Using Telehealth to Provide Diabetes Care to Patients in Rural Montana: Findings from the Promoting Realistic Individual Self-Management Program

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Abstract

Objective: *The objectives of this study were to demonstrate the feasibility of telehealth technology to provide a team approach to diabetes care for rural patients and determine its effect on patient outcomes when compared with face-to-face diabetes visits.* ***Materials and Methods:*** *An evaluation of a patient-centered interdisciplinary team approach to diabetes management compared telehealth with face-to-face visits on receipt of recommended preventive guidelines, vascular risk factor control, patient satisfaction, and diabetes self-management at baseline and 1, 2, and 3 years postintervention.* ***Results:*** *One-year postintervention the receipt of recommended dilated eye exams increased 31% and 43% among telehealth and face-to-face patients, respectively ($p = 0.28$). Control of two or more risk factors increased 37% and 69% ($p = 0.21$). Patient diabetes care satisfaction rates increased 191% and 131% among telehealth and face-to-face patients, respectively ($p = 0.51$). A comparison of telehealth with face-to-face patients resulted in increased self-reported blood glucose monitoring as instructed (97% vs. 89%; $p = 0.63$) and increased dietary adherence (244% vs. 159%; $p = 0.86$), respectively. Receipt of a monofilament foot test showed a significantly greater improvement among face-to-face patients (17% vs. 35%; $p = 0.01$) at 1 year postintervention, but this difference disappeared in years 2 and 3.* ***Conclusions:*** *Telehealth proved to be an effective mode for the provision of diabetes care to rural patients. Few differences were detected in the delivery of a team approach to diabetes management via telehealth compared with face-to-face visits on receipt of preventive care services, vascular risk factor control, patient satisfaction, and patient self-management. A team approach using telehealth may be a viable strategy for addressing the unique challenges faced by patients living in rural communities.*

Key words: *telehealth, telemedicine, policy*

Introduction

Diabetes continues to be the sixth leading cause of death in the United States. It is the leading cause of major vascular complications including cardiac disease, blindness, lower-limb amputation, and kidney disease[1] and has substantial economic impact estimated at $174 billion in 2007.[1,2] Diabetes-associated micro- and macrovascular complications are responsible for the bulk of healthcare costs and reduced quality of life.[3,4] The prevalence of diagnosed diabetes is projected to rise to 48.3 million in the United States in 2050.[5] As rural communities disproportionately suffer from diabetes and its associated complications,[6,7] this increase in disease prevalence combined with a small population base and low per capita income is likely to overwhelm the limited financial resources of rural healthcare facilities throughout the country, resulting in suboptimal diabetes care for rural patients.

Key studies have demonstrated that intensive early management of diabetes and its associated risk factors, hypertension and dyslipidemia, can prevent or delay disease progression and complications.[8–10] Evidence-based clinical diabetes management guidelines are published yearly by the American Diabetes Association (ADA),[11,12] yet routine clinical practice settings continue to struggle to achieve effective disease management in both urban and rural settings.[13] Quality improvement interventions have been developed and implemented with mixed results, including those utilizing health information technologies.[14]

Diabetes management needs to be comprehensive to be effective. Improved glycemic, blood pressure and lipid monitoring and control, patient self-management behaviors, and diabetes preventive care are all important elements of a successful treatment plan.[15] Diabetes management models have demonstrated success in improving glycemic control and patient education using an interdisciplinary team approach comprised of primary care providers (PCPs) and certified diabetes educators (CDEs), dieticians and/or nurses.[3,16,17] Rural providers and patients have limited access to this approach because of financial barriers and limited specialty provider resources in rural communities. In Montana, nurse educators, including CDEs, are concentrated in larger urban areas, leaving 70% of rural Montana communities without access to health education programs.

Telehealth technology has been used to effectively provide healthcare services and education to remote areas for chronic disease management, specifically for patients with diabetes,[18] and represents an important mechanism for cost-effective delivery of patient education.[19] However, few rigorous evaluations of telehealth approaches

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have been conducted.[20] Published studies used small sample sizes,[21,22] were limited to short-term follow-up periods,[21,22] or solely focused on glycemic control.[21–23] Use of an interdisciplinary team approach has also not been studied in a telehealth environment.

