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Nurse Practitioner Management of Type 2 Diabetes

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Abstract

Context: Multifactorial barriers prevent primary care clinicians from helping their adult patients with type 2 diabetes achieve good control of hemoglobin A_{1c} (HbA_{1c}) levels. Patients' depression and low self-efficacy can complicate diabetes management by impairing tasks needed for effective disease self-management.

Objectives: To evaluate whether nurse practitioners in collaborative practices with primary care clinicians are effective in helping improve control of HbA_{1c}, blood pressure (BP), and low-density lipoprotein cholesterol (LDL-C) in adults with uncontrolled hyperglycemia, and to assess whether nurse practitioner-guided care affects depression and self-efficacy in these patients.

Design: De-identified preintervention and postintervention data were collected from prospective review of medical charts of patients in a managed care organization's primary care clinics.

Main Outcome Measures: Preintervention and postintervention HbA_{1c} values were evaluated as the primary outcome measure. Preintervention and postintervention values for BP, LDL-C, body weight, and depression and self-efficacy scores were secondary outcome measures.

Results: After intervention, 50% of 26 patients achieved HbA_{1c} benchmarks, 95.6% achieved systolic and diastolic BP benchmarks, and 57.8% achieved LDL-C benchmarks. Wilcoxon paired samples tests showed significantly increased self-efficacy ($z = -3.42$, $p < 0.001$) from preintervention to postintervention. Depression scores decreased slightly from preintervention (mean = 0.44, standard deviation = 1.34, median < 0.001) to postintervention values (mean = 0.18, standard deviation = 0.73, median < 0.001), but this decrease was not significant.

Conclusion: Integrating nurse practitioners into primary care teams to provide innovative methods of support to adults with uncontrolled hyperglycemia improves clinical outcomes and self-efficacy for patients with type 2 diabetes.

Introduction

Diabetes is a global epidemic. An estimated 382 million people worldwide have diabetes, including 25.8 million Americans.[1,2] In the US, diabetes is the seventh leading cause of death.[1] Overall, the risk of death among people with diabetes is about twice the risk of death for people of similar age without diabetes.[1] Moreover, type 2 diabetes mellitus, the most common type of diabetes, is a chronic progressive disease associated with a host of complications and coexisting conditions. Among adults, diabetes is the leading cause of microvascular complications (eg, kidney failure, nontraumatic lower-limb amputations, and new cases of blindness) and a major cause of macrovascular cardiovascular disease (CVD), including heart attacks and strokes.[1] Adults with diabetes have heart disease death rates and risk of stroke 2 to 4 times higher than do adults without diabetes.[1] Common conditions such as hypertension and hyperlipidemia often coexist with diabetes, which further increases the cardiovascular risks. This increased risk of CVD necessitates stringent management of blood pressure (BP) and lipid control as essential components of care for persons with diabetes.[1,3] In 2007, the total costs related to the care of diabetes were estimated to be $174 billion, with $116 billion related to direct medical costs and the remaining $58 billion related to indirect costs associated with disability, work loss, and premature mortality.[1]

Depression and negative self-efficacy affect the management of persons with diabetes. People with diabetes are twice as likely to have depression as people without diabetes.[1] Comorbid depression in patients can complicate diabetes management by increasing disease burden, symptom severity, work disability, use of medical services, and hospital costs.[4] Additionally, depression can impair glycemic control through negative effects on self-care and/or self-efficacy (eg, depression impairs the confidence, skills, and tasks associated with adherence to diet, exercise, and self-medication administration). Self-efficacy is the perceived ability to engage in various situation-specific self-management tasks (eg, self-monitoring of blood glucose levels and meal choices). It relates to the willingness and ability of people to engage in behavioral challenges such as preventive and disease management behaviors; therefore, enhancing self-efficacy and diabetes self-management knowledge is an important goal of diabetes care and education.[5]

