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METHODS ARTICLE

Impact of a Chronic Care Coordinator Intervention on Diabetes Quality of Care in a Community Health Center

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Purpose. To evaluate the impact of a clinic-based chronic care coordinator (CCC) intervention on quality of diabetes care, health outcomes and health service utilization within six community health centers serving predominantly low-income Hispanic and non-Hispanic white patients.

Methods. We used a retrospective cohort study design with a 12-month pre- and 12-month postintervention analysis to evaluate the effect of the CCC intervention and examined: (1) the frequency of testing for glycated hemoglobin (HbAIC), cholesterol LDL level, and microalbumin screen and frequency of retinal and foot exam; (2) outcomes for HbAIC levels, lipid, and blood pressure control; and (3) health care service utilization. Patients with diabetes who received the CCC intervention (n = 329) were compared to a propensity score adjusted control group who are not exposed to the CCC intervention (n = 329). All of the data came from Electronic Medical Record. Four separate sets of analyses were conducted to demonstrate the effect of propensity score matching on results.

Results. The CCC intervention led to improvements in process measures, including more laboratory checks for HbAIC levels, microalbuminuria screens, retinal and foot exams and also increased primary care visits. However, the intervention did not improve metabolic control.

Conclusions. CCC interventions offer promise in improving process measures within community health centers but need to be modified to improve metabolic control.

Key Words. Diabetes, Hispanic, chronic care coordinators

The prevalence of type 2 diabetes in the U.S. Hispanic population is nearly double the rate in non-Hispanic whites (Mokdad et al. 2001). Hispanics are the fastest growing minority population in the United States (U.S. Census Bureau 2010), increasing the likelihood of more diabetes-related complications and health care costs. Despite the existing high expenditures for diabetes care, very few patients with diabetes are at goal for evidence-based recommendations, with only 7 percent of patients at goal for HbAIc, blood pressure, and LDL cholesterol (Saydah, Fradkin, and Cowie 2004).

A systematic review of culturally competent interventions for Hispanic adults with type II diabetes (Whittemore 2007) indicates that the majority have been in specialized diabetes education programs provided over a period of time in the community setting (i.e., church, community center; Brown et al. 2005; Lorig, Ritter, and Gonzalez 2003; Lorig, Rittler, and Jacquez 2005; Rosal et al. 2005; Two Feathers et al. 2005). Other interventions have been provided in the clinic setting, typically a community health center; among these, only one intervention provided individualized diabetes education assisted by a bilingual community health worker (CHW; Corkery et al. 1997); one used nurse case management combined with monthly education sessions with a CHW (Philis-Tsimikas et al. 2004) and other interventions provided a specialized diabetes education program over 1–3 months duration (Elshaw et al. 1994; Banister et al. 2004).

According to the Centers for Disease Control (CDC), there is evidence demonstrating the value and impact of CHWs in preventing and managing a variety of chronic diseases, including diabetes (CDC 2011). CHWs typically work in community settings; the specific characteristics of settings (i.e., community vs. clinic setting) and infrastructure for effective CHW interventions has not yet been identified (Norris et al. 2006). The literature uses different names to refer to CHWs, including promotora (health promoter), patient navigator, case-manager, and chronic care coordinator (CCC).

The purpose of this study is to evaluate the impact of a CCC intervention on quality of diabetes care within a Community Health Center's (CHC) serving predominantly low-income Hispanic and non-Hispanic white patients. We used a retrospective cohort study design with a 12-month pre- and 12-month post-intervention analysis to evaluate the effect of the CCC intervention on quality of care, outcomes, and health care utilization. Patients with diabetes who received the CCC intervention were compared to a propensity score adjusted comparison group who are not exposed to the CCC intervention. While previous studies have incorporated a CHW into the

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clinical setting (King et al. 2006; Joshu et al. 2007; Thompson, Horton, and Flores 2007), these studies' outcomes are limited to enrolled participants and have not used the EMR to evaluate outcomes; the methodology used to examine outcomes in this study contributes a novel approach because it provides data on all patients with diabetes within a network of CHCs. In addition, a previous qualitative study conducted at the Sea Mar Network evaluated provider and staff perceptions on the CCC role and indicates that the majority (92 percent) agreed or strongly agreed that care provided to patients with type 2 diabetes had improved (Shadish, Cook, and Campbell 2002). This study compliments this previous study by focusing on quantitative outcomes.