To promote comprehensive diabetes care in the region, we created the Promoting Realistic Individual Self-Management (PRISM) Diabetes Program. The PRISM Program utilizes an interdisciplinary team approach in tandem with PCPs in rural and urban clinic settings to improve the overall care of high-risk diabetes patients. Telehealth technology facilitated the incorporation of the program into rural clinics. This study describes the effects of the program on receipt of diabetes preventive care, vascular risk factors, patient self-management behavior and patient satisfaction, as well as program sustainability, among targeted rural patients. Study objectives were twofold: (1) to establish the feasibility of providing a team approach to diabetes care via telehealth and (2) to determine whether telehealth technology is comparable to face-to-face care.

Materials and Methods

This 3-year study compared PRISM patients in a face-to-face office setting with those receiving the program via telehealth in rural communities. All patients received a nurse practitioner (NP)-led interdisciplinary team approach for intensive diabetes management and education in conjunction with their usual PCP visits. Subjects in both groups were recruited on a rolling basis over 3 years until 1 year prior to study termination; rural telehealth patient enrollment was initiated 1 year following face-to-face patient enrollment. Patients were enrolled exclusively into one group, that is, telehealth or face-to-face.

Patients were referred by PCPs from five rural and one urban clinic. There were two to nine providers at the rural sites serving 30 to 300 patients annually. The urban comparison site had 48 PCPs managing 5,000 diabetes patients per year.

The telehealth technology consisted of videoconferencing connecting PRISM diabetes team members at one urban healthcare organization with patients at five rural primary care clinics. Telehealth systems used were Polycom HDX 7000 or Polycom HDX 8000 videoconference units. Billings Clinic connected to each site using dedicated T1 lines that provide both quality and security. Sites were bridged using the Polycom MGC 100. A document stand was available for sharing materials with items placed on the stand projected full size onto the screen. This was used for sharing printed educational materials as well as demonstrating techniques for using blood glucose meters, insulin pens and injections, and injection site selection.

Provided in both telehealth and face-to-face settings, the PRISM model of diabetes care utilized an NP diabetes specialist to lead a team of CDEs (registered nurses [RNs] and registered dieticians [RDs]) and a diabetes life coach (licensed clinical social worker). The team provided comprehensive diabetes self-management education and worked in collaboration with patients' PCPs to manage and monitor glycemic, blood pressure, lipid control, and preventive service receipt. The team applied a patient-centered approach and utilized motivational interviewing[24] to identify patient goals and developed and implemented a comprehensive plan of action for each patient. In both groups, visits were initially conducted monthly followed by quarterly visits once education was complete or patient was stable. The patient was initially seen by the NP and then by another team member chosen jointly by the NP and patient.

Patients were required to travel to their local primary care clinic to access telehealth services. Patients received all medical testing sample procurement at their local clinics, for example, glycemic, lipid, and microalbumin/creatinine testing. Testing was performed onsite or at an off-site reference laboratory, for example, Billings Clinic, Mayo Clinic. Dilated eye exams and monofilament testing were also conducted locally.

Disease-specific outcomes and demographic and medical history information were extracted from patient medical records. These included process measures, that is, annual receipt of dilated eye exam performed by an eye specialist (retinal screen), a monofilament foot test performed in the office (peripheral neuropathy screen), and a microalbumin/creatinine laboratory test (renal screen), and clinical measures, that is, vascular risk factor control per ADA guidelines.[15] Other outcomes included patient self-management behaviors (Kavookjian Diabetes Self-Management Tool),[25] diabetes knowledge (Diabetes Knowledge Test),[26] patient satisfaction, self-efficacy, communication, and self-reported symptom status (Diabetes Health History Tool).[27] All tools were previously validated.