The Diabetes Control and Complications Trial[6] found that for every 1% reduction in hemoglobin A_{1c} (HbA_{1c}) value, the risks of microvascular and neuropathic complications were reduced by 40% to 50%. Although an HbA_{1c} goal of less than 7% is recommended for most adults with diabetes to reduce diabetes-related complications, most people with diabetes are in poor glycemic control.[3,7,8] Endocrinologists show a better quality of diabetes care, but the number of these specialists is diminishing,[9] leaving primary care physicians and clinicians (PCPs) to meet the costly and time-intensive medical, psychosocial, and educational needs for this population of patients.[9,10] Other barriers that prevent PCPs from achieving HbA_{1c} goals

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with their patients include high patient loads, clinical inertia (ie, the failure to initiate, change, or intensify treatment therapy), patient diversity, cultural and language differences, racial insensitivity, lack of treatment protocols, and complex and difficult-to-follow algorithms.[9,11]

There is evidence that nurse practitioners (NPs) improve clinical outcomes for patients with type 2 diabetes in primary care practices through their capacity to initiate, change, and adjust medications without physician authorization. Their willingness to embrace alternate methods of patient communication (via telephone, e-mail or e-visits [ie, managing patient care through e-mail visits, such as changing medication, ordering labs, etc], faxes, and texting) has been shown to increase the convenience and quality of care while reducing costs and improving glycemic control.[12,13]

One framework often used in ambulatory care practices to improve patient care and guide clinical quality initiatives is the chronic care model. This model focuses on transforming the care of patients with chronic illnesses from acute and reactive care to proactive, planned, and population-based care.[14] The chronic care model promotes the enhancement of chronic disease management through six practice systems (ie, community resources, self-management support, delivery system redesign, decision support, clinical information systems, and organizational support) that partner collaboratively, rather than in isolation.[15] These systems work together to strengthen provider-patient relationships and to improve health outcomes.[15]

The aim of this quality-improvement project was to evaluate whether NPs in collaborative practices with PCPs are effective in improving control of HbA_{1c}, BP, and low-density lipoprotein cholesterol (LDL-C) values in adult patients with uncontrolled hyperglycemia, and to assess whether NP-guided care affects depression and self-efficacy in patients with uncontrolled hyperglycemia.

Methods

Local Problem

Kaiser Permanente Georgia (KPGA) is aware that the care of its patients with uncontrolled hyperglycemia is costly and both resource and time intensive. The organization therefore places a strong emphasis on implementing initiatives and interventions to improve the glycemic and cardiovascular health for its members with diabetes. The Region sets clinical quality priorities (ie, HbA_{1c} < 8%, BP < 140/90 mm/Hg, and LDL-C < 100 mg/dL) to measure and to evaluate the relationship between diabetes, hypertension, and cholesterol and their impact on clinical outcomes for its members. One way these priorities are measured and evaluated is through Healthcare Effectiveness Data and Information Set (HEDIS) measures. The HEDIS tool is used by more than 90% of America's health plans to measure performance on important dimensions of care and service.[16] The KPGA Region collects, reports, and uses HEDIS data to monitor clinical outcomes for its members with diabetes. In 2012, the Medical Group met the clinical quality priorities for its LDL-C target but did not meet its targets for HbA_{1c} and BP. The Region is currently evaluating opportunities to integrate NPs in the internal medicine modules to partner with internists and to improve the clinical quality priorities for patients with diabetes.

Setting

This study was conducted at KPGA, one of the largest nonprofit managed care organizations in metropolitan Atlanta, GA. The company is an organized delivery system, and most of its ambulatory services are provided on-site in the organization's outpatient medical centers. Two ambulatory care internal medicine modules were used for this study. Combined, these 2 modules provide medical services to 3677 adult patients with type 2 diabetes. Approximately 23.25% of these patients have uncontrolled hyperglycemia ($HbA_{1c} \geq 8\%$), which predisposes them to diabetes-related microvascular and macrovascular complications.

