Original Research

Evaluation of trends in diabetes care in a patient-centered medical home

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ABSTRACT

Background: The patient-centered medical home (PCMH) is a model used in primary care to achieve effective management of chronic diseases. The Augusta University Health Family Medicine Center (AUFMC), a PCMH recognized by the National Committee for Quality Assurance, has implemented strategies to manage its patient population with diabetes. The present study evaluated the effects of these interventions through trend analysis of selected diabetic core measures by use of a qualified clinical data registry, the Practice Partner Research Network.

Methods: For this retrospective study, de-identified data were abstracted for adult patients with diabetes for the period of 2013-2015. Process and outcome measures were determined for selected diabetic core measures, based on the 2015 American Diabetes Association and Physician Quality Reporting System of the Centers for Medicaid and Medicare (CMS). These measures included glycated hemoglobin (HbA1c), blood pressure (BP), low-density lipoprotein cholesterol (LDL), urine microalbumin (Um), diabetic foot and eye exams, and influenza and pneumococcal vaccinations. These values were analyzed by the Cochran-Armitage test for trends over time to determine the proportions of patients at the recommended goals.

Results: Over time, there were increasing trends for patients who were at the goals for frequencies of HbA1c, Um, LDL, pneumococcal vaccinations, and diabetic retinal exams ($p<0.01$). Increasing trends were also evident for patients at goal values for HbA1c, BP, and LDL levels ($p<0.01$). Decreasing trends were noted, however, in the rate of diabetic foot exams ($p<0.01$).

Conclusions: Since AUFMC achieved PCMH recognition status, efforts to improve the management of patients with diabetes have yielded positive outcomes and valuable lessons. Areas of strength include utilization of the diabetes registry, education by regular providers, tailored use of electronic health records for patient education and physician documentation, and appropriate utilization of all team members. Trend analysis indicated that targeted diabetic interventions contributed to improved outcomes in selected diabetic core measures.

Key words: Patient-Centered Care, Medical Home, Diabetes, Primary Health Care

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INTRODUCTION

Chronic disease is the leading cause of death worldwide (*Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020*, 2013). Diabetes is a cause of heart disease, stroke, kidney failure, blindness, and non-traumatic amputations (Stellefson, Dipnarine, & Stopka, 2013). According to the United States Diabetes Surveillance System of the Centers for Disease Control and Prevention, the prevalence of diabetes mellitus continues to rise. In Georgia, the age-adjusted percent of adults diagnosed with diabetes has increased from 9.6% in 2012 to 11.0% in 2014. In Richmond County, where the Augusta University Health Family Medicine Center (AUFMC) is located, the prevalence of diabetes is higher, with an age-adjusted percentage of adults with diabetes of 13.2% in 2013 ("United States Diabetes Surveillance System," 2016). The management of diabetes requires consistent and quality primary care to monitor and prevent the microvascular and macrovascular complications of diabetes, provide patient education and self-management support, and utilize health information systems that optimize the evaluation of data for individuals and for the patient population. From the perspective of healthcare providers, diabetes management is a team effort.

In primary care settings, the comprehensive Chronic Care Model is used to improve population-based health through interactions between motivated patients and a prepared and proactive health care team (Bodenheimer, Wagner, & Grumbach, 2002). In the United States, this model has been widely utilized, with positive outcomes in diabetes care (Stellefson et al., 2013). This model set the stage for a change in care of chronic diseases, and, in 2007, several primary care associations collaborated to develop the joint principles of the Patient-Centered Medical Home (PCMH) ("Defining the Medical Home," 2017).

The PCMH aims to improve primary care so that patients are provided with accessible, continuous, comprehensive, and coordinated care that is committed to quality and safety in the context of the family and community ("Defining the Medical Home," 2017; Peikes et al., 2012). It provides an outline to help practices manage their patients with chronic conditions. Studies on PCMH initiatives and diabetes show

improvement in various aspects of diabetes care, including patient satisfaction, preventive care, number of emergency room visits, length of hospital stay and readmissions, and patients at goal for selected core measures, such as glycated hemoglobin (HbA1c) (Ackroyd & Wexler, 2014; An, 2016; Andrews, Northam, & Gosselin, 2015; Rosenthal, Sinaiko, Eastman, Chapman, & Partridge, 2015; Stevens, Shi, Vane, & Peters, 2014). PCMH components that show the most benefits in outcomes for diabetic core measures are diabetes self-management, team-based care, other specialty providers such as behavioral health and pharmacists, and electronic health records (EHRs) as a tool to help implement other parts of the PCMH (Ackroyd & Wexler, 2014).