We hypothesize that patients engaged by the CCC will be more likely to receive appropriate laboratory assessments of their diabetes and more likely to achieve control of their diabetes (HbA1C <7), blood pressure (BP <130/80), and lipids (LDL cholesterol <100) than those in the comparison group. We also hypothesize that patients engaged by a CCC will be more likely to exhibit appropriate health care utilization via increased visits to PCPs and ophthalmologists and fewer visits to endocrinologists than patients not engaged by the CCC.

METHOD

Study Design

This study uses a retrospective cohort study design with a pre- and postintervention analysis to assess the effect of CCC support on the quality of diabetes care, health outcomes, and health service utilization, using nationally accepted guidelines (Funnell et al. 2008). The study analyses employed intention-to-treat principles; patients who had a visit with a CCC from February 1, 2009, to September 30, 2009, were enrolled in the *intervention arm*, and patients not seen by the CCC during this same time-frame were enrolled in a *comparison group*; these patients were followed for 12 months postenrollment to examine outcomes.

Setting

Sea Mar Community Health Center offers primary care services to predominantly low-income Hispanics and non-Hispanic white patients, including a large percentage of uninsured patients, in Western Washington. Health care services are provided to over 100,000 patients, including 9,900 patients with type 2 diabetes. For this study, we present data from six Sea Mar clinics that hired a CCC during a similar time-frame, February-March 2009, and are located in Seattle, Puyallup, Tacoma, Bellingham, Marysville, and Mt. Vernon. Each CCC was assigned to one clinic.

CCC Intervention

Sea Mar CHC network incorporated the Chronic Care Model (CCM; Coleman, Austin, Brach, and Wagner 2009) to improve diabetes care. The CCM provides an organizational framework for chronic care management and practice improvement. A recent study used qualitative and quantitative data to examine Sea Mar's implementation of the CCM, with the addition of the Chronic Care Coordinator role, in terms of provider and staff satisfaction (Bond et al. 2012). The Sea Mar CHC implementation of the CCM focused on five domains: health system, self-management support, decision support, delivery system design, and clinical information system. For this current study, the focus is on an evaluation of the CCC intervention on patient outcomes, utilizing the EMR data.

The training level of the CCCs at time of hire varied. All CCCs received similar training, which consisted of 4 weeks of didactic sessions, EMR and practice management training, in-class exercises, motivational interviewing training, self-management goal setting, CPR, shadowing other CCCs, and learning the Plan-Do-Study-Act rapid cycle quality improvement process. The CCC training program included (1) a screening protocol for identifying patients with type 2 diabetes in the EMR; (2) training on use of reminders and treatment algorithms; (3) a clinic visit counseling protocol; and (4) patient education methods and materials to encourage self-management. Before beginning work, each CCC passed a competency test. The CCCs received ongoing coaching during monthly meetings with the Chronic Care Program Director; such meetings allowed the CCCs to identify problems and brain storm solutions as a group as well as provided ongoing coaching on motivational interviewing.

The CCCs provided patients with individualized case management, care coordination, and self-management through brief in-person visits at the clinic site and/or telephone interventions (i.e., 15 minutes or less) and goal setting. The patient education was focused on general diabetes education, blood glucose monitoring, nutrition, physical activity, foot care, and medications. During visits, the CCC learned about patient's concerns, assessed metabolic control, reviewed progress on the self-management plan, provided targeted education, and assisted patients with health system navigation, including referrals. The CCCs were able to provide scheduling support and reminders for patients. The CCCs were bilingual in English and Spanish and provided educational materials in the patient's primary language. Access to the EMR allowed the CCC to prepare in advance for a patient's visit to the PCP to ensure that the patient received indicated services and to document all patient interactions; preparing in advance meant reviewing the EMR record and identifying patient's needs in terms of laboratory studies and referrals. The EMR includes patient's medical history, visits, medications, referrals, laboratory, and radiology orders and results. The CCCs made patients aware of needed laboratory studies and referrals and facilitated referrals at time of visit. Therefore, the CCC helped that patient become more aware about needed next steps in the management of their diabetes. All CCC efforts were documented in the EMR and this helped all medical staff, including providers, keep track of patient's management.

Study Patients

To evaluate the impact of the CCC intervention, we focused on adults with an established diagnosis of diabetes at study baseline. To be enrolled in the study, the patient must have met the following criteria: (1) be a current Sea Mar patient with a clinic visit between February 1, 2009, and September 30, 2009, at any of the six Sea Mar clinics; (2) have an EMR-documented diagnosis of type 2 diabetes in the past 12 months prior to enrollment (ICD-9 codes for diabetes, 250.xx); (3) be between the ages of 18 and 69 years; (4) have at least two additional visits at the same clinic in the year prior to the study; and (5) speak English or Spanish. This study used an upper age limit of 69 years as prevalence of co-morbidities increases with age, thus complicating disease self-management. Using EMR data, we excluded patients with the following conditions: (1) type 1 diabetes; (2) pregnant; (3) history of organ transplantation; (4) serum creatinine <2.5 mg/dl; (5) dementia; and (6) terminal illness.