Design and Implementation

A prospective pre- and postintervention quality-improvement project was implemented in primary care clinics using an NP (GCR) to coordinate and provide care to adult patients with uncontrolled type 2 diabetes in order to improve the clinical metrics that affect their morbidity and mortality (ie, HbA_{1c}, BP, and LDL-C values). This project was approved by the institutional review board at Duke University, Durham, NC, and was exempted from review by the institutional review board at KPGA. The study design was adopted from the chronic care model and was designed to transform the care of patients from reactive, acute care to proactive, planned care for a population of patients with type 2 diabetes.

Sample

A convenience sample of 28 adult patients with type 2 diabetes and an HbA_{1c} value of 8% or higher was selected for this project from 2 PCP patient panels at KPGA. Inclusion criteria were patients with Current Procedural Terminology (CPT) and/or International Classification of Diseases, Ninth Revision (ICD-9) codes of type 2 diabetes with an HbA_{1c} value of at least 8%. Exclusion criteria were patient conditions that can falsely affect HbA_{1c} values, such as patients with anemia and hemoglobin variants (eg, iron deficiency anemia and hemoglobin S or C variants), patients who received a blood transfusion in the previous 3 months, patients with Stages 4 and 5 chronic kidney disease, and pregnant women. The following patients were also excluded from the project: patients with a CPT diagnosis of prediabetes and/or impaired glucose tolerance without a diagnosis of type 2 diabetes; patients without a telephone; non-English-speaking patients; hospice patients and/or patients who were terminally ill; patients enrolled in research studies focusing on diabetes, BP, lipid, or depression management; and patients who declined to participate in the project.

Intervention

Patients were recruited and selected for the study from the diabetes registry by GCR or were directly referred to her by the patients' PCP. The PCP approached eligible patients for the study during a usual-care office visit, explained the study, and referred the patient to GCR if the patient agreed to participate. Patients who agreed to participate in the study were accepted into the study by their verbal informed consent. Patients who declined participation in the study continued usual care with their PCP.

After extensive review of patient medical records, GCR called each patient and reviewed purpose, interventions, risks, and benefits of the study. After discussion and agreement with the patient, individualized treatment plans were devised for each patient on the basis of individualized patient goals, medical history, clinical data (ie, HbA_{1c}, BP, and LDL-C values), current and past medications, and social history. The treatment plans also were designed in consideration of efficacy, safety, drug costs, and real or potential risks for adverse drug effects and drug interactions. The treatment strategies were guided by the existing evidence-based guidelines of the organization[17] (eg, treat-to-target algorithms and clinical guidelines) with goals to improve HbA_{1c} values to less than 8%, BP values to less than 140/90 mm Hg, and LDL-C values to less than 100 mg/dL. For example, a patient with an HbA_{1c} of 9% was instructed to follow an insulin treat-to-target guideline to improve HbA_{1c} control (see Sidebar: NPH Insulin: Controlling Your Blood Sugar for Longer and Healthier Living).

Follow-up care was provided by GCR every 2 to 5 weeks between January 28, 2013, and June 7, 2013, through a combination of office visits, telephone visits, and e-visits. Frequency of care was based on individualized patient need and the ability to establish communication with the patient.

The follow-up appointments were used to initiate and adjust medications, to order laboratory studies, to review and discuss laboratory results, to encourage lifestyle changes, to schedule office-based follow-up visits with the PCP or nurse, to refer patients to health education classes, to refer participants to specialty care, and to administer depression and self-efficacy screenings.

A clinical pharmacist, registered dietitian, and case manager were consulted by GCR as needed for questions regarding complex medication therapies; nutritional interventions; and care coordination for patients with complex medical, financial, and social needs. Collaboration with the PCPs and primary care teams regarding the study and the changes and updates in patient treatment regimens was ongoing throughout the project by verbal communication and messages through the organization's electronic health record.

NPH Insulin: Controlling Your Blood Sugar for Longer and Healthier Living

These instructions will help you start and adjust the dose of a medicine called NPH insulin. NPH insulin helps people with diabetes control their blood sugar (glucose) levels. By controlling your blood sugar, you will lower your risk of getting serious complications from diabetes.

The target range for your blood sugar (glucose) levels is between 80-120[a] before breakfast and before dinner.