Current literature on the effect of the PCMH on cost savings shows mixed results. If overall population health improves over time, there may be long-term financial benefits, but transformation of PCMH practice requires ongoing investments (Ackroyd & Wexler, 2014; Basu, Phillips, Song, Landon, & Bitton, 2016; Rosenthal et al., 2015). Nevertheless, health care is changing as the Centers for Medicare and Medicaid Services (CMS) utilize pay-for-performance rather than fee-for-service models with payment reform through the Medicare Access and Children's Health Insurance Program Reauthorization Act of 2015 (MACRA) (Mullins, 2016, 2017). The PCMH model assists practices in meeting the requirements of this new model (Mullins, 2016, 2017). With potential benefits of the PCMH model in chronic care management and in CMS healthcare payment reform, primary care settings continue to adopt this structure of care.

The Augusta University Family Medicine Center (AUFMC) is an academic medical center in Augusta, Georgia. As a Level III PCMH recognized by the National Committee for Quality Assurance (NCQA), providers and staff of the AUFMC have worked to optimize the delivery of care to patients with chronic medical problems, including diabetes. Currently, AUFMC is home to more than 2300 adult patients with diabetes. Since 2011, AUFMC has sought to improve diabetes care through protocols for physician documentation and adherence to standards of care, influenza and pneumococcal vaccination protocols, accessible laboratory services, and patient and provider education.

The purpose of the present investigation was to evaluate trends in selected diabetic core measures by use of a clinical data registry of patients with diabetes since the implementation of changes to enhance diabetes care using the constructs of the PCMH model. A goal is to use the results from this trend analysis to reinforce strengths and minimize weaknesses in diabetes care; to develop a model of care that results in improved, sustainable outcomes; and, for our patient population, to translate the results to other chronic diseases.

METHODS

The Augusta University Institutional Review Board approved this retrospective analysis of medical health records.

Participants and Setting

The present study was conducted at AUFMC, a faculty and resident practice site located in an academic medical center in Augusta, Georgia. AUFMC patients with diabetes mellitus ≥ 18 years old were included for the period of 2013-2015.

AUFMC Diabetes Care Interventions

To improve the care of patients with diabetes, various protocols have been implemented at the AUFMC over the last four years. Diabetes education on standard of care is provided to AUFMC physicians through conferences and structured chart reviews. A diabetes template, based on American Diabetes Association (ADA) guidelines, was developed and implemented for use by providers in the EHRs. The template accesses patient-specific diabetic information from the EHR database to create reminders and alerts regarding standards of care. Based on ADA guidelines, an individualized diabetes care management plan (DCMP) was created and implemented to improve patient education and encourage self-management. The DCMP provides patients with education on diabetes standards of care as well as an individualized outline of diabetic core values (HbA1c, BP, vaccination status, low-density lipoprotein cholesterol [LDL], renal function, urine microalbumin [Um], and smoking status). The DCMP was distributed to all patients with a diagnosis of diabetes encountered in the AUFMC. A vaccination protocol was developed to increase rates of pneumococcal, Tdap, and influenza vaccinations. Charts of patients presenting to the clinic and in need of these vaccines were flagged, and nurses were given standing orders to provide immunizations. This protocol included patients with diabetes in need of influenza and pneumococcal vaccinations according to ADA guidelines. Laboratory staff flagged the charts of patients with diabetes prior to the scheduled provider/patient encounter and indicated needed laboratory assessments. Same-day appointment slots with a registered dietician for diabetic patients two days per week increased their access to counseling on diabetic nutrition. The process of capturing outside ophthalmology and podiatry consultation information for diabetic retinal and foot exams was centralized in the AUFMC medical records department to facilitate documentation and ensure inclusion in the diabetes registry. To facilitate provider performance of this service, kits for examination of diabetic feet were placed in each examination room, which also had a poster reminding patients with diabetes of the schedule of their management needs (i.e., eye exam, foot exam, Um screening, and HbA1c).

