

Impact of a pharmacist–physician collaborative care model on patient outcomes and health services utilization

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Purpose. The impact of a pharmacist–physician collaborative care model on patient outcomes and health services utilization is described.

Methods. Six hospitals from the Carilion Clinic health system in southwest Virginia, along with 22 patient-centered medical home (PCMH) practices affiliated with Carilion Clinic, participated in this project. Eligibility criteria included documented diagnosis of 2 or more of the 7 targeted chronic conditions (congestive heart failure, hypertension, hyperlipidemia, diabetes mellitus, asthma, chronic obstructive pulmonary disease, and depression), prescriptions for 4 or more medications, and having a primary care physician in the Carilion Clinic health system. A total of 2,480 evaluable patients were included in both the collaborative care group and the usual care group. The primary clinical outcomes measured were the absolute change in values associated with diabetes mellitus, hypertension, and hyperlipidemia management from baseline within and between the collaborative care and usual care groups.

Results. Significant improvements ($p < 0.01$) in glycosylated hemoglobin, blood pressure, low-density-lipoprotein cholesterol, and total cholesterol were observed in the collaborative care group compared with the usual care group. Hospitalizations declined significantly in the collaborative care group (23.4%), yielding an estimated cost savings of \$2,619 per patient. The return on investment (net savings divided by program cost) was 504%.

Conclusion. Inclusion of clinical pharmacists in this physician–pharmacist collaborative care–based PCMH model was associated with significant improvements in patients' medication-related clinical health outcomes and a reduction in hospitalizations.

Keywords: chronic disease management, clinical pharmacist, comprehensive medication management, patient-centered medical home, transitions of care

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The healthcare reform initiatives of the past decade have frequently espoused the value of the patient-centered medical home (PCMH) as a means to improve patient outcomes and reduce the cost of care. Several PCMH demonstration projects and studies have demonstrated improvements in population health, disease prevention, access to care, and patient satisfaction.¹⁻⁵ Although the PCMH model holds promise for improving patient experiences and improving care processes, current evidence has not consistently substantiated beneficial effects on many clinical and economic outcomes.¹⁻⁵ In fact, recent evidence from the Federally Qualified Health Center Advanced Primary Care Practice Demonstration revealed significant increases in the number of emergency department (ED) visits,

inpatient admissions and as well as Medicare Part B expenditures.⁵

Team-based pharmacist interventions in hospital and community settings have contributed to improved clinical outcomes for patients with many acute and chronic diseases,⁶⁻¹² including diabetes mellitus,⁹⁻¹¹ hypertension,¹⁰⁻¹³ and hyperlipidemia,¹⁴ through the provision of medication therapy management (MTM),¹⁵ comprehensive medication management (CMM),¹⁶ and/or chronic disease state management (CDSM).¹⁷ Several recent meta-analyses and systematic reviews have indicated marked improvements in the attainment of clinical goals with these care management models.^{8,18-22} But there is limited documentation of the value of pharmacists' provision of MTM or pharmacist-led CDSM beyond usual care on hospitalizations, ED visits, and healthcare costs.^{8,23,24}

This article presents the key findings on patient clinical outcomes and ED and hospital utilization for patients who received collaborative care and those in the comparator group who received usual care.

Background

Six hospitals from the Carilion Clinic health system in southwest Virginia, along with 22 PCMH practices affiliated with Carilion Clinic, participated in this project. The hospitals comprised 2 critical access hospitals (25 beds), 2 small hospitals (25–50 beds), 1 community hospital (146 beds), and 1 level 1 trauma center (703 beds). All institutions, except the largest, were located in rural communities. The primary goal of this project was to optimize medication therapy for timely and sustained achievement of patients' clinical goals while reducing the number of ED visits and hospitalizations.²⁵ The pharmacist-physician collaborative care approach used in this project augmented the PCMH model by adding a clinical pharmacist who performed CMM and CDSM on the team and closely collaborated with clinical pharmacists in the inpatient environment.

KEY POINTS

- Inclusion of clinical pharmacists in this physician-pharmacist collaborative care-based patient-centered medical home model was associated with significant improvements in patients' medication-related clinical health outcomes and a reduction in hospitalizations.
- The resultant financial savings suggest that this care model has the potential to enhance population health and reduce healthcare costs.
- This integrated team care model may improve the performance of accountable care organizations on key quality metrics, reduce healthcare expenditures, and increase shared savings.