Instructions for starting NPH insulin:

Start by injecting 10 units of NPH insulin at bedtime. Continue all of your other oral diabetes medications at the same dose.

Check and record your blood sugars every day before BOTH breakfast and dinner.

Increase your dose of NPH insulin by ONE UNIT every day at bedtime if that day's BREAKFAST blood sugar is greater than 120. STOP increasing the amount of NPH insulin dose when your before-breakfast blood sugar is 120 or lower, OR the before-dinner blood sugar is 80 or lower.

If your before-breakfast or before-dinner blood sugar is BELOW 80 you may decrease your insulin by 1 unit per day until these results are between 80 and 120.

Example: Day 1
Continue to take oral medications
BEFORE-breakfast blood sugar is 150
BEFORE-dinner blood sugar is 175
Give 10 units NPH insulin at bedtime

Example: Day 2
Continue to take oral medications
BEFORE-breakfast blood sugar is 200
BEFORE-dinner blood sugar is 200
Give 11 units NPH insulin at bedtime

Example: Day 3
Continue to take oral medications
BEFORE-breakfast blood sugar is 175
BEFORE-dinner blood sugar is 180
Give 12 units NPH insulin at bedtime

Example: Day 4
Continue to take oral medications
BEFORE-breakfast blood sugar is 115
BEFORE-dinner blood sugar is 105
Give 12 units NPH insulin at bedtime

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[a] In milligrams per deciliter.
NPH = neutral protamine Hagedorn (insulin isophane suspension).

PATIENT HEALTH QUESTIONNAIRE-9 (PHQ-9)

Over the last 2 weeks, how often have you been bothered by any of the following problems? *(Use "✓" to indicate your answer)*	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

FOR OFFICE CODING 0 + _____ + _____ + _____
=Total Score: _____

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
☐	☐	☐	☐

Figure 1. Patient Health Questionnaire-9.

Developed by Robert L Spitzer, MD; Janet B W Williams, DSW; Kurt Kroenke, MD; et al, with an educational grant from Pfizer, Inc.
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University of Michigan Diabetes Research and Training Center

Diabetes Empowerment Scale-Short Form (DES-SF)

The 8 items below constitute the DES-SF. The scale is scored by averaging the scores of all completed items (Strongly Disagree =1, Strongly Agree = 5). Check the box that gives the best answer for you.

In general, I believe that I:

	☐1	☐2	☐3	☐4	☐5
1. ...know what part(s) of taking care of my diabetes that I am **dissatisfied** with.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
2. …am able to turn my diabetes goals into a workable plan.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
3. ...can try out different ways of overcoming barriers to my diabetes goals.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
4. ...can find ways to feel better about **having** diabetes.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
5. ...know the **positive** ways I cope with diabetes-related stress.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
6. ...can ask for support for having and caring for my diabetes when I need it.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
7. ...know what helps me stay motivated to care for my diabetes.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
8. ...know enough about myself as a person to make diabetes care choices that are right for me.	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

DES-SF; Diabetes Research and Training Center
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Figure 2. Diabetes Empowerment Scale-Short Form (DES-SF) of the University of Michigan Diabetes Research and Training Center.

Reprinted with permission from: Michigan Diabetes Research and Training Center. Diabetes Empowerment Scale-Short Form. Copyright University of Michigan, 2003. Available from: www.med.umich.edu/mdrtc/profs/documents/svi/DES-SF_english.pdf. The project described was supported by Grant Number P30DK020572 (MDRC) from the National Institute of Diabetes and Digestive and Kidney Diseases.

Outcome Measures

Pre- and postintervention HbA_{1c} values were evaluated as the primary outcome measure. Pre- and postintervention values for BP, LDL-C, body weight, and depression and self-efficacy scores were evaluated as secondary outcome measures.

