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Health Services Utilization of a Care Coordination/ Home-Telehealth Program for Veterans With Diabetes

A Matched-cohort Study

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Abstract: This study examined the effectiveness of a veterans affairs (VA) patient-centered care coordination/home-telehealth (CC/HT) program as an adjunct to treatment for veterans with diabetes. Using an adapted version of the *Chronic Care Model*, we analyzed the differences in healthcare service use between a cohort of 400 veterans with diabetes who were enrolled in a VA CC/HT program and a matched comparison cohort of 400 veterans with diabetes who received no CC/HT intervention. Propensity scores were used to improve the balance between the treatment and comparison groups. Service use outcomes were assessed at 12 months before and after enrollment. A difference-in-differences approach was used in the multivariate models to assess the treatment effect for patients in the CC/HT programs. Twelve months after enrollment, there was a significant difference between the treatment and comparison groups in terms of need-based primary care visits (newly scheduled visits that enable the veteran to be seen "just in time," where the health status is monitored and met before health deteriorates), increasing in the treatment group and decreasing in the comparison group ($P < .01$). In a subgroup analysis, where we were able to control for the patients' Hb A_{1c} values, we found that the treatment group had a lower likelihood of having 1 or more hospitalizations than patients in the comparison group. Our findings have implications for management in that the CC/HT program appears to improve the ability of older veterans with diabetes to receive appropriate, timely care, thereby improving the quality of care for them and making more efficient use of VA healthcare resources. **Key words:** *care coordination*, *diabetes*, *technology*, *veterans*

DIABETES is a serious and expensive chronic health condition affecting 18 million Americans (Villagra & Ahmed, 2004). Diabetes is a prevalent, chronic condition

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for America's veterans as well. The diabetes prevalence in the Department of Veterans Affairs (VA) enrollee population has increased significantly in recent years and the prevalence is substantially higher than that of the general population (Miller et al., 2004). Furthermore, diabetes is associated with high rates of morbidity and costs for the VA (Sawin et al., 2004). Approximately two thirds of veterans with diabetes had lower limb amputations. These individuals also experienced 1.6 times as many hospital admissions as veterans without diabetes (Pogach et al., 1998; Sawin et al., 2004). A recent study found that annual VA pharmacy costs for veterans with diabetes increased from 1994 to 2000 and veterans with diabetes were given 30% of all pharmacy prescriptions (Weinstock et al., 2004). Weinstock et al. (2004) reported that the increased expenditures were driven by a rise in the amount of glucose monitoring supplies distributed to veterans.

The Veterans Health Administration (VHA), one of the 3 administrations within the VA, went through a structural transformation over the past 10 years that reallocated care from inpatient facilities to ambulatory-care facilities and the home environment (Perlin et al., 2004). Moreover, diabetes management services have moved into patients' homes from the traditional ambulatory care setting. The VHA has made considerable advances in the quality of care provided to veterans with diabetes, yet effective coordination of care remains an often-ignored aspect of diabetes management (Pogach et al., 2004; Reiber et al., 2004). In fact, coordination of care is a crucial organizational issue for improving the quality of chronic care delivery (Pogach et al., 2004). To overcome this shortcoming, the VHA has embarked on a systemwide initiative called *patient-centered care coordination*. This perspective, where the patient is the locus of control and the care environment is shifted to the patient's home, extends disease management to more effectively match every veteran's disease-specific needs with the resources of the VHA (Perlin et al., 2004). The VHA's response to the new patient-centered care coordination perspective has been to employ home-telehealth technologies to support the self-care and noninstitutional long-term care needs of older veterans with disabling, chronic disease (Perlin et al., 2004). Home-telehealth technologies, which combine health status data and communication technologies (eg, an in-home dialogue box), are especially suitable for those veterans with diabetes who may experience considerable nonfinancial barriers (eg, travel distances, clinic wait times) when accessing VA clinic–based diabetes care (Meyer et al., 2002). Home-telehealth allows a provider and a patient with chronic illness and/or his or her caregiver to maintain direct communication. Veterans with diabetes are also able to monitor their disease, using the special equipment provided by the VA care coordination/home-telehealth (CC/HT) program.