Assessment Tool: Primary (Care) Practices Research Network (PPRNet)

The Primary (Care) Practices Research Network (PPRNet) is a learning and research organization designed to improve healthcare in its member practices and to perform research involving data from primary healthcare systems. An aim is to create actionable data from EHRs for quality improvement and reports for quality incentive programs. PPRNet serves as a Centers for Medicare and Medicaid Services (CMS) Qualified Clinical Data Registry ("PPRNet-Primary (Care) Practices Research Network," 2016). Since

2013, PPRNet has served as the qualified clinical data registry for AUFMC, increased the capacity of the center to maintain its PCMH recognition status, and assisted the practice with quality reporting to the CMS. This registry has allowed monitoring of selected core measures over time and has provided a mechanism to compare trends of selected core data for AUFMC patients with diabetes.

Selected Diabetic Core Measures

Quality improvement is best measured by assessing the dually significant process measures and outcome measures ("Types of Quality Measures," 2011). A retrospective chart review was performed to determine the number of patients meeting selected outcome and process quality improvement measures according to the 2015 ADA guidelines (American Diabetes, 2015). These included HbA1c, LDL, blood pressure (BP), Um, influenza and pneumococcal vaccinations, diabetic foot exams, and diabetic eye exams. This chart review also determined the number of diabetic patients meeting selected 2015 CMS Physician Quality Report System measures ("2015 Physician Quality Reporting System," 2015), including poor control of HbA1c (>9.0%), LDL control, eye examinations, and foot examinations. Table 1 shows the selected diabetic core measurements.

Table 1. Selected Diabetic Core Measurements

Process Measures	Outcomes Measures
HbA1c in past 6 months	HbA1c ≤7% and ≥ 9%
LDL in past 12 months	BP <140/90mmHg
Um in past 12 months	LDL < 100mg/dL
Eye examination in the past 12 months	Um < 30 mg/dL
Foot examination in the past 12 months	
Influenza vaccine in the past 12 months	
Pneumococcal vaccines rates(<65 y/o and ≥65y/o)	

Statistical Analyses

De-identified data were abstracted from the PPRNet data registry for all adult patients with diabetes mellitus who were treated in the AUFMC from 2013 – 2015. Information obtained included gender, race, and age, along with each of the quality measures described in Table 1. Descriptive statistics were calculated for each of the quality measures and patient demographics. Quality measures were grouped into process measures, such as tests and vaccines and outcome measures, which consist of the clinical values. Patients were considered to have met goals for process measures if the test or vaccine was administered within the required time frame: HbA1c tested within 6 months, LDL tested within 6 months, Um tested within 12 months, pneumococcal vaccine given once in two age cohorts, and flu vaccine given once per year. Patients were considered to have met goals for outcomes measures if the clinical values were within the required range: HbA1c ≤ 7.0%, BP ≤ 140/90 mmHg, LDL < 100 mg/dL, and Um < 30 mg/dL. Also examined was the proportion of patients who had HbA1c ≥ 9.0%. The Cochran-Armitage test was used to test for trends in the proportion of patients who met goals for each of the quality measures. Because PPRNet data were received on a quarterly basis, trends across quarters for all three years were analyzed. Statistical tests were two-sided, with significance set at $P<0.05$. All analyses were accomplished with SAS 9.4 (Cary, NC).

RESULTS

The patients with diabetes mellitus were mostly female (>63% all years), black (>64% all years), and had an average age of 56.8 years ± SD 11.7 (Table 2). Trends across three years for performance on diabetes core process measures (Table 3) and diabetes core outcome measures (Table 4) were assessed for significance. There were significant increasing performance trends for the proportion of patients meeting goals for LDL testing, Um testing, and pneumococcal vaccination. HbA1c testing had a marginally significant increasing trend, although there were greater variations in the percentages of those at goal for that measure across the entire time period. There was no statistically significant trend for influenza vaccination. Patients having diabetic eye exams within the past 12 months, for which data were available only from the 4th quarter of 2014 through 2015, showed a significant increasing trend over time. Patients with diabetic foot examinations within past 12 months showed significantly decreased performance trends over time. There were consistently increasing trends for outcomes performance for patients meeting goals for clinical values of BP, LDL, and Um. Although values for HbA1c ≤ 7.0% had an overall increasing trend, there was greater variation in the proportion of patients meeting this goal across time. The proportion of patients with HbA1c ≥ 9.0% remained stable across time.