The Patient Health Questionnaire-9 (PHQ-9) was used to evaluate depression (Figure 1). The PHQ-9 is the depression module of the Patient Health Questionnaire. It is a self-administered assessment tool and is used to screen, diagnose, monitor, and measure the severity of depression. The PHQ-9 measure uses a 4-point Likert scale that ranges from 0 *(not at all)* to 4 *(nearly every day)*. The PHQ-9 was used as the assessment tool in a study linking comorbid depression to patients with type 2 diabetes.[17] The PHQ-9 showed excellent internal reliability in a PHQ primary care study when used telephonically.[18] The Diabetes Empowerment Scale-Short Form was used to evaluate self-efficacy (Figure 2). This assessment tool was developed by the Michigan Diabetes Research and Training Center in Ann Arbor, MI, to assess the psychosocial self-efficacy of people with diabetes.[19] The full scale evaluates 3 subscales of assessment: 9 items assess managing the psychosocial aspects of diabetes ($\alpha = 0.93$); 9 items assess dissatisfaction and readiness to change ($\alpha = 0.81$); and 10 items assess setting and achieving goals ($\alpha = 0.91$). The 8-item Diabetes Empowerment Scale-Short Form measure uses a 5-point Likert scale that ranges from 1 *(strongly disagree)* to 5 *(strongly agree)*. The content validity of the questionnaire was supported in the study by the Michigan center, which demonstrated that both the questionnaire scores and HbA_{1c} levels changed in a positive direction after their subjects completed a 6-week problem-based patient education program. These data provided preliminary evidence that the assessment questionnaire was a valid and reliable measure of overall diabetes-related psychosocial self-efficacy.[19]

Data Collection and Analysis

Pre- and postintervention data were collected by GCR from the electronic medical record for each participant in the study. Data collected included demographic variables for age, race, and sex; clinical metrics for HbA_{1c}, BP, LDL-C, and body weight; depression questionnaire scores; self-efficacy questionnaire scores; and information on patient medications, diagnoses, and comorbidities.

Preliminary analyses for normality were conducted at the conclusion of data collection. Specific benchmark values were set a priori for clinical outcome values. The mean and standard deviation (SD) for outcomes were presented for all outcomes. Descriptive statistics on demographic variables of the sample, including mean, SD, and frequency counts were presented.

The pre- and postintervention assessments of depression and self-efficacy were assessed using questionnaire scores. Depression and self-efficacy were analyzed as a total score (paired *t* test) and as an ordinal outcome variable using Wilcoxon paired-samples test.

Results

Patient Characteristics

The NP (GCR) conducted a search of the electronic diabetes registry for the 2 PCP patient panels using the keywords *type 2 diabetes,* = and > *18 years of age,* and *HbA_{1c} ≥ 8%.* The PCPs directly referred 5 patients for the study. GCR randomly selected 75 of 131 patient medical records to review for the study's predetermined inclusion and exclusion criteria. Twenty-two patients met the exclusion criteria and were therefore excluded from the study. Fifty-three patients were called by GCR to discuss potential inclusion for the study. One patient declined participation, 21 patients were unreachable, and 28 patients agreed to participate in the study. Two patients dropped out of the study (did not complete laboratory tests and stopped responding to requests to attend follow-up clinic visits, telephone visits, or e-visits as requested by GCR). Therefore, 26 patients completed the study (responded to requests for follow-up clinic visits, telephone visits, and e-visits and completed laboratory tests as requested by GCR).

Table 1 presents the descriptive characteristics of the 26 study participants who completed pre- and postintervention measures. The average age of the participants was 57.58 years. The mean duration of years living with type 2 diabetes was 9.40 years. The sample was evenly split into men and women (n = 13 each), with 46.2% reporting their race or ethnicity to be "African American" (n = 12), followed by white ("Caucasian") (n = 9; 34.6%). Most participants were nonsmokers (n = 21; 80.8%), and most had diagnoses that included type 2 diabetes with hypertension and hyperlipidemia (n = 15; 57.7%).