A recent observational study utilized the health service use outcomes in 297 veterans with diabetes enrolled in 2 VHA CC/HT programs. One program monitored the patients with diabetes on a daily basis, whereas the other monitored them on a weekly basis. The hospital admission rate and the days of hospitalization, for all-cause and diabetes conditions, were lower in the daily monitored group than in the weekly monitored group (Chumbler et al., 2005). These findings were informative, but since the patients were not randomly assigned to either CC/HT program and nor was there a matched comparison group of patients with equivalent characteristics to the treatment group, selection bias and regression to the mean could have influenced the study's findings. As disease and case management programs have proliferated over the last decade, initial evaluations of such programs have found impressive reductions in use and savings in costs. More recently, however, such conclusions have been called into question because of potentially serious flaws in the research designs of many of these early evaluations (Congressional Budget Office [CBO], 2004; Fetterolf et al., 2004; Tinkelman & Wilson, 2004).

The objective of this study was to examine the effectiveness of a VA patient-centered CC/HT program as an adjunct to treatment for

veterans with diabetes. More specifically, we analyzed the differences in healthcare service use between a cohort of veterans with diabetes who were enrolled in a CC/HT program and a matched comparison cohort of veterans with diabetes who received no intervention. In a subanalysis, we also examined the effectiveness of the program after controlling for an important additional clinical covariate (hemoglobin A_{1c} [Hb A_{1c}]), which tests for glucose control. We also use a research design that corrects for any residual selection bias between the treatment and comparison groups and controls for any regression to the mean when measuring the effect of the intervention on service use.

THEORETICAL PERSPECTIVE

We used an adapted version of the *Chronic Care Model* (CCM) as the conceptual framework that guided the CC/HT intervention (Bodenheimer et al., 2002a; E. H. Wagner et al., 1996, 1999; T. H. Wagner et al., 2001). The CCM is a conceptual framework developed for the effective care of patients with serious chronic illness, such as diabetes (Bodenheimer et al., 2002a) and includes 6 essential interdependent elements, 4 of which are applicable for this study: (1) self-management support (assisting patients and their families to acquire the skills and confidence to better care for their diabetes symptoms); (2) decision support (evidence-based clinical practice guidelines incorporated into daily practice prompts); (3) delivery system design (nonphysician personnel, such as nurse care coordinators, supporting patient self-management); and (4) clinical information systems (reminder systems and feedback to physicians and nonphysician personnel on patients' health status on an ongoing basis) (Bodenheimer et al., 2002a, 2002b; Casalino, 2005).

The CC/HT program within the VHA is an excellent system to execute these CCM elements. The VHA has established a national office of care coordination, which has implemented the CC/HT program throughout the system, as 1 of its primary foci to provide self-management and decision support for veterans with chronic diseases. This is coupled with the VHA's state-of-the-art computerized patient record system where daily practice prompts, reminder systems, and important clinical information can be instantaneously transmitted to physicians to help improve patients' health and quality of life (Perlin et al., 2004). The CC/HT programs provide the means for more intensive monitoring of the patient and better collaboration between patient and provider. Continued follow-up of patients also helps in early identification of disease complications.

METHODS

Intervention

This study evaluated a VA CC/HT program in a Florida, Puerto Rico, and Georgia veteran population with diabetes. This CC/HT program targeted veterans with diabetes who were at high risk for expensive, multiple inpatient and outpatient visits (including emergency department [ED] visits). Veterans with diabetes were eligible for the program if they had 2 or more VA hospitalizations or VA ED visits in the 12 months preceding enrollment. Veterans also needed access to telephone service and had to be noninstitutionalized to be eligible for the program. The CC/HT program consisted of a care coordinator (RN or ARNP) who applied disease management principles through the care continuum, managed treatment, and equipped the veteran with self-management skills to avert later more costly interventions (eg, hospitalizations) and to increase preventive services, such as need-based primary care clinic visits. (Need-based primary care clinic visits are newly scheduled visits that enable the veteran to be seen "just in time" rather than "just in case.")