Table 2. Patient Demographics

	N	%
Patient Gender		
Female	2607	63.3
Male	1515	36.8
Patient Race		
Asian	52	1.26
Black	2656	64.43
Hispanic	53	1.29
Other	54	1.31
Race Not Reported	46	1.12
White	1261	30.59
Patient Age	M 56.8	SD 11.7

Table 3. Trends for Performance on Measures of Diabetes Core Processes

	2013								2014								2015								
	1st Qtr		2nd Qtr		3rd Qtr		4th Qtr		1st Qtr		2nd Qtr		3rd Qtr		4th Qtr		1st Qtr		2nd Qtr		3rd Qtr		4th Qtr		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	P-value
HbA1c 6 months																									
Met	1012	76.6	1066	77.1	1107	79.4	1131	78.9	1138	78.1	1149	79.5	1201	81.2	1266	81.0	1341	79.9	1264	71.9	1460	81.7	1505	81.0	0.054
Not Met	309	23.4	317	22.9	288	20.6	302	21.1	320	21.9	297	20.5	278	18.8	297	19.0	337	20.1	495	28.1	328	18.3	353	19.0	
LDL 6 months																									
Met	1026	77.7	1022	73.9	1043	74.8	1100	76.8	1121	76.9	1140	78.8	1229	83.1	1332	85.2	1427	85.0	1419	80.7	1532	85.7	1602	86.2	<0.01
Not Met	295	22.3	361	26.1	352	25.2	333	23.2	337	23.1	306	21.2	250	16.9	231	14.8	251	15.0	340	19.3	256	14.3	256	13.8	
Um 12 months																									
Met	740	56.0	793	57.3	830	59.5	848	59.2	863	59.2	905	62.6	989	66.9	1054	67.4	1143	68.1	1168	66.4	1306	73.0	1351	72.7	<0.01
Not Met	581	44.0	590	42.7	565	40.5	585	40.8	595	40.8	541	37.4	490	33.1	509	32.6	535	31.9	591	33.6	482	27.0	507	27.3	
Flu Vaccine																									
Met	540	40.9	536	38.8	543	38.9	728	50.8	589	40.4	576	39.8	587	39.7	818	52.3	623	37.1	628	35.7	658	36.8	879	47.3	0.84
Not Met	781	59.1	847	61.2	852	61.1	705	49.2	869	59.6	870	60.2	892	60.3	745	47.7	1055	62.9	1131	64.3	1130	63.2	979	52.7	
Pneumovax < 65																									
Met	133	10.1	161	11.6	179	12.8	213	14.9	241	16.5	266	18.4	319	21.6	370	23.7	412	24.6	446	25.4	476	26.6	455	24.5	<0.01
Not Met	1188	89.9	1222	88.4	1216	87.2	1220	85.1	1217	83.5	1180	81.6	1160	78.4	1193	76.3	1266	75.4	1313	74.6	1312	73.4	1403	75.5	
Pneumovax > 65																									
Met	81	6.1	94	6.8	108	7.7	130	9.1	136	9.3	152	10.5	178	12.0	225	14.4	269	16.0	300	17.1	338	18.9	356	19.2	<0.01
Not Met	1240	93.9	1289	93.2	1287	92.3	1303	90.9	1322	90.7	1294	89.5	1301	88.0	1338	85.6	1409	84.0	1459	82.9	1450	81.1	1502	80.8	
DM Eye Exam																									
Met	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	0.3	95	5.7	124	7.0	214	12.0	291	15.7	<0.01
Not Met	1321	0.0	1383	0.0	1395	0.0	1433	0.0	1458	0.0	1446	0.0	1479	0.0	1559	99.7	1583	94.3	1635	93.0	1574	88.0	1567	84.3	
DM Foot Exam																									
Met	.	.	.	.	.	.	.	.	504	34.6	485	33.5	467	31.6	434	27.8	379	22.6	313	17.8	287	16.1	212	11.4	<0.01
Not Met	1321	0.0	1383	0.0	1395	0.0	1433	0.0	954	65.4	961	66.5	1012	68.4	1129	72.2	1299	77.4	1446	82.2	1501	83.9	1646	88.6	