Given this criteria, cases in the intervention and comparison group were pulled from a sample of 1,483 total patients. Patients were divided into those who had previous visits with the CCC (664) and those who had no history of visits with a CCC (819); these were the intervention and the comparison group, respectively. Patients in the comparison group who were not followed by CCC received the standard diabetes care. All of the EMR patient data was extracted using database queries.

All patients with type 2 diabetes at each clinic site were eligible for the CCC intervention, regardless of HbAIc level; the CCC intervention was designed this way because it was understood that patient needs vary (e.g., some need help in seeing an ophthalmologist for their annual eye exam, some may need vouchers to pay for medications). The CCCs used the EMR to identify patients with type 2 diabetes who were scheduled to see their PCP on the next day to conduct either an initial assessment or a follow-up assessment. At times, type 2 diabetes patients presented to the clinic without having had prior CCC contact; these patients were then referred to the CCC by the PCP, after their visit, for ongoing follow-up care with the CCC. Due to time and scheduling constraints, the CCCs were not able to assist all patients with type 2 diabetes during their first 12 months of employment at each of the clinic sites.

In comparing Sea Mar CHC baseline rates for diabetes care quality to national benchmarks (National Healthcare Quality Report 2003), it was noted that Sea Mar CHC rates were lower for the following key measures: percent of adults with diabetes who had a HbAIC measurement at least twice in past year (32.5 percent vs. 79.4 percent), percent of adults with diabetes who had a retinal eye examination in past year (19.8 percent vs. 66.7 percent), and percent of adults with diabetes who had a foot examination in past year (29.5 percent vs. 64.6 percent).

Dependent Variables

Dependent variables included measures of diabetes process of care, measures of intermediate outcomes of diabetes care, and health care utilization in the postenrollment period. Processes of care measures included the number of HbAIc tests (at least two measures taken at least 3 months apart), cholesterol tests (i.e., LDL), microalbumin urine test (at least one), retinal eye exam (at least one), and foot exam (at least one). Intermediate diabetes outcome measures included glycemic control (HbAIc <7.0 percent), lipid control (LDL Cholesterol <100 md/dl), and blood pressure control ($<130/80$ mgHg); it was expected that HbAIC levels would improve within 12 months of a CCC visit (Joshu et al. 2007). Health care utilization measures included number of primary care visits, at least one referral to ophthalmology, and at least one referral to endocrinology.

Independent Variables

The primary independent variable of interest was whether a patient received at least once CCC visit.

Covariates

Covariates included clinic, age, gender, race/ethnicity, insurance status and type, language preference, smoking status, depression diagnosis, diabetes medications, and Diabetes Complications Severity Index (DCSI). ICD-9 codes for diabetes-related complications were used to identify at-risk patients and to develop a DCSI (Young et al. 2008).

Data Analysis

We used propensity score analysis (Rosenbaum and Rubin 1984, 1985) to balance the distributions of observed baseline characteristics between the intervention and comparison groups, an approach that has been shown to reduce the effect of selection bias (McWilliams et al. 2007a,b). Within each of the six clinics, we used baseline variables and logistic regression to model the odds of being in the intervention group. We then calculated the predicted probability of receiving intervention (the propensity score) for each subject and matched subjects from the intervention and comparison groups based on their propensity scores. Note that clustering due to clinic was handled by carrying out propensity score calculations and matching separately in each clinic and including clinic as a covariate in every model.

Our general approach was to fit models comparing outcomes between the intervention and comparison groups at the end of the 12-month postenrollment period, adjusting for outcomes at baseline in addition to the covariates listed above (Van Belle et al. 2004). Due to a large proportion of missing HbA1C observations, we developed a linear mixed effects model (Diggle et al. 2002) that included HbA1C as the outcome and the following baseline variables as covariates: all covariates listed above, indicator of whether appropriate HbA1C tests were done in pre-enrollment period, number of PCP visits, endocrinology and ophthalmology referrals, eye and foot exams, and blood pressure in the pre-enrollment period. The model also included a binary indicator of treatment group and an interaction between this indicator and time. We utilized all data from the 12-month pre- and postenrollment periods to fit the models and obtained predicted values at baseline and 12 months postenrollment for each subject. Predicted values were used in all analyses, including the development of the propensity score.