The program was implemented across 4 sites in the region. Each site used the same types of home-telehealth technology to monitor the veterans with diabetes. The first and predominant form of technology was an in-home "dialogue box" that plugs into the patient's phone. The patients used this dialogue

box each day to answer questions about their health status (eg, general discussions about diabetes care and metabolic control), which were preprogrammed into a relational database. The dialogue box was programmed with an algorithm that contained questions about the patient's symptoms, behavior, and knowledge related to chronic disease management. The patient's answers were sent through the Internet to the care coordinator's desktop daily. The care coordinator monitored these responses each day to determine if it was necessary to call the patient or facilitate an appointment with a provider. The second and third forms of technology, which were used sparingly, consisted of both (1) a telemonitor with 2-way audio-video connectivity and (2) a videophone with 2-way audio-video connectivity used for weekly contact.

Study design

After institutional review board approval was obtained, we used a retrospective, concurrent matched cohort study design. The treatment group was selected as described in the discussion of the intervention. The inclusion and exclusion criteria for the comparison group were identical to those used to select the treatment group. Candidates for our comparison group were veterans with diabetes seen at the same sites as the treatment group who had 2 or more ED visits or hospital admissions in the 1-year period prior to enrollment. (Individuals who died during the study period were not eligible for inclusion in the comparison group.) The treatment and comparison groups were matched on the basis of the treatment group members' study enrollment dates, so both groups had identical distributions of enrollment and service periods. Both groups had to remain enrolled for the entirety of the 12-month observation window. Three controls were randomly selected for each member of the treatment group to ensure an adequately sized control group. To improve the match between the treatment and comparison groups, we used propensity scores by (1) estimating a model of the probability that a patient "selects" into the treatment group as opposed to the comparison group, (2) dividing our sample into the quintiles of the predicted propensity scores distribution (<20%, 20%–40%, 40%–60%, 60%–80%, and 80%–100%), and (3) randomly sampling equal numbers of cases and controls from each quintile. The selected veterans were used to fit our outcome models (Berg et al., 2004).

Use of identical selection criteria for both the treatment and comparison groups and propensity score matching for selecting the comparison group help ensure comparability of the treatment and comparison groups on observable covariates. Still, in the absence of randomization between the treatment and comparison groups, we wanted to control for any remaining differences between the treatment and comparison groups, including those differences that might not be directly observed. To the extent that any unobserved factors influenced both the treatment-comparison assignment and also influenced our outcomes of interest, our estimated treatment effect could be biased. We addressed such selection bias by using a difference-in-differences (DiD) method to measure the effect of the intervention on service use. This method has long been used in studies of labor economics, and has more recently been applied to health services research (Gray, 2001; Smith, 2000; Tai-Seale et al., 2001; T. H. Wagner et al., 2001). In addition, this method seeks to measure a treatment effect while accounting for any pretreatment differences between the treatment and comparison groups.

The motivation behind DiD is presented in Figure 1, which shows a hypothetical example of pretreatment and posttreatment outcomes among the treatment and comparison groups. In Figure 1, we observe a treatment group and a comparison group both before and after an intervention. Prior to the intervention, the difference between the comparison and treatment groups measures any innate or intrinsic difference between the 2 groups. (In Fig 1, this difference is shown by Comparison/Pre minus Treatment/Pre.)

Following the intervention, the difference between the comparison and treatment groups measures the treatment effect plus any intrinsic difference. (In Fig 1, this is shown