Table 4. Trends for Diabetes Core Outcome Measures Performance

	2013								2014								2015								
	1st Qtr		2nd Qtr		3rd Qtr		4th Qtr		1st Qtr		2nd Qtr		3rd Qtr		4th Qtr		1st Qtr		2nd Qtr		3rd Qtr		4th Qtr		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	P-value
HbA1c <= 7.0%																									
Met	454	34.4	450	32.5	460	33.0	481	33.6	459	31.5	446	30.8	515	34.8	617	39.5	683	40.7	616	35.0	653	36.5	646	34.8	<0.01
Not Met	867	65.6	933	67.5	935	67.0	952	66.4	999	68.5	1000	69.2	964	65.2	946	60.5	995	59.3	1143	65.0	1135	63.5	1212	65.2	
HbA1c >= 9.0%																									
Met	241	18.2	253	18.3	253	18.1	267	18.6	289	19.8	293	20.3	273	18.5	259	16.6	256	15.3	264	15.0	360	20.1	364	19.6	0.47
Not Met	1080	81.8	1130	81.7	1142	81.9	1166	81.4	1169	80.2	1153	79.7	1206	81.5	1304	83.4	1422	84.7	1495	85.0	1428	79.9	1494	80.4	
BP <= 140/90																									
Met	595	45.0	660	47.7	633	45.4	632	44.1	674	46.2	740	51.2	780	52.7	814	52.1	890	53.0	875	49.7	1017	56.9	996	53.6	<0.01
Not Met	726	55.0	723	52.3	762	54.6	801	55.9	784	53.8	706	48.8	699	47.3	749	47.9	788	47.0	884	50.3	771	43.1	862	46.4	
LDL <= 100																									
Met	554	41.9	576	41.6	592	42.4	611	42.6	649	44.5	667	46.1	698	47.2	751	48.0	821	48.9	810	46.0	889	49.7	897	48.3	<0.01
Not Met	767	58.1	807	58.4	803	57.6	822	57.4	809	55.5	779	53.9	781	52.8	812	52.0	857	51.1	949	54.0	899	50.3	961	51.7	
Um < 30																									
Met	413	31.3	427	30.9	457	32.8	470	32.8	460	31.6	493	34.1	533	36.0	732	46.8	767	45.7	754	42.9	754	42.2	748	40.3	<0.01
Not Met	908	68.7	956	69.1	938	67.2	963	67.2	998	68.4	953	65.9	946	64.0	831	53.2	911	54.3	1005	57.1	1034	57.8	1110	59.7	

DISCUSSION

The relevance of this practice-based population study to public health lies in the development of strategies for primary care practices to manage patients with diabetes. Since primary care is often the first point of access to care for and prevention of the long-term complications of diabetes, effective management of this chronic disorder by use of versatile interventions to achieve evidence-based outcomes can contribute to improved community health.

The present research demonstrates a statistically significant increase in performance for various process measures, including appropriate testing frequency of LDL and Um, pneumococcal immunization rates, and diabetic retinal exams, all of which could relate to diabetes complications. Other investigations have shown that features of care delivery models, such as PCMH, allow for similar results on process measures (Stevens et al., 2014; Friedberg, Rosenthal, Werner, Volpp, & Schneider, 2015; Smith et al., 2015). Improving access and continuity of care to Medicaid patients increased the likelihood of receiving appropriate HbA1c testing and diabetic retinal exams (Stevens et al., 2014). Results obtained by the Pennsylvania Chronic Care Initiative, which looked at similar quality measures of diabetes care, as demonstrated with medical home practices, showed statistically significant improvements in HbA1c, LDL, nephropathy monitoring, and diabetic retinal exams (Friedberg, Rosenthal, Werner, Volpp, & Schneider, 2015). Testing frequency of HbA1c did not increase significantly, ranging from 76-81% overall with one outlying quarter in 2015. A retrospective analysis of HbA1c trends after PCMH implementation showed similar levels of performance without significant improvement (Smith et al., 2015).

