1.**
Trial Protocol

**SUPPLEMENT 2.**
Data Sharing Statement