All of the clinical pharmacists, inpatient and PCMH based, completed a workforce development plan to prepare for their new roles, improve collaboration between pharmacists and physicians, and provide patients with high-quality comprehensive healthcare. The ADAPT program, an online educational program developed by the Canadian Pharmacists Association, was the core of the clinical pharmacists training plan. It comprised 6 postintroductory modules: (1) a comprehensive medication assessment approach for patients, (2) how to work collaboratively with all members of the healthcare team and how to develop a medication care plan, (3) patient interviewing, (4) evidence-based practice in clinical decision-making, (5) documentation of medication-related care, and (6) creation of a plan to implement the pharmacists' new skills in the PCMH practice setting.²⁶ The clinical pharmacists spent 1–2

days per week in each of their respective PCMH practices: more time was dedicated to those with a larger patient population. Initially, 2 clinical pharmacists began providing care at 8 clinics in close proximity to the community hospital, Carilion New River Valley Medical Center, which was the primary inpatient facility, in January 2013. In July 2013, an additional 3 clinical pharmacists were embedded in 14 additional clinics. All clinics were level 3-certified PCMHs that used the same electronic medical record (EMR) used by the hospitals (Epic, Epic Systems, Verona, WI). None of the clinics had a clinical pharmacist embedded in the practice before the initiation of this project.

The clinical pharmacists called patients within 72 hours of any hospital discharge to ascertain whether the patient had any medication-related problems or issues. Within 14 days of patient identification, an office visit was scheduled. The clinical pharmacists' clinic interventions were ideally conducted face-to-face, as described previously.²⁵ Interventions were conducted at least quarterly, often by phone because of patient transportation issues. Patients were contacted more frequently, if necessary, to address patient-specific problems or concerns, thereby empowering patients to self-manage their medications and health conditions. The most common durations of patient interactions were 15 minutes (41.7%) and 16–30 minutes (36.7%), with 21.6% of interactions exceeding 30 minutes. The clinical pharmacists spent a mean of 6.5 hours in direct patient care per day. Unlike many pharmacist-led disease management projects, the clinical pharmacists assessed all medications and not just for those associated with specific chronic conditions.

Methods

The collaborative care group comprised hospitalized patients identified via an EMR algorithm and/or referral from a physician or care coordinator

from a participating PCMH practice. Approximately 56% of patients were identified while hospitalized. Eligibility criteria included documented diagnosis of 2 or more of the 7 targeted chronic conditions (congestive heart failure, hypertension, hyperlipidemia, diabetes mellitus, asthma, chronic obstructive pulmonary disease, and depression), prescriptions for 4 or more medications, and having a primary care physician in the Carilion Clinic health system. Number of chronic conditions was relevant to patient inclusion but degree of illness was not taken into consideration. From January 2013 through December 2014, 2,678 patients opted to receive collaborative care and were enrolled in this project. Collaborative care was delivered through June 30, 2015. Ultimately, 198 did not appear for a scheduled encounter with their clinical pharmacist. Thus, 2,480 evaluable patients comprised the collaborative care group.

The usual care group patient pool ($n = 12,097$) was retrospectively identified by applying the EMR algorithm to patients in health-system PCMHs without an embedded clinical pharmacist. Propensity score matching was used to match the usual care patients on a one-to-one basis to those in the collaborative care group using nearest-neighbor matching. The matching variables, from the health-system EMR, were age, sex, race, insurance status, and number of chronic conditions. The clinical data of the 2,480 usual care patients who were matched with their collaborative care counterparts were made available only after the match and thus could not be considered in the matching process.