The process of care outcome measures and the intermediate diabetes outcome measures were binary outcomes, which were assessed using logistic regression models. To investigate health care utilization outcomes, we fit

Poisson regression models for number of PCP visits and logistic regression models for the rest of the outcomes, which were binary.

Four separate sets of analyses were conducted to demonstrate the effect of propensity score matching on results. The first set utilized all subjects and did not adjust for potential confounders (referred to as the "Unadjusted" analysis). The second set of analyses adjusted for all the variables that were used to calculate the propensity score ("Standard Adjustment"). The third set adjusted only for the propensity score ("Propensity Score Adjustment"). Finally, the fourth set utilized only the propensity score matched sample and adjusted for propensity score. This is the main analysis used for drawing conclusions.

In a secondary analysis, we investigated the intervention effect by number of CCC visits, race/ethnicity (i.e., Hispanic patients and non-Hispanic white patients), and by insurance status.

Statistical analyses were performed using *R* statistical software (version 2.14.1, R Core Team, Vienna, Austria). All reported p-values were two-sided, with statistical significance taken to be $p < .05$. There was no adjustment for multiple testing.

RESULTS

Baseline demographics and characteristics for the original study sample are summarized in Table 1. After propensity score matching, 616 patients remained in the analysis, with 308 subjects in each group. Propensity score matching results in a decrease in the number of subjects because we exclude any patient in the intervention group who does not have a matching comparison. Table 2 shows that in this propensity score matched sample, the two groups were similar with regards to baseline measures. The propensity score matched sample consisted of subjects who were 18–69 years old, with equal proportions of men and women in the sample. More than half of the patients (54.9 percent) were Hispanic. Over half (55.0 percent) spoke English only, under half (44.6 percent) spoke Spanish only, and the rest (0.4 percent) spoke both languages. Most patients were on diabetes medications (54.1 percent using oral only and 44.3 percent using insulin) and a considerable proportion (15.6 percent) had no insurance. Just under half (48.4 percent) of the patients had appropriate assessments of HbA1C in the pre-enrollment period and most patients (69.6 percent) had HbA1C ≥7.0 percent at baseline. The mean number of PCP visits in the pre-enrollment period was 4.5 (SD 3.4).

Table 1: Demographic Characteristics of All Participants in Original Study Sample

	All		Comparison Group		Intervention Group		
	%	(*n*)	%	(*n*)	%	(*n*)	*p*-value
Overall	100.0	(1,483)	100.0	(819)	100.0	(664)	
Row %			55.2		44.8		
Clinic							
Bellingham	14.1	238	16.4	134	13.0	86	<.001*
Marysville	16.6	279	20.5	168	13.4	89	
Mount Vernon	21.4	360	23.2	190	14.5	96	
Puyallup	9.7	163	8.5	70	11.0	73	
Seattle	23.2	391	19.9	163	28.6	190	
Tacoma	15.1	254	11.5	94	19.6	130	
Age (years)							
18–39	13.8	233	13.7	112	14.9	99	.581*
40–49	25.5	430	24.4	200	26.2	174	
50–59	34.7	585	35.0	287	34.8	231	
60–69	25.9	437	26.9	220	24.1	160	
Mean ± SD	52.4 ± 11.0		52.7 ± 11.1		52.0 ± 10.9		.216†
Gender							
Female	51.2	863	49.3	404	52.7	350	.214*
Male	48.8	822	50.7	415	47.3	314	
Race/ethnicity							
Non-Hispanic white	32.3	544	36.6	300	27.0	179	<.001*
Hispanic	55.5	935	51.3	420	60.4	401	
Other	12.2	206	12.1	99	12.7	84	
Health insurance							
Private	50.6	852	49.8	408	49.4	328	.444*
Public	29.7	501	30.5	250	28.5	189	
No insurance	19.7	332	19.7	161	22.1	147	
Language							
English	57.2	963	67.5	553	46.8	311	<.001*
Spanish	42.3	712	32.0	262	52.7	350	
Both	0.6	10	0.5	4	0.5	3	
Tobacco use							
Never	62.0	1,045	64.5	528	59.5	395	.758*
Past	5.8	97	6.1	50	4.8	32	
Current	12.9	218	13.3	109	12.8	85	
No. of PCP visits							
1–2	40.1	676	40.5	332	39.3	261	.433*
3–4	26.5	447	28.1	230	25.5	169	
5–6	16.1	272	15.1	124	16.9	112	
≥7	17.2	290	16.2	133	18.4	122	
Mean ± SD	4.1 ± 3.3		3.9 ± 3.2		4.2 ± 3.4		.198†