Outcome Measures

Table 2 presents the benchmark results for HbA_{1c}, LDL-C, and BP values, which were set a priori preintervention for this study. Specifically, this project was designed to help patients achieve an HbA_{1c} concentration below 8%, an LDL-C value less than 100 mg/dL, and BP under 140/90 mm Hg. Postintervention HbA_{1c} values were evaluated for each participant. Postintervention BP values were measured for participants who had an office visit for any reason near the end of the implementation phase of the study, which included 23 study participants. Postintervention LDL-C values were measured only for participants not at goal before the intervention for LDL-C control and/or participants who had not had an LDL-C value measured in the previous 12 months, which included 19 study participants. Of the interventions used to interact and follow-up with patients (ie, clinic visits, telephone visits, and e-visits), most of the contact between GCR and patients was by telephone. The average telephone time spent with patients during the course of the study was 55.81 minutes for each patient.

Table 3 presents the results of the self-efficacy and depression screening scores, which were examined using Wilcoxon paired sample tests. There was a significant increase in self-efficacy from before to after the intervention. Depression scores decreased slightly from before to after intervention, but this decrease was not significant.

Discussion

This study supports the evidence that NPs can be effective in helping patients lower their HbA_{1c} levels and improve clinical outcomes for patients with type 2 diabetes in collaborative primary care practices with PCPs. At the end of the study, 50% of the participants achieved the study's glycemic goals (ie, HbA_{1c} value less than 8%), 95.6% achieved BP goals (ie, BP less than 140/90 mm Hg), and 57.8% achieved lipid goals (ie, LDL-C level less than 100 mg/dL). This study demonstrated significant improvements in patient's HbA_{1c} and self-efficacy scores from before to after intervention. This finding may suggest that the willingness of NPs to provide innovative methods of support for follow-up care (ie, office visits combined with e-visits and

Table 1. Baseline characteristics of study participants (N = 26)

Characteristic	Participants, n (%)[a]
Men	13 (50)
Women	13 (50)
Mean age, years	57.6
Mean body weight, kg (lb)	93 (205.9)
Race/ethnicity	
African American	12 (46.2)
White ("Caucasian")	9 (34.6)
Canadian[b]	1 (3.8)
Cuban[b]	1 (3.8)
Dominican[b]	1 (3.8)
Irish	1 (3.8)
Liberian	1 (3.8)
Mean duration of type 2 diabetes, years	9.4
Smoking status	
Nonsmokers	21 (80.8)
Smokers	5 (19.2)
Diagnoses	
T2DM alone (no hypertension or hyperlipidemia)	1 (3.8)
T2DM + hypertension (no hyperlipidemia)	3 (11.5)
T2DM + hyperlipidemia (no hypertension)	7 (26.9)
T2DM + hypertension + hyperlipidemia	15 (57.7)
Comorbidities	
None	17 (65.4)
Depression	3 (11.5)
Peripheral neuropathy	3 (11.5)
Congestive heart failure	2 (7.7)
Coronary artery disease	1 (3.8)
Retinopathy	1 (3.8)
Chronic kidney disease (Stages 2-3)	2 (7.7)

[a] Percentages may not total to 100 because of rounding.
[b] This information on race/ethnicity was the only information available.
T2DM = type 2 diabetes mellitus; + = plus.

telephone visits) positively affect HbA_{1c} and self-efficacy in adult patients with uncontrolled hyperglycemia. Although there was no statistically significant difference in depression scores, there were small improvements in depression, so it appears that the study's implementation had a positive impact clinically on depression.

NPs are effective in improving clinical metrics because of their capacity to initiate, change, and adjust medications or medication doses without physician authorization. Additionally, because of their training and scope of practice, NPs in the US are able to deviate outside clinical guidelines, and when problems are identified or clinical metrics are not improving as anticipated, they can make immediate changes to patient treatment regimens as appropriate without awaiting physician approval. The findings of two systematic reviews are consistent with this finding. A systematic review by Shojania et al[20] concluded that nurses, when empowered with the ability to make independent medication changes without awaiting physician approval, are effective in achieving reductions in HbA_{1c} values. A literature review and synthesis on nurse care coordination by Ingersoll and colleagues[11] concluded that patients with diabetes showed significant reductions in HbA_{1c} and LDL-C values when their care was managed by nurses compared with patients who received usual care not managed by nurses who specialize in diabetes care or nurse managers. The willingness of NPs to embrace alternate methods of patient communication (via telephone, e-mail or e-visits, faxes, and texting) to provide care to patients with diabetes may make them effective in improving HbA_{1c} control. Chang et al[12] found that NP-based care management clinics achieved significant reductions in HbA_{1c} values when using telephone intervention as a venue to provide care.