As shown in the present report, analysis of selected outcome measures reveal statistically significant improvements in the percentage of patients at desired goals for HbA1c, LDL, Um, and BP. Results for previous PCMH interventions and improvement in these specific outcome measures is mixed. Some showed improvement in diabetic outcome measures, including HbA1c, BP, and LDL as results of PCMH-related interventions (Ackroyd & Wexler, 2014; Andrews et al., 2015; Gunter, Nocon, Gao, Casalino, & Chin, 2016; Hsieh, Shin, Tsai, & Chiu, 2016). However, others demonstrated that, although process measures may improve, there were no statistically significant improvements in outcome measures (Gunter et al., 2016; LeBlanc et al., 2016; Williams, Walker, Smalls, Hill, & Egede, 2016).

For the diabetic population at AUFMC, various interventions contributed to the improvement in the process and outcome measures. AUFMC utilized team members (i.e., nurses, laboratory technicians, and medical records personnel) standing orders, EHR laboratory reminders, and monitoring of centralized medical records for external consulting requests and EHR entries of external consultation reports to include podiatry and ophthalmology. As a PCMH facility, AUFMC utilizes EHRs to monitor performance and facilitate process and outcome measures. Computer tracking systems in primary care settings were helpful in improving management of diabetes (Renders et al., 2001). The hallmark of an advanced EHR lies in its capacity to utilize registries and to be integrated into an effective clinic workflow (Ackroyd & Wexler, 2014). The AUFMC EHR has allowed the practice to develop and utilize a diabetes registry, diabetes provider templates, alerts, flowsheets, and individualized diabetes education. Regular standard-of-care education for providers along with provider templates and alerts has increased appropriate testing and documentation of required diabetic care elements. The EHR organizes diabetic standard-of-care elements into a flow chart that provides physicians with a quick point-of-care reference. The plan for management of diabetes care has increased support for self-management by patients.

The present effort provides the AUFMC with results that can be used to continue improvement in the current diabetic care model. Analysis of specific outcome measures also reveals an area worthy of further exploration. The number of patients with HbA1c values ≥9% shows no changes in outcome over time. Further analysis is necessary to identify interventions to improve outcome measures in this high-risk group.

Process measures that did not improve include influenza immunization rates and diabetic foot exams. Extra steps required for documentation, in the EHR, of vaccinations from outside pharmacies and clinics may have contributed to reduced recorded immunization rates over time. From a more patient-centric view, investigation of vaccination refusal rates may be necessary to identify confounding variables.

PCMH had a positive, but not statistically significant, effect on rates of diabetic foot examinations (An, 2016). However, the AUFMC data for diabetic foot examinations are disappointing, in view of the interventions (e.g., provider template reminders, readily available diabetic foot exam kits in each examination room) to increase provider compliance and capture of outside podiatry consultations. Lack of improvement in foot examinations, which is provider-dependent, could be affected by competing demands during the patient encounter. Use of a registered nurse care coordinator to implement and promote group visits, tailor patient education, and lead daily consultations and monthly meetings showed a statistically significant improvement in the rates of diabetic foot examinations, along with other core measures (Biernacki, Champagne, Peng, Maizel, & Turner, 2015).

Some interventions do not demonstrate adequate sustainability. Due to competing clinical demands, AUFMC was not able to sustain flagging of charts for diabetic patients with needed tests before provider visits. Implementing standing orders for nursing staff has been complicated by existing policies that require identical nursing policies across all ambulatory clinics of our large multispecialty institution, which may not be present in individual practice settings.

Changes to AUFMC's PCMH model, as a result of this study, include the addition to the staff of a clinical pharmacist and a behavioral health specialist, who may

enhance diabetes care. There are clinical benefits of having a pharmacist integrated into primary care practices to facilitate care quality (Berdine & Skomo, 2012; Edwards, Webb, Scheid, Britton, & Armor, 2012; Johnson et al., 2010; Taveira, Dooley, Cohen, Khatana, & Wu, 2011). Patients with diabetes who are more likely to experience depression and other behavioral health problems (Ali, Stone, Peters, Davies, & Khunti, 2006) can be managed more appropriately by the collaborative presence of behavioral health personnel in PCMH settings, which has resulted in improved outcomes (Ackroyd & Wexler, 2014; Calman et al., 2013; Katon et al., 2010).

There are limitations to this study. Although the Cochrane-Armitage test for trends was sufficiently powered by a large patient sample size, this could have led to relatively small effect sizes yielding statistically significant results. Since the PPRNet registry at AUFMC started in 2013, trends for these data prior to PCMH interventions are not available. The registry does not facilitate the analysis of other outcomes measures, such as hospitalization rates, emergency room utilization, and cost of care.