Study inclusion criteria were (1) definitive type 2 diabetes (ICD = 250.x) diagnosis, (2) at least one uncontrolled vascular risk factor ($HbA_{1C} > 7\%$, LDL-C > 100, or BP > 130/80) per ADA guidelines, and (3) adult age ≥ 21 years. Exclusion criteria included type 1 or steroid-induced diabetes, end-stage renal or liver disease, dementia, or mental retardation; significant drug/alcohol use in past 18 months; active malignant process including chemotherapy patients; chronic or intermittent steroid use; acute/chronic inflammatory or infectious disease process; or pregnancy.

Because of small numbers of patients, providers, and available rural clinics and potentially serious contamination issues, the formation of rural control groups was not feasible. This decision was supported by study funders. Baseline and 1-, 2-, and 3-year medical chart reviews were completed on patients to determine receipt of preventive screening exams/tests (dilated eye exam, monofilament foot test, microalbumin/creatinine test) and vascular risk factor control. At similar study intervals, patient assessments were conducted using survey instruments listed above. Number, type, and date of all diabetes care visits were recorded.

Baseline patient characteristics were compared between groups using Student's *t*-tests for continuous variables and Pearson's chi-square tests for categorical variables. Fisher's exact test was used when 2×2 table cell sizes were less than 10. To test for equality between groups, the dichotomous outcome variables were compared between telehealth and face-to-face patients, using generalized estimating equations with an AR(1) correlation structure to account for the intraclass correlation from repeated measurements for each subject at baseline and follow-up time periods. The logistic regression models included study group, time, and group by time interaction as predictors, where the interaction term was the relative effect from differential modes of diabetes care delivery. No differences in baseline characteristics were identified, negating the need to include as covariates.

All patients were included to the extent that data were available. Partial or all data for 41 patients were excluded when patient no longer met study inclusion criteria or if outcome data were unobtainable based on a minimum of 1-year postintervention data, for example, patient expired, moved to another community or clinic, or diabetes no longer managed by PCP.

The telehealth intervention ($n = 118$) and face-to-face intervention ($n = 88$) sample sizes provided > 80% power to detect a 20% point difference at a type I error rate of 0.05 for a two-sided test comparing two proportions. In year 2, sample sizes dropped to 69 and 66. In year 3, only receipt of preventive services and control of vascular risk factors maintained a sufficient sample size for analysis at 42 and 36 patients in the telehealth and face-to-face groups, respectively. This study is underpowered in years 2 and 3.

All components of this study were approved by the Billings IRB and informed consent was obtained from all participants.

Results

Table 1 displays patient demographic and relevant clinical information for telehealth ($n = 118$) and face-to-face ($n = 88$) patients. No significant differences were observed between the two groups. Income and education level data were not available.

Following program initiation, the number of patient visits with CDE RNs, RDs, NPs, and social workers for diabetes care increased in both groups. In the first year, mean annual face-to-face patient visits increased from 1.7 to 26.3. Mean annual telehealth visits increased from 0.3 to 14.3 visits. In the second year, after required education hours were received, visits tapered off to 14.8 and 5.1 visits for face-to-face and telehealth patients, respectively.

Table 1. Patient Baseline Demographics ($n = 206$)

MODE OF DIABETES CARE DELIVERY	TELEHEALTH ($N = 118$)		FACE-TO-FACE ($N = 88$)		*P*-VALUE
	N	%	N	%	
Female[a]	69	58	57	65	0.36
Diagnoses[a]					
Hypertension	84	71	68	77	0.33
Dyslipidemia	85	72	71	81	0.15
Depression	29	25	24	27	0.66
Medications					
Insulin[a]	23	20	21	25	0.45
Non-insulin injectable[b]	4	3	5	6	0.50
Oral BG medication[a]	103	88	73	83	0.30
Any BG medication[a]	107	91	79	90	0.82
Statin[a]	71	60	57	65	0.50
	MEAN ± SD		MEAN ± SD		
Age (years)[c]	61.3 ± 11.6		62.3 ± 11.7		0.53
Years since diabetes diagnosis[c]	6.6 ± 8.1		7.8 ± 8.0		0.28
HbA1C (%)[c]	7.7 ± 1.5		7.8 ± 1.8		0.59
LDL-C (mg/dl)[c]	96.3 ± 36.9		105.2 ± 33.1		0.09
Diastolic blood pressure (mm/Hg)[c]	74.3 ± 10.7		76.5 ± 9.9		0.13
Systolic blood pressure (mm/Hg)[c]	132.0 ± 15.8		134.4 ± 16.3		0.30
Body mass index (kg/m^2)[c]	35.3 ± 7.7		36.5 ± 7.7		0.27

[a]Pearson's chi-square test.
[b]Fisher's exact test.
[c]Student's *t*-test.