The 22 PCMH practices comprised physicians, nurse practitioners, nurses, care coordinators, and medical assistants. The 5 clinical pharmacists who were devoted to the collaborative care PCMH practices provided CMM and CDSM, as previously described, in accordance with the working relationships developed with the primary care team providers.²⁵

All sociodemographic and health-related data, including numbers of ED visits and hospitalizations, were extracted from the health-system EMR. Disease-specific clinical measures, including systolic blood pressure (SBP), diastolic blood pressure (DBP), glycosylated hemoglobin (HbA_{1c}), low-density-lipoprotein (LDL) cholesterol, and total cholesterol (TC) values, obtained 90 days before enrollment or up to 14 days after enrollment were designated as baseline values. The latest reported value in the EMR within 12 months of enrollment was designated as the follow-up value, which aligns with National Committee for Quality Assurance measures used by the health system for quality monitoring.²⁷

The primary clinical outcomes were the absolute changes in the measures associated with diabetes mellitus, hypertension, and hyperlipidemia management (HbA_{1c} , SBP, DBP, LDL cholesterol, and TC) from baseline within and between the collaborative care and usual care groups. The secondary clinical outcomes were the absolute changes in HbA_{1c} , SBP, DBP, LDL cholesterol, and TC of those patients in the collaborative care and usual care groups who had baseline clinical measures above goal (i.e., those with uncontrolled disease). The health services utilization outcome was the change in the absolute number of all-cause ED visits and hospitalizations documented within the health system EMR in the 12 months before and after enrollment (pre- and post-periods, respectively). The economic outcome was the difference in the costs, based on national estimates, associated with ED visits and hospitalizations by collaborative care and usual care patients in the pre- and post-periods. ED visit and hospitalization costs in 2014 dollars were derived from national estimates from the 2014 Medical Expenditure Panel Survey and 2014 Healthcare Cost and Utilization Project, respectively.^{28,29} In both cases, weighted mean costs were calculated based on costs by age group, resulting in cost estimates for

the collaborative care and usual care groups of \$1,679.48 per ED visit and \$13,266.17 per hospitalization. Program costs consisted of the salary and fringe benefits of the clinical pharmacists in the PCMHs as well as the administrative staff who supported their efforts during the project. The costs for space in the clinics; utilization of the computers and printers; and materials for patients were covered by the health system as part of the program and thus not included in the program cost calculation. Return on investment was calculated as the difference between the estimated cost savings related to changes in ED visits and hospitalizations for the collaborative care group compared with the usual care group divided by total program cost.

Descriptive statistics were calculated for all variables. Bivariate analyses (t test and chi-square analysis) were used to assess baseline differences between the collaborative care and usual care groups for demographic (age, sex, race, insurance type) and health-related variables (number of chronic conditions, total number of ED and hospital encounters at baseline [i.e., 1 year before enrollment or index date]). Bivariate analyses assessed pre-post differences for clinical outcomes in each group. Generalized estimating equation models were used to examine the differences between the pre and post periods on the outcomes of interest between collaborative care and usual care. Covariates included age, sex, race, insurance type, number of chronic conditions, and total numbers of ED and hospital encounters at baseline. For the subset of patients above goal at baseline for each clinical outcome, repeated bivariate analyses and generalized estimating equation, controlling for covariates listed above, were conducted. The a priori significance level was 0.05. SAS/PC for Windows, version 9.4 (SAS Institute, Cary, NC), was used for data analysis.

This project was approved by the Virginia Commonwealth University institutional review board for the in-

investigators' retrospective analysis of existing data.

Results

Enrollment began in January 2013, and the last patient completed the project in June 2015. The baseline characteristics of the 2,480 collaborative care and 2,480 usual care patients were well matched in terms of age, sex, race, health insurance provider, and number of chronic conditions (Table 1). However, significant differences were noted between care groups in the rates of some diagnosed diseases, baseline clinical measures, and prior-year health services utilization. The usual care group was healthier (i.e., more patients had clinical measures within the desired ranges at baseline), and the numbers of ED visits and hospitalizations were markedly

lower during the year preceding the index date. The numbers of patients in the collaborative care and usual care groups with a diagnosis of diabetes mellitus were similar, while the usual care group had significantly more patients diagnosed with hypertension and hyperlipidemia.

Primary clinical outcomes. Each of the clinical outcome measures in the collaborative care group significantly improved over the course of the project. The mean differences in HbA_{1c} (−0.46%, $p < 0.0001$), SBP (−6.28 mm Hg, $p < 0.0001$), DBP (−2.69 mm Hg, $p < 0.0001$), LDL cholesterol (−3.72 mg/dL, $p = 0.0105$), and TC (−5.08 mg/dL, $p = 0.0036$) are noted in Table 2. Significant improvements in the usual care group were observed for only DBP, LDL cholesterol, and TC. The improvements in HbA_{1c}, SBP, and DBP

were significantly greater in the collaborative care group compared with the usual care group ($p < 0.0001$, $p < 0.0001$, and $p = 0.0071$, respectively).