CONCLUSIONS

This study, accomplished in the setting of an academic primary care practice, revealed, for care of diabetic patients, interventions that facilitate management and result in improved process and outcome measures. It also found areas for continued refining of these techniques over time.

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References

2015 Physician Quality Reporting System. (2015, 09/22/16). Retrieved from www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/PQRS/2015_Physician_Quality_Reporting_System.html

Ackroyd, S. A., & Wexler, D. J. (2014). Effectiveness of diabetes interventions in the patient-centered medical home. *Curr Diabet Rep*, *14*(3), 471. doi:10.1007/s11892-013-0471-z

Ali, S., Stone, M. A., Peters, J. L., Davies, M. J., & Khunti, K. (2006). The prevalence of co-morbid depression in adults with Type 2 diabetes: a systematic review and meta-analysis. *Diabet Med*, *23*(11), 1165-1173. doi:10.1111/j.1464-5491.2006.01943.x

American Diabetes, A. (2015). Standards of medical care in diabetes-2015 abridged for primary care providers. *Clin Diabetes*, *33*(2), 97-111. doi:10.2337/diaclin.33.2.97

An, J. (2016). The Impact of Patient-Centered Medical Homes on Quality of Care and Medication Adherence in Patients with Diabetes Mellitus. *J Manag Care Spec Pharm*, *22*(11), 1272-1284. doi:10.18553/jmcp.2016.22.11.1272

Andrews, C. A., Northam, S., & Gosselin, K. (2015). Evaluation of an Innovative Program To Improve Outcomes among Military Beneficiaries with Diabetes. *Nurs Econ*, *33*(5), 271-280.

Basu, S., Phillips, R. S., Song, Z., Landon, B. E., & Bitton, A. (2016). Effects of New Funding Models for Patient-Centered Medical Homes on Primary Care Practice Finances and Services: Results of a Microsimulation Model. *Ann Fam Med*, *14*(5), 404-414. doi:10.1370/afm.1960

Berdine, H. J., & Skomo, M. L. (2012). Development and integration of pharmacist clinical services into the patient-centered medical home. *J Am Pharm Assoc (2003)*, *52*(5), 661-667. doi:10.1331/JAPhA.2012.10206

Biernacki, P. J., Champagne, M. T., Peng, S., Maizel, D. R., & Turner, B. S. (2015). Transformation of Care: Integrating the Registered Nurse Care Coordinator into the Patient-Centered Medical Home. *Popul Health Manag*, *18*(5), 330-336. doi:10.1089/pop.2014.0131

Bodenheimer, T., Wagner, E. H., & Grumbach, K. (2002). Improving primary care for patients with chronic illness. *JAMA*, *288*(14), 1775-1779.

Calman, N. S., Hauser, D., Weiss, L., Waltermaurer, E., Molina-Ortiz, E., Chantarat, T., & Bozack, A. (2013). Becoming a patient-centered medical home: a 9-year transition for a network of Federally Qualified Health Centers. *Ann Fam Med*, *11 Suppl 1*, S68-73. doi:10.1370/afm.1547

Defining the Medical Home. (2017). Retrieved from www.pcpcc.org/about/medical-home

Edwards, H. D., Webb, R. D., Scheid, D. C., Britton, M. L., & Armor, B. L. (2012). A pharmacist visit improves diabetes standards in a patient-centered medical home (PCMH). *Am J Med Qual*, *27*(6), 529-534. doi:10.1177/1062860612444304

Friedberg, M. W., Rosenthal, M. B., Werner, R. M., Volpp, K. G., & Schneider, E. C. (2015). Effects of a Medical Home and Shared Savings Intervention on Quality and Utilization of Care. *JAMA Intern Med*, *175*(8), 1362-1368. doi:10.1001/jamainternmed.2015.2047

Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020. (2013). (pp. 1-103). Retrieved from http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng.pdf

Gunter, K. E., Nocon, R. S., Gao, Y., Casalino, L. P., & Chin, M. H. (2016). Medical Home Characteristics and Quality of Diabetes Care in Safety Net Clinics. *J Community Health*. doi:10.1007/s10900-016-0256-9