Table 2 displays the effect of the program on process and clinical outcomes among telehealth and face-to-face groups over time. Receipt of ADA-recommended preventive services increased in both groups within the first study year and was sustained or increased in the second year except for renal screening among telehealth patients in year 2. Increases in receipt of annual dilated eye exams were not significantly different between groups over the three study years ($p = 0.28$, 0.56). For monofilament testing, increases between groups were significantly different ($p = 0.01$) at 1 year postprogram implementation; this difference disappeared in years 2 and 3 ($p = 0.11$ and $p = 0.58$, respectively). Increases in renal screening were not significantly different between groups at 1 year postintervention ($p = 0.90$). A decreased rate of renal screens in telehealth patients in year 2 resulted in a significant difference between groups at 2 years postintervention; this difference disappeared in year 3.

Control of each vascular risk factor ($HbA_{1C} < 7\%$, LDL-C < 100, or BP < 130/80) increased in both groups over time as did the proportion of patients with two or more controlled risk factors. Differences in increases between groups were present only for blood pressure control, which increased at a slower rate among telehealth patients than face-to-face patients, and only for study year 1 ($p = 0.03$). Differences in increases disappeared by study year 2 ($p = 0.06$) and were sustained into study year 3 ($p = 0.21$).

Table 2. American Diabetes Association–Recommended Annual Preventive Screenings and Risk Factor Control at Baseline (Pre) and 1, 2, and 3 Years (Post)

MODE OF DIABETES CARE DELIVERY	INTERVENTION								PRE-POST CHANGE YEAR 1 *P*-VALUE	PRE-POST CHANGE YEAR 2 *P*-VALUE	PRE-POST CHANGE YEAR 3 *P*-VALUE
	TELEHEALTH ($N=118$)				FACE-TO-FACE ($N=88$)						
	PRE	POST YEAR 1	POST YEAR	POST YEAR 3	PRE	POST YEAR 1	POST YEAR 2	POST YEAR			
ADA-Recommended Annual Preventive Screenings											
Retinal screen (dilated eye exam)	51%	67%	67%	69%	56%	80%	80%	67%	0.28	0.28	0.56
Neuropathy screen (monofilament foot test)	64%	75%	79%	83%	72%	97%	94%	92%	0.01	0.11	0.58
Renal screen (microalbumin/creatinine)	64%	75%	62%	76%	72%	82%	89%	78%	0.90	0.02	0.65
Vascular Risk Factor Control											
Blood Pressure	36%	41%	45%	48%	31%	55%	59%	57%	0.03	0.06	0.21
HbA1C	36%	58%	49%	52%	36%	60%	56%	51%	0.92	0.58	0.41
LDL-cholesterol	53%	62%	68%	69%	46%	64%	62%	70%	0.23	0.90	0.76
2+ controlled risk factors	43%	59%	52%	60%	39%	66%	69%	65%	0.21	0.045	0.58

p-Values indicate comparisons between face-to-face and telehealth at each time period.

All *p*-values were obtained from a generalized estimating equations model.

ADA, American Diabetes Association.

Table 3 shows nonclinical patient outcomes by group over time. At 1 and 2 years postintervention, there were no significant differences in increases between telehealth and face-to-face patients on any measures including self-management, diabetes knowledge, satisfaction, communication, self-efficacy, and self-reported symptoms ($p=0.08$–0.97). Improvements were observed among patients in both telehealth and face-to-face groups on all measures.

For all measured outcomes, no significant effects related to the following covariates were detected: age, gender, years since diabetes diagnosis (a proxy for diabetes education level), treatment type, disease comorbidities, and initial risk factor status. Differences by clinic site varied for some outcomes, but this did not diminish the overall group and time effects presented.