In contrast, Krein et al[21] concluded that collaborative case management was not effective in improving physiologic outcomes of HbA_{1c}, lipid, or BP control for high-risk patients with type 2 diabetes. A significant difference in the study by Krein et al[21] vs the present study is that the nurses were not allowed to independently initiate and change medications. A systematic review by Loveman and associates[22] found that nurses who specialize in diabetes care demonstrated reductions in HbA_{1c} values, but the HbA_{1c} reductions were not found to be significantly different over a 12-month follow-up period in groups not managed by specialist diabetes nurses. The conclusions from the review were questionable because of the poor quality of the studies.

The current study was limited by its small sample size and the short timeframe for implementation. Also, the management of patients with type 2 diabetes is complex, involving several diverse components. Roles in caring for patients with type 2 diabetes are driven by individual patient needs, which make it difficult to clearly define specific clinicians' roles and responsibilities. Although telephone and e-visits can be effective as alternate means of communication with patients, their effectiveness depends on patient availability, patient telephone and computer access, and patient unresponsiveness to multiple clinician requests to respond and follow-up for care. This study included only those patients who agreed to participate. Several patients were unreachable or declined participation for the study, so alternative methods of supporting patients with type 2 diabetes may be necessary for this group. It is essential that support staff be available to assist with the recruitment and scheduling of patients for care so that the NPs time is more focused on patient care and less on administrative matters. Future studies should replicate this study over a longer duration with a larger sample of patients to evaluate the long-term effects of nurse practitioner management of patients with uncontrolled type 2 diabetes. Any future study should also include a cost analysis to evaluate cost-effectiveness.

Table 2. Clinical outcomes comparison between preintervention and postintervention

Outcome	Preintervention, no. (%)	Postintervention, no. (%)	McNemar p value
HbA_{1c}	0 (0)	13 (50.0)	0.0001
LDL cholesterol	15 (60.0)	11 (57.9)	0.687
Systolic BP	23 (88.5)	22 (95.7)	0.625
Diastolic BP	25 (96.2	22 (95.7)	0.999

BP = blood pressure; HbA_{1c} = hemoglobin A_{1c}; LDL = low-density lipoprotein.

Table 3. Self-efficacy and depression comparison between preintervention and postintervention

	Preinvention		Postintervention		Wilcoxon paired test
Outcome	Mean	Median	Mean	Median	p value
Self-efficacy	30.31	31.00	36.58	37.00	0.001
Depression	0.68	< 0.001	0.73	< 0.001	0.225

Conclusion

NPs, when added to primary care practices, are effective as treatment providers in improving clinical values in adult patients with uncontrolled hyperglycemia. Improvements in HbA_{1c}, BP, and LDL-C values reduce the microvascular and macrovascular complications associated with uncontrolled hyperglycemia, especially CVD. Providing care through telephone and e-visits is an innovative way to improve clinical values, make care convenient to patients, reduce the financial burden of costs associated with office visit appointments, and improve adherence to treatment plans. Telephone and e-visit care also potentially offer health care practices an additional revenue stream though coding and billing for these services.

With the implementation of the Affordable Care Act,[23] the KPGA Region is expecting an influx of patients with uncontrolled type 2 diabetes and is considering innovative, cost-effective interventions to assist PCPs with managing these patients. The Region will consider the integration of NPs in the Region's internal medicine modules to partner with internists to assist in improving clinical metrics for patients with type 2 diabetes.

The prevalence of type 2 diabetes is expected to double or triple by 2050, and many health care organizations are under considerable pressure to find cost-effective interventions to care for this population of patients. Integrating NPs into primary care teams to provide innovative methods of support to improve the clinical metrics of patients with type 2 diabetes may be a cost-effective alternative to provide care. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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