Secondary clinical outcomes.

The absolute improvements in the values of the 5 specific clinical measures were significant in both collaborative care and usual care patients who had baseline values above the desired goals (Table 3). Analysis of the changes between groups revealed that the mean improvements in SBP (8.2 mm Hg) and TC (9.3 mg/dL) were significantly better in the collaborative care group ($p < 0.0001$ and $p = 0.0449$, respectively). At baseline, no patients in the collaborative care or usual care group were at goal; at the end of the project, 60.6% and 65.8%, respectively, had an SBP of <140 mm Hg and 82.1% and 78.1%, respectively, had a DBP of <90 mm Hg (data not shown).

ED and hospital utilization.

A small but nonsignificant increase (1.3%) in ED utilization was noted among the 1,969 collaborative care patients who participated for 12 months, from 1,995 in the 12 months before enrollment to 2,021 in the 12 months after enrollment. In the usual care group of 1,969 matched patients, a nonsignificant decrease (8.0%, from 475 to 437) in the number of ED visits was noted. The difference in ED use between the two groups over the observation period was not significant. The number of collaborative care patients who were hospitalized in the 12 months before the intervention decreased by 31.2% (from 984 to 677) during the 12-month postintervention period. The number of all-cause hospitalizations in the collaborative care patients decreased by 23.4%, from 1,675 in the preintervention period to 1,283 in the postintervention period. In the usual care group, hospitalizations decreased by 8.7% from 355 in the pre-period to 324 in the post-period. The absolute change in hospitalizations was significantly greater in the collaborative care than the usual care groups ($p < 0.0001$).

Table 1. Demographics of Intervention (Collaborative Care) and Comparator (Usual Care) Groups at Baseline^a

Variable	Collaborative Care Group	Usual Care Group	<i>p</i>
Mean ± S.D. age, yr	65.2 ± 13.0	65.5 ± 14.2	0.4544
Female	1,424 (57.4)	1,437 (57.9)	0.7021
Race/ethnicity, no. (%)			
White	2,166 (87.3)	2,180 (87.9)	
Black	289 (11.7)	275 (11.1)	
Hispanic	8 (0.3)	15 (0.6)	
Other	17 (0.7)	10 (0.4)	
Mean ± S.D. no. chronic conditions	3.3 ± 1.3	3.2 ± 1.2	<0.0001
Diabetes, no. (%)	1,409 (56.8)	1,363 (55.0)	0.1593
Hypertension, no. (%)	2,042 (82.3)	2,129 (85.9)	0.0004
Hyperlipidemia, no. (%)	1,891 (76.3)	2,043 (82.4)	<0.0001
Health insurance, no. (%)			0.6673
Medicare	1,574 (63.5)	1,584 (63.9)	
Medicaid	169 (6.8)	188 (7.6)	
Commercial	425 (17.1)	416 (16.8)	
Self-pay/other	312 (12.6)	292 (11.8)	
Mean ± S.D. GFR, mL/min	65.0 ± 25.6	64.5 ± 22.9	0.3966
Mean ± S.D. BMI, kg/m ²	32.0 ± 8.1	32.0 ± 8.4	0.9867
Mean ± S.D. no. total ED encounters	1.3 ± 2.2	0.6 ± 1.1	<0.0001
Mean ± S.D. no. total hospitalizations	0.4 ± 1.5	0.2 ± 0.60	<0.0001

^aGFR = glomerular filtration rate, BMI = body mass index, ED = emergency department.

Cost implications. Applying the 2014 ED visit and hospitalization cost factors of \$1,679.48 and \$13,266.17^{28,29} to the change in ED and hospitalization use, respectively, of all collaborative care patients enrolled for at least 12 months ($n = 1,969$) yielded a cost reduction of \$5,156,675, or \$2,619 per patient (increase of 26 ED visits and decrease of 392 hospitalizations). In contrast, the cost reduction in the usual care group was \$475,071, or \$241 per patient (decreases of 38 ED visits and 31 hospitalizations). The net savings (collaborative care reduction minus usual care reduction) was \$4,681,604, or \$2,378 per patient. Since the total cost of providing the collaborative care program during the 1-year patient intervention period was \$929,726, or \$478 per patient, the return on investment (net savings divided by program cost) was 504%.