Hsieh, H. M., Shin, S. J., Tsai, S. L., & Chiu, H. C. (2016). Effectiveness of Pay-for-Performance Incentive Designs on Diabetes Care. *Med Care*, *54*(12), 1063-1069. doi:10.1097/MLR.0000000000000609

Johnson, K. A., Chen, S., Cheng, I. N., Lou, M., Gregerson, P., Blieden, C., . . . McCombs, J. (2010). The impact of clinical pharmacy services integrated into medical homes on diabetes-related clinical outcomes. *Ann Pharmacother*, *44*(12), 1877-1886. doi:10.1345/aph.1P380

Katon, W. J., Lin, E. H., Von Korff, M., Ciechanowski, P., Ludman, E. J., Young, B., . . . McCulloch, D. (2010). Collaborative care for patients with depression and chronic illnesses. *N Engl J Med*, *363*(27), 2611-2620. doi:10.1056/NEJMoa1003955

LeBlanc, E., Belanger, M., Thibault, V., Babin, L., Greene, B., Halpine, S., & Mancuso, M. (2016). Influence of a Pay-for-Performance Program on Glycemic Control in Patients Living with Diabetes by Family Physicians in a Canadian Province. *Can J Diabetes*. doi:10.1016/j.jcjd.2016.09.008

Mullins, A. (2016). Medicare Payment Reform: Making Sense of MACRA. *Fam Pract Manag*, *23*(2), 12-15.

Mullins, A. (2017). Making Sense of MACRA, Part 2: Value-Based Payment and Your Future. *Fam Pract Manag, 24*(1), 12-15.

Peikes, D., Zutshi, A., Genevro, J., Smith, K., Parchman, M., & Meyers, C. (2012, February 2012). Early Evidence on the Patient-Centered Medical Home. Retrieved from www.pcmh.ahrq.gov/page/early-evidence-patient-centered-medical-home

PPRNet- Primary (Care) Practices Research Network. (2016). Retrieved from http://academicdepartments.musc.edu/PPRNet/index.html

Renders, C. M., Valk, G. D., Griffin, S., Wagner, E. H., Eijk, J. T., & Assendelft, W. J. (2001). Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings. *Cochrane Database Syst Rev*(1), CD001481. doi:10.1002/14651858.CD001481

Rosenthal, M. B., Sinaiko, A. D., Eastman, D., Chapman, B., & Partridge, G. (2015). Impact of the Rochester Medical Home Initiative on Primary Care Practices, Quality, Utilization, and Costs. *Med Care, 53*(11), 967-973. doi:10.1097/MLR.0000000000000424

Smith, J. J., Johnston, J. M., Hiratsuka, V. Y., Dillard, D. A., Tierney, S., & Driscoll, D. L. (2015). Medical home implementation and trends in diabetes quality measures for AN/AI primary care patients. *Prim Care Diabetes, 9*(2), 120-126. doi:10.1016/j.pcd.2014.06.005

Stellefson, M., Dipnarine, K., & Stopka, C. (2013). The chronic care model and diabetes management in US primary care settings: a systematic review. *Prev Chronic Dis, 10*, E26. doi:10.5888/pcd10.120180

Stevens, G. D., Shi, L., Vane, C., & Peters, A. L. (2014). Do experiences consistent with a medical-home model improve diabetes care measures reported by adult Medicaid patients? *Diabetes Care, 37*(9), 2565-2571. doi:10.2337/dc14-0440

Taveira, T. H., Dooley, A. G., Cohen, L. B., Khatana, S. A., & Wu, W. C. (2011). Pharmacist-led group medical appointments for the management of type 2 diabetes with comorbid depression in older adults. *Ann Pharmacother, 45*(11), 1346-1355. doi:10.1345/aph.1Q212

Types of Quality Measures. (2011). Retrieved from www.ahrq.gov/professionals/quality-patient-safety/talkingquality/create/types.html

United States Diabetes Surveillance System. (2016). Retrieved from www.cdc.gov/diabetes/data/index.html

Williams, J. S., Walker, R. J., Smalls, B. L., Hill, R., & Egede, L. E. (2016). Patient-Centered Care, Glycemic Control, Diabetes Self-Care, and Quality of Life in Adults with Type 2 Diabetes. *Diabetes Technol Ther, 18*(10), 644-649. doi:10.1089/dia.2016.0079