continued

Table 1: *Continued*

	All		Comparison Group		Intervention Group		
	%	(*n*)	%	(*n*)	%	(*n*)	*p*-value
Diagnosed with depression							
No	90.9	1,531	90.6	742	90.7	602	.962*
Yes	9.1	154	9.4	77	9.3	62	
Diabetes complications severity index (DCSI)							
0	87.4	1,472	88.0	721	86.6	575	.329*
1	8.3	140	7.4	61	9.5	63	
≥2	4.3	73	4.5	37	3.9	26	
Mean ± SD	0.2 ± 0.6		0.2 ± 0.6		0.2 ± 0.5		.888†
Diabetes medications							
Oral only	55.4	933	59.6	488	51.5	342	<.001*
None	2.1	35	3.4	28	0.6	4	
Insulin (any combination)	37.5	632	29.1	238	45.8	304	
Hemoglobin A1C (%) baseline value							
Mean ± SD	8.2 ± 1.6		8.0 ± 1.6		8.4 ± 1.6		<.001†
HbA1C no. of measurements							
No	51.9	875	62.4	511	54.8	364	<.001*
Yes	32.5	547	30.2	247	45.2	300	
HbA1C <7.0%							
No	43.0	725	46.0	377	52.4	348	<0.001*
Yes	17.4	294	23.7	194	15.1	100	
Endocrinology referral (within 12 months)							
No	86.5	1,458	98.0	803	98.6	655	.492*
Yes	1.5	25	2.0	16	1.4	9	
Ophthalmology referral (within 12 months)							
No	80.3	1,353	93.0	762	89.0	591	.008*
Yes	7.7	130	7.0	57	11.0	73	
Microalbuminuria screen (within 12 months)							
No	36.1	608	42.9	351	38.7	257	.113*
Yes	51.9	874	57	467	61.3	407	
Retinal exam (within 12 months)							
No	68.1	1,148	82.2	673	71.5	475	<.001*
Yes	19.8	334	17.7	145	28.5	189	
Foot exam (within 12 months)							
No	58.5	985	70.9	581	60.8	404	<.001*
Yes	29.5	497	28.9	237	39.2	260	
Blood pressure (<130/80)							
No	37.7	635	43.6	357	41.9	278	.030*
Yes	36.0	607	46.3	379	34.3	228	
LDL cholesterol (<100)							
No	23.1	389	24.2	198	28.8	191	.799*
Yes	16	270	17.2	141	19.4	129	
PCP visits							
Mean ± SD	4.0 ± 3.3		3.9 ± 3.2		4.2 ± 3.5		0.036†

*Chi-square test of homogeneity.
†Two-sample *t*-test for difference in means.

Table 2: Demographic Characteristics of Participants in Propensity Score Matched Sample

	All		Comparison Group		Intervention Group		
	%	(n)	%	(n)	%	(n)	p-value
Overall	100.0	(616)	100.0	(308)	100.0	(308)	
Row %			50.0		50.0		
Clinic							
Bellingham	14.9	92	14.9	46	14.9	46	1.000*
Marysville	18.2	112	18.2	56	17.0	56	
Mount Vernon	18.8	116	18.8	58	20.1	66	
Puyallup	8.8	54	8.8	27	7.3	24	
Seattle	20.5	126	20.5	63	24.6	81	
Tacoma	18.8	116	18.8	58	14.6	48	
Age (years)							
18–39	14.3	88	14.3	44	14.3	44	.882*
40–49	25.2	155	24.7	76	25.6	79	
50–59	34.3	211	35.7	110	32.8	101	
60–69	26.3	162	25.3	78	27.3	84	
Mean ± SD	52.4 ± 11.1		52.5 ± 11.2		52.3 ± 11.0		.868†
Gender							
Female	49.5	305	48.7	150	50.3	155	.747*
Male	50.5	311	51.3	158	49.7	153	
Race/ethnicity							
Non-Hispanic white	33.4	206	34.7	107	32.1	99	.789*
Hispanic	54.9	338	53.9	166	55.8	172	
Other	11.7	72	11.4	35	12.0	37	
Health insurance							
Private	51.9	320	53.2	164	50.6	156	.648*
Public	32.5	200	32.5	100	32.5	100	
No insurance	15.6	96	14.3	44	16.9	52	
Language							
English	55.0	339	56.8	175	53.2	164	.671*
Spanish	44.6	275	42.9	132	46.4	143	
Both	0.4	2	0.3	1	0.4	1	
Tobacco use							
Never	77.1	475	76	234	78.2	241	.472*
Past	5.7	35	6.8	21	4.5	14	
Current	17.2	106	17.2	53	17.2	53	
No. of PCP visits							
1–2	30	185	26.6	82	33.4	103	.274*
3–4	30.2	186	32.8	101	27.6	85	
5–6	18.3	113	18.5	57	18.2	56	
≥7	21.4	132	22.1	68	20.8	64	
Mean ± SD	4.6 ± 3.4		4.7 ± 3.4		4.5 ± 3.3		.581†