The technology itself was also acceptable to staff and patients. Staff surveys found that 98% of the time, PRISM team felt the picture and sound quality were clear and 97% of the time staff felt that telehealth was a useful tool for patient diabetes management and education. Patients also reported feeling comfortable learning health information using this technology and said they understood as if it were in person. Ninety-nine percent of patients felt the picture and sound were clear.

Discussion

The PRISM Diabetes Program, an NP-led patient-centered interdisciplinary intensive diabetes management program was successfully incorporated into rural diabetes care through telehealth technology. The interdisciplinary team worked with rural diabetes patients in conjunction with rural PCPs. Results suggest that telehealth diabetes care visits may be as effective as traditional face-to-face office visits as a way to provide a comprehensive disease management team approach to high-risk rural diabetes patients. In general, over time diabetes-specific processes (i.e., receipt of preventive services) and clinical outcomes (i.e., vascular risk factor control) increased at similar rates between the two groups. Patient outcomes for diabetes self-management, diabetes knowledge, and patient satisfaction, communication, self-efficacy, and self-reported symptom status were also similar. Findings were sustained for 2 or 3 years, depending on the data available for each measure. Insufficient sample sizes for years 2 and 3 may have contributed to variable results.

This study makes an important contribution to the literature through (1) the unique use of telehealth technology to deliver an interdisciplinary team approach for rural diabetes care; (2) an examination of program effects on a broad range of outcomes (clinical, process, and patient-centered measures); and (3) evaluation of program effectiveness over time, that is, sustainability. Previous diabetes telehealth studies focused on effects of telehealth on vascular risk factor levels but not on risk factor control per ADA guidelines.[23] Published studies have not evaluated disease-specific outcomes such as adherence to preventive care

Table 3. Patient Self-Management Diabetes Knowledge and Patient Satisfaction Outcomes at Baseline (Pre) and 1 and 2 Years (Post)

MODE OF DIABETES CARE DELIVERY	INTERVENTION						PRE-POST CHANGE YEAR 1 *P*-VALUE	PRE-POST CHANGE YEAR 2 *P*-VALUE
	TELEHEALTH (*N* = 118)			FACE-TO-FACE (*N* = 88)				
	PRE	POST YEAR 1	POST YEAR 2	PRE	POST YEAR 1	POST YEAR 2		
Self Management Behaviors								
Checks BG as instructed past 6 months (self-report)	33%	65%	61%	35%	66%	58%	0.63	0.68
Follows diet as instructed past 6 months (self-report)	9%	31%	33%	17%	44%	35%	0.86	0.29
Diabetes Knowledge								
Preventative Foot Care	91%	98%	97%	95%	99%	98%	0.59	0.51
Satisfaction								
Very satisfied with diabetes care	22%	64%	52%	29%	67%	74%	0.51	0.41
Diabetes care in last few years just about perfect	47%	89%	90%	55%	89%	94%	0.58	0.48
Communication								
Kept informed about next steps in diabetes care	43%	75%	76%	46%	85%	87%	0.23	0.48
Communications between different healthcare providers very good or excellent	39%	70%	76%	56%	88%	89%	0.40	0.93
Self-Efficacy								
Know who to ask with questions about my health	45%	73%	76%	53%	87%	87%	0.32	0.97
Feel good to excellent about managing my diabetes	49%	77%	72%	43%	83%	83%	0.27	0.08
Symptoms								
Diabetes symptoms somewhat or much better in past 6 months	40%	67%	41%	34%	72%	46%	0.36	0.37

p-Values indicate comparisons between face-to-face and telehealth at each time period.

All *p*-values obtained from a generalized estimating equations model.

guidelines, patients' self-management behaviors, self-efficacy, or satisfaction.[20,22] Until now, a telehealth team approach to diabetes management that works in conjunction with PCPs has not been tested.