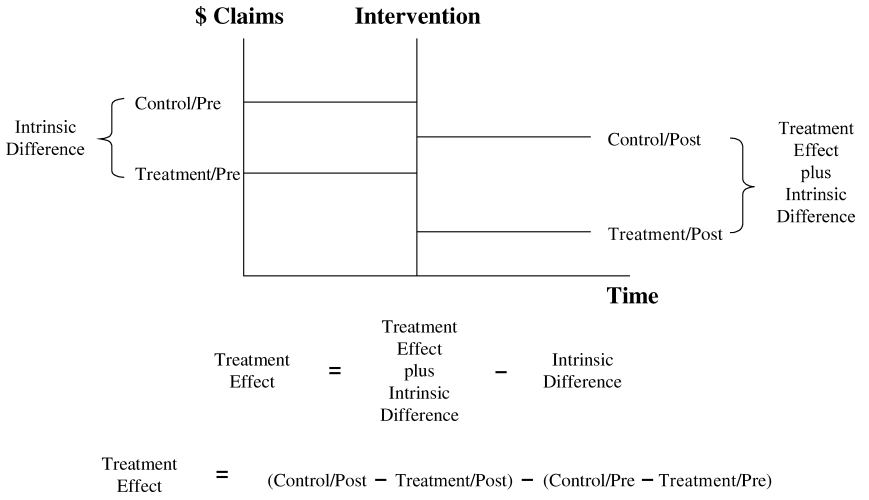

Figure 1. The concept behind the difference-in-differences approach.

by Comparison/Post minus Treatment/Post.) To calculate the treatment effect by itself, we subtract the intrinsic difference between the 2 groups from the combined treatment effect plus intrinsic difference. The intrinsic difference is given by the difference between the comparison and treatment groups prior to the intervention, whereas the treatment effect plus the intrinsic difference is given by the difference between the comparison and treatment groups following the intervention. So, to calculate the treatment effect alone, we subtract the difference between the comparison and treatment groups prior to the intervention from the difference between the comparison and treatment groups following the intervention. The treatment effect is therefore measured as the difference between two differences, hence the label "difference in differences."

Measures

Service use outcomes were measured at 12 months before and after enrollment in the CC/HT program and were derived from the National Patient Care Database, a VHA administrative database that consists of inpatient and outpatient data. Inpatient service use was measured by hospital admissions (separately for diabetes and all-causes) and the days of hospitalization for the hospital admissions (separately for diabetes and all-causes).

Outpatient service use was measured as ambulatory-care clinic visits (clinic stops) by (1) ED (separately for diabetes and all-causes), (2) need-based primary care clinic visits, (3) podiatry, (4) ophthalmology, and (5) diabetes specialty clinic. Since our data were derived primarily from administrative data, we employed the ICD-9 codes from the Dartmouth-Manitoba ICD-9 comorbidity index of Romano et al. (1993) (along with ICD-9 codes for depression and hyperlipidemia, but used each item as a dummy variable). We also collected data on the study participants' age (in years), ethnicity (recoded as White, Hispanic, and other), marital status (recoded as married vs not married), facility site, and service-connected disability (ranking on a scale from 0% to 100% based on disabilities that were sustained or aggravated during military service). These latter sociodemographic variables and comorbidities were used as covariates in the models, except for ethnicity. Because multicollinearity was problematic, we deleted the ethnicity variable from our model.

In a subanalysis, we were able to obtain access to the patients' medical records for one site. We collected the Hb A_{1c} 12 months before and after the intervention in both the treatment and comparison groups to control for this important factor in diabetes care and to assess whether its inclusion influenced our measurement of the effect of the intervention.

Statistical analysis

We used logistic regression for binary service use outcomes (eg, whether or not a patient was hospitalized over the 1-year period) and ordinary least squares regression for continuous outcomes (eg, days of hospitalization). All statistical tests were 2-tailed and the analyses were executed using SAS, version 8.0 (SAS Institute, Cary, NC).

The DiD approach was implemented via a multivariable statistical model. The model used for days of hospitalization in this research was

$$E(\text{Service use} \mid \text{Explanatory Variables}) = \alpha_0 + \alpha_1(\text{Treatment}) + \alpha_2(\text{Post}) + \alpha_3(\text{Treatment} \times \text{Post}) + \beta'\mathbf{X},$$

where Treatment denotes membership in the treatment group, Post denotes the postintervention time period, and $\beta'\mathbf{X}$ denotes the linear combination of control variables discussed above. The parameter α_3 represents the DiD estimate of the treatment effect controlling for $\mathbf{X}$.