Discussion

This pharmacist–physician collaborative care model for patients with multiple chronic diseases was associated with significant improvements in clinical outcomes while reducing hospitalizations. Significant reductions in HbA_{1c}, SBP, DBP, LDL cholesterol, and TC within the collaborative care group and DBP, LDL cholesterol, and TC in the usual care group were noted. The primary outcome was deemed achieved since the improvements were significantly greater in the collaborative care patients for 3 of the 5 clinical measures.

Various meta-analyses have found that a pharmacist-led intervention can reduce SBP by 6–11 mm Hg,^{10,17-20} and a recent review of systematic reviews and meta-analyses reported a mean reduction of 5.4 mm Hg.²¹ The reduction of 5.2 mm Hg in SBP in the entire collaborative care group relative to the entire usual care group is thus consistent with recent evidence. This is noteworthy, since all patients in this project who were diagnosed with hypertension were included in this evaluation, unlike previous reports that almost exclusively evalu-

Table 2. Changes in Clinical Outcome Measure Values Within Collaborative Care and Usual Care Groups^a

Variable	Collaborative Care Group			Usual Care Group			P Between Care Groups
	n	Mean ± S.D. (First Value, Last Value)	Mean Change (95% CI)	n	Mean ± S.D. (First Value, Last Value)	Mean Change (95% CI)	
HbA _{1c} , %	962	8.5 ± 2.3, 8.0 ± 2.0	0.46 (0.33 to 0.58)	599	7.3 ± 1.5, 7.2 ± 1.5	0.08 (-0.02 to 0.18)	0.1388 <0.0001
Systolic blood pressure, mm Hg	1,967	140.7 ± 28.3, 134.4 ± 22.1	6.28 (4.88 to 7.68)	1,184	132.2 ± 18.3, 131.1 ± 19.0	1.05 (-0.20 to 2.30)	0.0994 <0.0001
Diastolic blood pressure, mm Hg	1,967	76.4 ± 14.3, 73.8 ± 11.9	2.69 (1.99 to 3.39)	1,184	73.9 ± 10.9, 72.7 ± 10.7	1.23 (0.51 to 1.94)	0.0008 0.0071
LDL cholesterol, mg/dL	613	102.2 ± 35.1, 98.5 ± 34.8	3.72 (0.88 to 6.57)	566	103.1 ± 32.2, 99.0 ± 34.8	4.15 (1.66 to 6.64)	0.0011 0.8271
Total cholesterol, mg/dL	611	181.4 ± 42.6, 176.3 ± 43.0	5.08 (1.67 to 8.49)	566	182.8 ± 38.3, 177.4 ± 42.4	5.34 (2.43 to 8.25)	0.0003 0.9085

^aCI = confidence interval, HbA_{1c} = glycosylated hemoglobin, LDL = low-density lipoprotein.

Table 3. Change in Clinical Outcome Values in Patients With Baseline Values Above Goal Within Collaborative Care and Usual Care Groups^a

Variable	Collaborative Care Group			Usual Care Group			p		
	n	Mean ± S.D. (First Value, Last Value)	Mean Change (95% CI)	n	Mean ± S.D. (First Value, Last Value)	Mean Change (95% CI)			
HbA _{1c} %	462	10.3 ± 2.0, 9.1 ± 2.2	1.22 (1.01–1.44)	<0.0001	148	9.4 ± 1.4, 8.5 ± 1.7	0.88 (0.59–1.17)	<0.0001	0.1026
Systolic blood pressure, mm Hg	825	166.2 ± 23.1, 139.1 ± 23.7	27.05 (25.0–29.1)	<0.0001	272	156.7 ± 16.1, 137.9 ± 20.6	18.83 (16.2–21.4)	<0.0001	<0.0001
Diastolic blood pressure, mm Hg	273	101.3 ± 10.1, 78.8 ± 13.4	22.48 (20.5–24.4)	<0.0001	65	97.8 ± 5.8, 79.0 ± 11.7	18.80 (15.7–21.9)	<0.0001	0.0908
LDL cholesterol, mg/dL	284	132.8 ± 26.1, 113.8 ± 36.8	19.00 (14.3–23.7)	<0.0001	284	128.6 ± 24.3, 114.7 ± 37.0	13.91 (9.9–17.9)	<0.0001	0.1038
Total cholesterol, mg/dL	189	232.7 ± 26.2, 201.6 ± 43.0	31.14 (24.4–37.8)	<0.0001	169	229.6 ± 25.0, 207.8 ± 43.9	21.80 (15.7–27.9)	<0.0001	0.0451