continued

Table 2: *Continued*

	All		Comparison Group		Intervention Group		
	%	(*n*)	%	(*n*)	%	(*n*)	*p*-value
Diagnosed with depression							
No	90.6	558	89.9	277	91.2	281	.679*
Yes	9.4	58	10.1	31	8.8	27	
Diabetes complications severity index (DCSI)							
0	85.9	529	86.7	267	85.1	262	.784*
1	9.3	57	8.4	26	10.1	31	
≥2	4.9	30	4.9	15	4.9	15	
Mean ± SD	0.2 ± 0.6		0.2 ± 0.6		0.2 ± 0.5		.834†
Diabetes medications							
Oral only	54.1	333	54.5	168	53.6	165	.405*
None	1.6	10	2.3	7	1	3	
Insulin (any combination)	44.3	273	43.2	133	45.5	140	
Hemoglobin A1C (%) baseline value							
Mean ± SD	8.4 ± 2.1		8.3 ± 2.2		8.4 ± 2.1		.437†
HbA1C no. of measurements							
No	51.6	318	53.6	165	49.7	153	.375*
Yes	48.4	298	46.4	143	50.3	155	
HbA1C <7.0%							
No	69.6	429	67.2	207	72.1	222	.220*
Yes	30.4	187	32.8	101	27.9	86	
Endocrinology referral (within 12 months)							
No	99.2	611	99.4	306	99	305	1.000*
Yes	0.8	5	0.6	2	1	3	
Ophthalmology referral (within 12 months)							
No	91.6	564	92.5	285	90.6	279	.469*
Yes	8.4	52	7.5	23	9.4	29	
Microalbuminuria screen (within 12 months)							
No	33.9	209	35.1	108	32.8	101	.610*
Yes	66.1	407	64.9	200	67.2	207	
Retinal exam (within 12 months)							
No	73.2	451	74	228	72.4	223	.716*
Yes	26.8	165	26	80	27.6	85	
Foot exam (within 12 months)							
No	58.4	360	58.8	181	58.1	179	.935*
Yes	41.6	256	41.2	127	41.9	129	
Blood pressure (<130/80)							
No	51.1	315	50	154	52.3	161	.629*
Yes	48.9	301	50	154	47.7	147	
LDL cholesterol (<100)							
No	29.2	180	26.9	83	31.5	97	.408*
Yes	20.8	128	21.4	66	20.1	62	
PCP visits							
Mean ± SD	4.5 ± 3.4		4.6 ± 3.4		4.5 ± 3.3		.738†

*Chi-square test of homogeneity.
†Two-sample *t*-test for difference in means.

Tables 3(b) and 4 show that the intervention group was more than twice as likely as the comparison group to have appropriate process measures in the postenrollment period ($p < .001$). The intervention did not show statistically significant effects on the HbA1C outcome measures or for lipid or blood pressure control. To further examine HbAIc outcomes between intervention and comparison groups, we compared baseline HbA1c levels (i.e., <7 percent, 7–8 percent, 8–9 percent, 9–10 percent, >10 percent) and proportions of patients who achieved a HbAIc of less than 7 percent at 12 months post intervention; we found no differences among the two groups (Table 5). For the health utilization measures, an intervention effect was seen. The rate of PCP visits per year was 1.39 times greater in the intervention group compared to the comparison group ($p < .001$).

In the secondary analysis, we found that the proportion of patients with appropriate HbA1C measurements increased with the number of CCC visits received (see Appendix, Table S1). There was a slight improvement in the proportion of patients with HbA1C <7 percent among those who received one CCC visit compared to the comparison group, followed by a decline for patients who received more visits. Examining the last HbA1C values in the pre- and postenrollment periods shows a reduction in all categories. However, the degree of reduction is not affected by the number of CCC visits. Moreover, the groups who received two or three CCC visits had higher baseline HbA1C values.

The intervention effects were found to be significant for process measures for Hispanics and whites; however, the intervention effect was more pronounced for whites than Hispanics (see Appendix, Tables S2 and S3). In terms of outcomes for HbAIc, neither group experienced an intervention effect. Both Hispanics and whites had a significant intervention effect for PCP visits; however, whites had a more pronounced effect.