In this study, few differences between telehealth and face-to-face intervention patients were detected. Monofilament foot testing rates for telehealth patients increased more slowly over time compared with face-to-face patients, but within 2 years rates were comparable. A possible explanation is that PRISM team providers could not perform foot tests using existing telehealth technology. PRISM team members began alerting rural PCPs and patients of the need for annual foot tests, and testing by PCPs may have increased as a result.

Blood pressure control also improved at a slower rate among telehealth patients. Rural PCPs may have been reluctant to allow the PRISM NP to adjust BP medications. Although there were no significant differences between groups for dilated eye exams, rates tended to be consistently lower in the telehealth group. Using technology or rural staff training that incorporates eye and foot testing into the telehealth program could improve these findings, as might increasing efforts toward relationship building between urban and rural clinic staff.

Increasing patient contact with non-PCP diabetes specialists from multiple disciplines may have contributed to program success in both modes of diabetes care delivery. Prior to the start of the PRISM program, diabetes patients received an average of two annual visits. PRISM patients in both groups received significantly more annual team member visits. This may have contributed to the improved patient knowledge, self-management skills, and preventive care observed in this study. More visits translate to increased opportunities to ensure preventive services are received, vascular risk factor levels are controlled, and patient self-management skills are learned with improvement in disease-specific outcomes.

Another potential contributing factor was that the team was led by an NP who could perform or order preventive screening tests/exams and co-manage vascular risk factors with PCPs to improve disease control. Designed as a proactive team approach, the PRISM program was able to use telehealth technology to facilitate patient adherence to follow-up visits and work with PCPs to improve overall diabetes care.

This study was limited to high-risk diabetes patients, that is, those with at least one uncontrolled vascular risk factor, in need of intensive disease management. It is unclear whether all diabetes patients would benefit from such an intensive approach. Out-of-pocket costs to patients were also an issue. Although patients were billed for PCP visits, eye, foot, and renal exams and laboratory tests, PRISM team visits were provided free of charge. This may have accounted for the increase in non-PCP diabetes care visits in both groups. However, as the mean number of non-PCP patient visits was within the allowable numbers of Medicare reimbursable visits (and private insurers that follow Medicare reimbursement guidelines), this is not an unreasonable approach to intensive diabetes management.

In the PRISM program, frequent patient-team visits occurred and appeared to be an important component of the intervention. Within current reimbursement structures, this is arguably a realistic approach in the typical PC office setting. For telehealth services only CDE RN visits are currently not reimbursed. As CDE RNs are an integral part of diabetes management teams, advocate organizations, such as the American Association of Diabetes Educators, are working to change this. Other private insurers, including the state Medicaid program, are currently reimbursing for these services in our region. In addition, national healthcare policy changes that include the patient-centered medical home and accountable care organizations may make these diabetes services even more available and affordable to patients as capitated and bundled payments are considered and tested.

The study design was a limitation. Rural patients were not randomized to a controlled trial, because there were too few clinics and patients to randomize and still produce a sufficient telehealth and control patient population. Also, small clinic size, often with one or two providers, raises contamination issues, which are less prevalent in larger clinic practices. Therefore, we included a face-to-face comparison group. In a separate analysis, this group also demonstrated significantly greater improvements on all measures compared with a randomized face-to-face control group (results submitted elsewhere).

Future efforts to integrate telehealth more fully into diabetes care may include sharing of home-measured laboratory data between patients and their providers. Telemonitoring, specifically, and data sharing, in general, have demonstrated success in improving patient outcomes among diabetes patients.[28–31]

This study demonstrates the effectiveness of an innovative model of care in the comprehensive management of an increasingly prevalent chronic disease and its associated vascular risk factors, which can be implemented in a primary care setting and successfully delivered using telehealth technology. Successful components of this comprehensive interdisciplinary diabetes management program are in the process of being integrated into regular clinical practice for diabetes patients seen at our healthcare organization. In addition, telehealth diabetes services have been extended to all rural primary care clinics in our telehealth network. Through these efforts, we expect to improve access to much needed diabetes care services, improve diabetes-specific patient outcomes, improve healthcare efficiencies, increase distance learning, and reduce unnecessary healthcare utilization.

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Disclosure Statement

No competing financial interests exist.

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