^aCI = confidence interval. HbA_{1c} = glycosylated hemoglobin, LDL = low-density lipoprotein.

ated patients with uncontrolled blood pressure at baseline. Furthermore, the blood pressure outcomes achieved in the collaborative care group, of whom 56.8% had diabetes and 32.7% stage 3 chronic kidney disease (i.e., estimated glomerular filtration rates of <60 mL/min), are equivalent to or surpass the results in many trials that excluded patients with abnormal renal function or diabetes.³⁰

The improvement in HbA_{1c} levels in patients with uncontrolled diabetes mellitus from pharmacist-led studies is highly variable, ranging from 0.41% to 2.1%.^{9-11,18-22} The goal for those younger than 65 years is generally less than 7%; however, this goal may not be appropriate for patients with multiple comorbidities, such as the patients in this project. Furthermore, the avoidance of medications to achieve HbA_{1c} levels below 7.5% in most adults age 65 years or older has been recommended in favor of moderate control.³¹ These considerations likely contributed to the lower-than-anticipated but significant change in HbA_{1c} in the collaborative care patients, since all of them had at least 1 chronic disease in addition to diabetes and 56.8% were older than 65 years.

The analysis of those collaborative care and usual care patients who had baseline clinical measures above goal indicated significant reductions in all clinical measures in both groups (Table 3). The reductions in the collaborative care group exceeded those in the usual care group by 0.34% for HbA_{1c}, 8.3 mm Hg for SBP, 3.7 mm Hg for DBP, 5.1 mg/dL for LDL cholesterol, and 9.3 mg/dL for TC. These improvements are consistent with or exceed previously reported values.^{8-14,17-24}

Although ED use increased in the collaborative care group and declined in the usual care group, this finding was not significant. An increase in ED visits (30.3 more per 1,000 beneficiaries) was also noted in the demonstration sites of the Federally Qualified Health Center Advanced Primary Care Practice Demonstration, and these results may reflect the encouragement

of patients by staff to self-manage their care.⁵ All-cause hospitalizations were reduced significantly in the collaborative care group relative to the usual care group. A similar reduction in medication adverse event-related hospitalizations was noted by Pellegrin et al.³² among Medicare patients who received clinical pharmacy services focused on reducing admissions at any time after the index hospitalization. Whether the reduction in hospitalizations noted in our population was predominantly attributable to the prevention of medication-associated adverse events is unknown.

The cost savings associated with the reduction of healthcare use—\$2,378 per patient—that may be attributed to the clinical pharmacists' interventions was more than twofold and fivefold higher than the previous reports by Surbhi et al.³³ and Smith and colleagues,³⁴ respectively, and similar to the \$2,507 per patient calculated by Pellegrin et al.³² based on the estimated cost of a hospital admission by the 2014 Health Care Utilization Project. The healthcare cost savings typically accrues to Medicare, Medicaid, and commercial insurers rather than health systems. However, health systems that are part of accountable care organizations may benefit as the result of shared cost-savings plans. Thus, there are many vested parties that can facilitate the adoption of this care model among primary care practices and hospitals.

Two recent systematic reviews have evaluated the impact of outpatient MTM and pharmacist-led CDSM on clinical goal attainment and health services utilization.^{23,24} Viswanathan and colleagues²³ reported that there was insufficient evidence to prove that MTM improved blood pressure or diabetes control. Furthermore, they did not note a positive association between MTM provision and decreased outpatient visits or hospitalizations. Greer et al.²⁴ noted that pharmacist-led CDSM did improve diabetes, blood pressure, and lipid goal attainment. However, the improvements

were similar to what was observed in patients who received usual care. The rates of office visits, ED visits, and hospitalizations were similar, and “only a few” studies found significant differences between pharmacist-led CDSM patients and the usual care group. This was partly due to the small sample sizes of most studies and the short durations of the interventions and patient follow-up times. The significant improvement in clinical measures and the decline in hospitalizations in this large collaborative care patient population suggest that there is marked value in having PCMH-embedded clinical pharmacists providing CMM integrated with their counterparts within the hospital setting.