DISCUSSION

We found that patients in a community health center system in Washington State who had at least one visit with a CCC experienced more HbAIc tests, microalbuminuria screens, retinal exams, foot exams, and more PCP visits. However, the CCC intervention did not lead to improved metabolic control. Further evaluation of quality of care provided by the CCC appears warranted.

When we examined the intervention effect for HbAIc, cholesterol, and microalbumin tests as well as for a retinal and foot exams separately for

Table 3: A Comparison of Process Measures, Outcome Measures, and Health Care Utilization among Intervention and Comparison Groups in a Twelve-Month Period

		Comparison Group		*Intervention Group*	
Aim	*Study Outcome Measure*	*Pre*	*Post*	*Pre*	*Post*
(a) Original study sample (%)					
Aim 1: Process measures	HbA1C measurements (≥2 taken ≥3 months apart in 12-month period)	32.6	39.4	45.2	67.8
	Microalbuminuria screen	57.1	43.5	61.3	67.9
	Retinal exam	17.7	20.9	28.5	40.7
	Foot exam	29.0	51.3	39.2	83.7
Aim 2: Outcome measures	HbA1C <7%	34.0	37.7	22.3	25.0
	HbA1C last value, mean (SD)	7.99	7.73	8.38	8.13
	Blood pressure < 130/80	51.5	55.8	45.1	54.1
	LDL – cholesterol < 100	41.6	41.4	40.3	41.0
Aim 3: Utilization measures	PCP visits only, mean (SD)	3.88	2.84	4.24	4.67
	Endocrinology referral	2.0	1.8	1.4	2.0
	Ophthalmology referral	7.0	5.3	11.0	9.5
(b) Propensity score matched data (%)					
Aim 1: Process measures	HbA1C measurements (≥2 taken ≥3 months apart in 12-month period)	46.4	47.4	50.3	70.5
	Microalbuminuria screen	64.9	50.6	67.2	74.4
	Retinal exam	26.0	24.4	27.6	41.2
	Foot exam	41.2	59.7	41.9	88.3
Aim 2: Outcome measures	HbA1C <7%)	27.6	31.8	25.6	27.3
	HbA1C last value	8.19	7.91	8.25	8.02
	Blood pressure <130/80	50.0	54.1	47.7	53.2
	LDL – cholesterol <100	44.3	47.8	39.0	41.3
Aim 3: Utilization measures	PCP visits only, mean (SD)	4.59	3.32	4.50	4.62
	Endocrinology referral	0.6	2.3	1.0	2.3
	Ophthalmology referral	7.5	6.2	9.4	9.4

Hispanics and whites, we found that both groups experienced improved process measures. However, improvements in outcomes were more pronounced for whites than Hispanics. Still, the improvements for Hispanic patients are encouraging given that in the 2008 Healthcare Disparities Report from the Agency for Healthcare Research and Quality, Hispanics consistently lagged behind whites in receipt of recommended diabetes services, including HbA1c testing, foot checks, and ophthalmology examination (Department of Health and Human Services 2008). However, when we examined the intervention

Table 4: Intervention Impact on Outcomes in Propensity Score Matched Sample in a Twelve-Month Period

Study Outcome Measure	*Intervention Effect*	*95% CI*	*p-value*
HbA1C measurements (≥2 taken ≥3 months apart in 12-month period)*	2.63	(1.88, 3.68)	<.001
Microalbuminuria screen*	2.94	(2.07, 4.17)	<.001
Retinal exam*	2.27	(1.59, 3.25)	<.001
Foot exam*	5.22	(3.42, 7.98)	<.001
HbA1C <7%*	0.70	(0.39, 1.27)	.242
HbA1C last value†	0.06	(−0.02, 0.13)	.151
Blood pressure*	0.99	(0.69, 1.42)	.968
LDL-cholesterol*	0.53	(0.26, 1.09)	.084
PCP visits only‡	1.39	(1.28, 1.51)	<.001
Endocrinology referral*	0.88	(0.30, 2.60)	.818
Ophthalmology referral*	1.59	(0.86, 2.94)	.142

Note. All models adjusted for propensity score and clinic.
*Odds ratio from logistic regression model.
†Difference in means from linear regression model.
‡Incident rate ratio from Poisson regression model.