The analysis for discrete dependent variables is the same as the preceding analysis except the expected log-odds of the event is modeled:

$$E\left(\ln\left(\frac{p}{1-p}\right)\right) = \delta_0 + \delta_1(\text{Treatment}) + \delta_2(\text{Post}) + \delta_3(\text{Treatment} \times \text{Post}) + \gamma'\mathbf{X}$$

The term P is the probability of event occurrence, and the other variables are as defined above. We employed the Ai and Norton (2003) estimator for the interaction effect (cross-difference) for the logistic regression models since the interaction effect in nonlinear models is not equivalent to the marginal effect of the interaction term.

RESULTS

Baseline characteristics of 2 groups

Table 1 presents a descriptive comparison of the treatment and comparison groups prior to the intervention. There were no statistically significant preintervention differences

Table 1. Patient characteristics in treatment and comparison groups at baseline

	Treatment ($n = 400$)	Comparison ($n = 400$)	*P*
Age	68.2	61.5	.95
Marital status			
Married	256 (64.0%)	262 (65.5%)	.71
Not married	144 (36.0%)	138 (34.5%)	
Ethnicity			
White	165 (41.25%)	161 (40.25%)	
Hispanic	190 (47.5%)	193 (48.25%)	.96
Black/other	45 (11.25%)	45 (11.25%)	
Facility			
A	71 (17.75%)	72 (18.0%)	
B	92 (23.0%)	87 (21.75%)	.90
C	59 (14.75%)	54 (13.5%)	
D	178 (44.5%)	187 (46.75%)	
Service-connected disability			
None	270 (67.5%)	271 (67.75%)	
10%–49%	44 (11%)	43 (10.75%)	.99
≥50%	86 (21.5%)	86 (21.5%)	
Comorbidity Index	1.4	0.7	<.0001
Hospitalization (pre)	0.57	0.54	.00
Length of stay (pre)	6.40	5.86	.00
Outpatient visits (pre)	4.93	4.86	.15

between the treatment and comparison groups in age, marital status, ethnicity, facility, service-connected disability, and outpatient use. There were, however, small statistically significant differences between the 2 groups in preintervention hospitalization and days of hospitalization, with the treatment group having greater hospitalization (57% vs 54%) and more days of hospitalization (6.40 vs 5.86). The mean number of comorbidities was 1.4 for the treatment group and 0.7 for the comparison group ($P < .0001$). As discussed above under design, our DiD approach was intended to adjust observed postintervention differences for such preintervention differences, thereby ensuring an unbiased measure of the effects of the intervention.

Multivariate results: Changes in service utilization

As shown in Table 2, 1 year after enrollment, both the treatment ($P < .0001$) and comparison ($P < .01$) groups experienced significant decreases in hospital admissions (all-cause and diabetes-related) and days of hospitalization (all-cause). Despite the fact that the treatment group experienced a stronger reduction in the likelihood of hospital admissions, the declines for the treatment group were statistically indistinguishable from the declines for the comparison group. In other words, we were unable to detect a statistically significant treatment effect for hospital admissions and days of hospitalization.

With reference to outpatient services, there was a significant difference between the treatment and comparison groups in the likelihood of 1 or more need-based primary care visits ($P < .01$), increasing in the treatment group by 7.6 percentage points (from 42.1% to 49.7%) and decreasing in the comparison group by 12 percentage points (from 40.7% to 28.7%). About 90% of the

Table 2. Service utilization (pre- and post-) in treatment and comparison groups* ($n = 846$)

	Treatment			Comparison			Telehealth effect†
	Pre	Post	*P*	Pre	Post	*P*	
1+ Hospital admissions	42.48%	18.73%	<.0001	37.97%	20.59%	<.01	−0.06
1+ Hospital admissions (diabetes related)	37.64%	16.47%	<.0001	35.36%	19.02%	<.01	−0.05
Days of hospitalization	12.15	14.77	.55	22.73	23.24	.91	2.10
Days of hospitalization (diabetes related)	11.10	13.72	.56	21.93	22.67	.87	1.88
1+ Emergency department visits	66.29%	47.61%	<.01	98.00%	50.72%	<.0001	0.29‡
1+ Emergency department visits (diabetes related)*							
1+ Need-based primary care clinic visit	42.12%	49.68%	.13	40.65%	28.73%	.01	0.18‡
1+ Podiatry visits	43.51%	42.03%	.76	27.48%	22.15%	.21	0.04
1+ Ophthalmology visits	38.74%	40.38%	.75	24.01%	20.69%	.41	0.05
1+ Diabetes clinic visits	15.15%	19.72%	.21	18.57%	13.71%	.18	0.10

*Outcomes as means or %. Outcomes adjusted for (1) sociodemographic characteristics (patient's age, marital status, service-connected disability, and facility site); (2) comorbidities; (3) pre/post enrollment status. Model failed to converge.