This project was different from many other investigations^{22-24,33,35} in that the clinical pharmacists were embedded in the PCMH practices and their focus was to improve the clinical and economic outcomes of the 7 targeted diseases as well as address the medication appropriateness of all prescribed therapies. The hospital-based care transition program described by Kirkham et al.³⁵ resulted in a twofold reduction in the odds of patient readmission within 30 days, but any subsequent health services utilization was not evaluated. The intervention they employed was very brief—1 hospital encounter (bedside medication delivery) and 1 follow-up phone call—unlike ours, which followed patients for up to 1 year after their first encounter. Furthermore, Kirkham et al.³⁵ did not quantify the economic impact of the change in readmission rate and the cost of the intervention and thus could not ascertain if the program yielded a positive return on investment. Surbhi et al.³³ evaluated the influence of a brief (45-day) care transition plan to identify and resolve medication-related problems in “super-utilizers” of health services. They also estimated the impact of the intervention on physician office and ED visits and hospitalizations. The estimated cost savings of \$991 per patient is approximately 38% of what we found based on the

EHR-documented significant reduction in hospitalizations. Although our project did not evaluate patients who had a history of “super” utilization of health services, the savings was more dramatic.

Pharmacist interactions as members of primary care teams are associated with improvement in many clinical outcomes,⁹⁻¹² but the impact on health services utilization is less clear. The recent report of Brunisholz and colleagues¹¹ is similar to our work in that they integrated clinical pharmacists into established PCMHs and evaluated blood pressure and diabetes goal achievement in intervention patients relative to a propensity-matched reference group. The desired clinical outcomes were indeed more frequently achieved in the intervention patients. Their assessment of health services utilization, however, revealed a significant increase in ED visits in the intervention group and no difference in hospital admissions between the 2 groups. The enhanced value of our care model lies in the fact that the collaborative care patients not only experienced improved clinical outcomes but also that the health insurer, in this case predominantly Medicare, benefited from the reduced costs of care.

The IHARP program was offered to patients who met the inclusion criteria as a voluntary, quality enhancement, health services benefit. Those who opted into the program may have been less healthy than the usual care patients, since they were offered the opportunity to participate while hospitalized or after referral from their primary care provider or care coordinator. Randomization was not possible, as is common with practice-based research projects, and the result is a retrospective data analysis design. Baseline laboratory values were not available for all those diagnosed with the respective conditions because they were not measured within the designated time frame.

The ED and hospitalization utilization data for both the collabora-

tive care and usual care groups were extracted from the health system's records. Since we cannot be sure that the patients did not receive care at another health system, this may have underestimated healthcare utilization. The costs of individual ED and hospitalizations were estimated from previously published data and utilized to calculate the total costs for each patient group because the health system was not able to disclose the charges that were billed or the revenue received from insurers.

During the course of this project, several new guidelines were published that altered the desired goals for the management of hypertension and hyperlipidemia.^{36,37} Treatment escalation to achieve specific LDL cholesterol targets for patients with and without chronic kidney disease was not recommended in the 2013 guidelines. This change in LDL cholesterol monitoring to guide therapy likely contributed to the low frequency with which LDL cholesterol and associated lipid measures were monitored. Finally, the blood pressure goals for diabetics and those with chronic kidney disease were increased from 130/80 mm Hg to 140/90 mm Hg during the course of this project. In addition, the target SBP for individuals over age 60 years without diabetes or chronic kidney disease was increased to less than 150 mm Hg.³¹ These changes likely confounded the effect of our intervention, because the changes in blood pressure goals may have reduced clinicians' management assertiveness.

Conclusion

Inclusion of clinical pharmacists in this physician–pharmacist collaborative care–based PCMH model was associated with significant improvements in patients' medication-related clinical health outcomes and a reduction in hospitalizations.

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Previous affiliations

During the time this study was conducted, Dr. Moczygemba was affiliated with Virginia Commonwealth University School of Pharmacy.

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