Table 5: Baseline HbAIc and Percentage of Patients with HbAIc <7% Twelve Months Post-Enrollment

	12 Months Post-Enrollment HbA1c< 7%	
Baseline HbA1c	*Comparison Group*	*Intervention Group*
<7%	92.9	87.3
7%–8%	18.8	20.3
8%–9%	7.7	1.6
9%–10%	0	0
>10%	0	0

effect on metabolic outcomes separately for Hispanic and whites, we found that neither group achieved metabolic control.

This study finding is consistent with previous studies which indicate that more laboratory testing may not necessarily be associated with improvements in metabolic control (O'Connor et al. 1987; Greenfield et al. 1995).

More research is needed that focuses on how to standardize the activities of the CCCs to improve patient outcomes. Such research needs to evaluate how the trained CCCs deliver quality of care to diabetic patients (i.e., how they apply motivation interviewing skills with patients, how they assess patient self-management goals), as described in a previous study (Wolber and Ward 2010). In addition, consideration needs to be given to the place of the CCC intervention delivery, frequency, and intensity of contact, with some studies indicating there is the potential to improve outcomes for diabetes patients through telephone (Williams et al. 2012) and home visits (Ingram, Torres, and Redondo 2007).

Interest in identifying the best way to incorporate a CCC into federally qualified CHC settings is likely to depend on ability to obtain payment for such services. Payment reform is fundamental to the successful implementation and transformation of any chronic care services (Merrell and Berenson 2010). Although current payment models have tended to incentivize face-to-face visits and may not cover the services of a CCC in non-FQHCs, there are payment provisions that offer flexibility on payments for FQHCs, although training of staff is considered an important factor. In the recent passage of the Affordable Care Act, care coordination for patients with chronic health conditions is described as an important component of Patient-Centered Medical Homes (Department of Health and Human Services 2010).

The methodology used for this study is promising for evaluating future CHC interventions, utilizing EMR data. Previous studies that assessed outcomes for CHW interventions in clinical settings (King et al. 2006; Joshu et al. 2007; Thompson, Horton, and Flores 2007) were limited to enrolled participants in evaluating outcomes. In this study, the EMR data was used to evaluate outcomes; this methodology contributes a novel approach because it provides data on all patients with diabetes within a CHC network. In addition, a previous mixed methods study conducted at the Sea Mar Network evaluated provider and staff perceptions on the CCC role and indicates that the majority (92 percent) agreed or strongly agreed that care provided to patients with type 2 diabetes had improved (Shadish, Cook, and Campbell 2002). The present study compliments this previous study by focusing on quantitative outcomes, based on EMR data.

This study has several limitations that need to be discussed. Our analysis is based on observational data, where results may be prone to bias due to confounding factors. We used propensity score analysis to adjust for confounding using the variables available to us in the EMR. Other variables of interest that we did not have data on are BMI, income, marital status, employment status, education, alcohol use, and time with diabetes; while some of the weight and height measures to calculate BMI were included in the EMR, over 50 percent of the data were missing. Therefore, potential confounding may still exist due to unmeasured variables. Although propensity scores matching attempts to adjust for this bias, there may be remaining bias due to unobserved variables. In the absence of a randomized clinical trial or a time series design (employed to demonstrate the association between an intervention and the care process changes and in turn the association with the desired outcomes), we are limited in the conclusions that we can draw regarding intervention effect. Another limitation is that we are unable to study the effect of the number of CCC visits in groups of patients who received more than two CCC visits due to small sample sizes; however, when we compared patients who had at least one CCC visit to those who had zero visits, it was noted that even this one visit had a positive effect on process measures (i.e., increased HbAIC laboratory measures). Data on duration of time spent by each CCC with each patient was also not available. Future studies need to consider the intensity of the CCC intervention both in terms of CCC visits and in duration of time for each visit. A final limitation of this study is that it did not examine which CCC skills (i.e., motivational interviewing, facilitating appointments) led to the improvement in process measures. Future research needs to focus on examining this.

In conclusion, the methodology used to examine quality of diabetes care, including propensity-matched patients and EMR data, is promising in evaluating diabetes quality of care. The results suggest that CCC engagement may benefit patients with type 2 diabetes by improving their receipt of recommended diabetes services, including HbA1c testing, foot checks, and ophthalmology examination. However, further evaluation of the processes that the trained CCC used with patients with diabetes appears warranted.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Table S1: Effect of Number of CCC Visits on HbA1C Outcomes Twelve Months Postenrollment.

Table S2: Intervention Impact on Outcomes Twelve Months Post-Enrollment in Hispanic Subjects versus White Subjects Using Propensity Score Matched Data.

Table S3: Intervention Impact on Outcomes Twelve Months Post-Enrollment in Hispanic Subjects versus White Subjects Using Propensity Score Matched Data.