†Treatment effect measured using the difference-in-differences approach. For discrete dependent variables, the numbers represent the arithmetic change in the log odds of event occurrence due to the intervention. For continuous dependent variables, the numbers represent difference-in-differences estimates for the arithmetic changes in the dependent variable due to the intervention.

‡$P < .05$.

Table 3. Service utilization (pre- and post-) in treatment and comparison groups in Site B* ($n = 278$)

	Treatment			Comparison			Telehealth effect†
	Pre	Post	*P*	Pre	Post	*P*	
1+ Hospital admissions	57.08%	23.78%	<.01	34.96%	26.35%	.37	−0.21‡
1+ Hospital admissions (diabetes related)	52.58%	24.22%	<.01	33.18%	25.64%	.42	−0.18
Days of hospitalization	16.50	20.45	.53	26.65	24.66	.82	5.94
Days of hospitalization (diabetes related)	16.08	20.69	.47	26.61	25.68	.92	5.55
1+ Emergency department visits	77.22%	64.04%	.08	92.22%	68.72%	<.0001	0.21
1+ Emergency department visits (diabetes related)	34.89%	17.37%	.01	60.79%	36.00%	.01	0.08
1+ Need-based primary care clinic visit	52.83%	24.78%	<.01	30.75%	17.13%	.07	−0.11
1+ Podiatry visits	57.62%	61.72%	.63	19.95%	23.47%	.62	0.02
1+ Ophthalmology visits	34.74%	45.79%	.19	29.70%	41.32%	.19	−0.0005
1+ Diabetes clinic visits	11.21%	9.94%	.77	2.88%	6.42%	.28	−0.07

*Outcomes as means or %. Outcomes adjusted for (1) sociodemographic characteristics (patient's age, marital status, service-connected disability, and facility site); (2) comorbidities, Hb A_{1c}; (3) pre/post enrollment status.

†Treatment effect measured using the difference-in-differences approach. For discrete dependent variables, the numbers represent the arithmetic change in the log odds of event occurrence due to the intervention. For continuous dependent variables, the numbers represent difference-in-differences estimates for the arithmetic changes in the dependent variable due to the intervention.

‡$P < .10$.

sample had statistically significant point changes in the probability of a visit ranging from .15 to .20, with no general pattern with changes in predicted probabilities of visits.

Both the treatment and comparison groups experienced decreases in the likelihood of 1 or more ED visits, decreasing 18.9 percentage points in the treatment group (from 66.3% to 47.6%, $P < .01$) and decreasing 47.3 percentage points in the comparison group (from 98.0% to 50.7%, $P < .0001$). The differences between these 2 groups were distinguishable ($P < .0001$). In terms of the all-cause ED visits, about 80% of the sample had statistically significant percentage point changes in the probability of a visit ranging from .6 to .2, and generally declined with increased predicted probabilities of ED use. There were no significant differences found within or between the treatment and control groups for podiatry visits, ophthalmology clinic visits, and diabetes clinic visits.

In a subgroup analysis, for 1 site only (site B in Table 1), we were able to add the patients' Hb A_{1c} values to the model. The baseline Hb A_{1c} values between the treatment group (7.86) and comparison group (7.78) were not statistically significant ($P > .05$). The addition of Hb A_{1c} to the model did impact the findings differently than in the full sample. For instance, there was a difference that approached significance ($P = .08$) between the treatment and comparison groups in the likelihood of 1 or more hospital admissions. The likelihood of 1 or more hospitalizations decreased in the treatment group relative to the comparison group. Also, 10% of the sample had statistically significant percentage point changes in the probability of hospital admissions (all-cause) and the change in the probability of an admission was –.2. In terms of the diabetes-related hospital admissions, 50% of the sample had statistically significant percentage point changes in the probability of diabetes-related

hospital admissions, and the change in the probability of an admission was –.2 to –.25. Patient Hb A_{1c} had a statistically significant main effect in one of the service use outcomes: days of hospitalization. Patients who had higher levels of Hb A_{1c} spent a greater number of days in the hospital.

DISCUSSION

Both the treatment and comparison groups were selected on the basis of their high use of VA healthcare. Not surprisingly, pre-post analysis of the comparison group confirmed that such high-use patients exhibited declines in utilization over time. This is consistent with recent research about how such regression to the mean can bias the kinds of simple pre-post studies of disease management programs that have characterized the literature to date (CBO, 2004; Fetterolf et al., 2004; Tinkelman & Wilson, 2004). The DiD design of the present work, however, avoided this methodological pitfall (Berg et al., 2004). The rigor of our study design strengthened the finding that the VA CC/HT program was effective in increasing new, need-based primary care visits. The increase of such visits supports the notion of the "just in time" care approach, where the veterans' health status was monitored and their clinical needs were met before their health deteriorated. This suggests that the care coordinators were assessing patients and identifying the need for follow-up diabetes care.

Our subgroup analysis, where we were able to control for the patients' Hb A_{1c} values in the multivariate model, indicated that the CC/HT program had a negative effect on the probability of veterans having 1 or more hospitalizations. This finding indicates that the CC/HT program may be cost-effective in some instances. This finding also indicates the importance of considering the patients' Hb A_{1c} values when determining the effectiveness of a CC/HT program, especially in evaluating the extent to which the program reduces costly hospital admissions.

From an organizational standpoint, the fact that there was an increase in need-based primary care clinic visits does translate into an increase in workload once veterans with diabetes were enrolled. Notwithstanding this increased workload, there was an increase in the access to care. Patients were treated sooner than they would have otherwise been through traditional care—seeing patients at regular intervals to identify problems promptly. From a management standpoint, our findings also have noteworthy implications for ambulatory care for veterans with diabetes. For instance, as the findings from our subanalysis indicated, a tighter glucose control through daily monitoring could have reduced short- and long-term complications of diabetes and improved self-management of their symptoms.

Limitations

There were some limitations in our study. Patients in both groups were comparable by age, marital status, ethnicity, facility, service-connected disability status, and preenrollment outpatient visits. However, the treatment and comparison groups were not comparable in terms of preenrollment hospitalization and days of hospitalization. Although propensity score matching and DiD help to compensate for these differences, the techniques will not necessarily compensate for the lack of data on important clinical variables for patients with diabetes (eg, body mass index, insulin use, systolic blood pressure, diastolic blood pressure; Berg et al., 2004). We were able to adjust only for Hb A_{1c} at 1 of the 4 facility sites. Other important unobserved variables not considered were the patients' decision to participate or persist in the intervention (Berg et al., 2004). Moreover, our study was implemented in a single VHA geographical region that contained a racially and geographically diverse group of patients with diabetes. While the intervention studied here could be used in other VHA regions and the non-VHA sector, we have no evidence on the effects of the intervention in alternative settings. However, such evidence will likely be forthcoming as similar interventions are implemented throughout the VA and non-VA sectors.

CONCLUSIONS

In sum, the findings from this VA patient-centered CC/HT program for veterans with diabetes who were high users of the healthcare system were consistent with the notion that the CC/HT program improved the quality of care for veterans through the incorporation of new patient education and telecommunication technologies that involve greater, timelier patient-clinician interaction. In this way, the program supports greater access to care as evidenced by increased likelihood of need-based primary care clinic visits. Also, when considering patients' Hb A_{1c} values in the model, the CC/HT program reduced costly hospital admissions. The comparison group was well-matched on some, but not all, variables. Our research design (DiD), however, corrected for potential residual selection bias between the treatment and comparison groups and separated any regression to the mean in use from any treatment effect on use. The approach applied in this study provides a valuable technique for evaluators to assess similar health service innovations when a randomized trial design is not feasible (Berg et al., 2004).

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