Original Work

Identifying Drug Therapy Opportunities and Medication Discrepancies in Patients with Chronic Conditions via a Pilot Comprehensive Medication Management Program (CMM) in a Rural Integrated Healthcare System

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Abstract

Objectives: Comprehensive medication management (CMM) program goals include: 1) identification of the frequency, type, and severity of any drug therapy opportunities (DTOs) present; 2) identification of medication reconciliation discrepancies (MRDs); 3) reduction of future healthcare-associated costs for patients, health system, and third-party payers; and 4) ensuring optimal therapy per current clinical guidelines.

Methods: To improve patient care, we developed, implemented, and evaluated a pilot CMM program at a rural healthcare system among employees and their spouses with ≥ one chronic condition and high (≥$10,000) medical expenses. Templates were pre-populated with patient information and medication lists prior to an initial Phase I pharmacist-mediated medication therapy management (MTM) review. Provider acceptance of pharmacist recommendations was measured at the conclusion of Phase I. A follow up Phase II of the CMM review assessed the impact of pharmacist-mediated MTM review in Phase I. Program evaluation included: determining the impact of CMM program interventions on blood pressure and hemoglobin A1c (HbA1c), 2) achieving optimal therapy for patients' chronic high risk conditions, 3) optimizing medication possession ratio (MPR), and 4) determining the economic impact of the program.

Results: There were 83 Phase 1 appointments and 58 Phase II appointments conducted. A total of 192 DTOs and 195 MRDs were identified in Phase I with 73% of DTOs being accepted by providers. In Phase II, only 27 MRDs were identified. Significant potential cost savings were associated with pharmacist identified DTOs.

Conclusions: Pharmacist-mediated MTM increased identification of DTOs, enhanced accuracy of electronic medication lists, decreased healthcare costs, impacted MPR, and increased the number of patients at goal and/or receiving optimal therapy for chronic high risk conditions.

Healthcare organizations today must simultaneously ensure optimal health outcomes and reduce patient costs. Medication therapy management (MTM) programs prevent or resolve medication-related problems by identifying adverse drug-drug and/or drug-disease interactions, ensuring patients receive appropriate medications during care transitions, and providing patient education.[1-4] Medication-related problems as well as adverse drug events are significant contributors to overall healthcare costs and morbidity/mortality within a patient population.[5] Pharmacists are uniquely positioned as one of the most accessible healthcare professionals for patients to discuss their healthcare needs with and are capable of providing cost-effective medication management services.

A 2016 systematic review by Garcia et al. sought to evaluate the impact of pharmacists' interventions on clinical asthma outcomes within a population of adult patients.[6] Authors analyzed 11 clinical outcomes in 21 studies, which used pharmacist-driven medication management and patient education as the primary interventions. Pharmacist intervention led to improvement in the percentage of patients considered to have good asthma control. One study found that patients in the intervention group were nearly three times as likely to have their asthma controlled when compared to patients in the group who did not receive pharmacist intervention as assessed by Asthma Control

TABLE 1. Comprehensive Medication Management (CMM) Program Goals and Study Objectives

CMM Program Goals	*Study Primary Objectives*	*Study Secondary Objectives*
• Increase pharmacist identification of the frequency, type, and severity of any DTOs present upon initial patient contact. • Increase pharmacist identification of MRDs • Reduce future healthcare-associated costs for the patient, health system, and third-party payers • Ensure optimal therapy per current clinical guidelines	Determine therapeutic impact that pharmacist CMM program MTM interventions made (pre/post) with regards to: • BP at goal per JNC-8 • Optimal anti-hyperglycemic therapy • Optimal heart failure therapy per 2013 ACCF/AHA guidelines • Optimal asthma therapy per 2007 NHLBI guidelines • Optimal COPD therapy per 2017 GOLD guidelines • Assess the economic impact of pharmacist CMM program DTO recommendations	Assess impact that pharmacist CMM program MTM interventions made (pre/post) with regards to: • Correct anti-hypertensive medication class per JNC-8 • Meets criteria for 2013 AHA statin benefit group and on statin • Short-acting beta-agonist (SABA) use • Eligible for bisphosphonate and on bisphosphonate • Patient taking a DMARD for RA • MPR

Abbreviations: ACCF: American College of Cardiology Foundation, AHA: American Heart Association, BP: blood pressure, CMM: comprehensive medication management, COPD: Chronic obstructive pulmonary disease, DMARD: disease-modifying anti-rheumatic drug, DTOs: drug therapy opportunities, GOLD: Global Initiative for Chronic Obstructive Lung Disease, JNC-8: Eighth Joint National Committee, MPR: medication possession ratio, MRDs: medication reconciliation discrepancies, MTM: medication therapy management, NHLBI: National Heart, Lung, and Blood Institute, RA: Rheumatoid arthritis

Questionnaire (ACQ) score (OR 3.06, 95% CI 1.63–5.73; p<0.001). Improved medication adherence and inhaler technique was also observed.

To expand upon existing knowledge related to the feasibility of comprehensive medication management (CMM) interventions conducted across a large, predominantly rural, multi-center integrated health system, a pilot pharmacist-driven program was developed, implemented, and evaluated for patients with chronic medical conditions and high annual healthcare spending.

Methods

Ethical Considerations

The Marshfield Clinic Institutional Review Board approved the development and execution of this pilot program.

Study Design

A retrospective cohort observational design was used to analyze data collected during Phases I and II of the pilot CMM program.

Primary and Secondary Objectives

The overarching goal of this program was to improve patient adherence to medication regimens for chronic conditions through increased interaction with pharmacists. The primary and secondary objectives of this project are outlined in Table 1.

Description of the Healthcare System

The CMM program was implemented at three Marshfield Clinic Health System (MCHS) outpatient pharmacies in Wisconsin. MCHS is a healthcare system of over 10,000 healthcare providers and staff that serves 350,000 unique patients annually across 60 locations in northern, western, and central Wisconsin. In 2011, all 34 primary care sites within MCHS achieved Level 3 patient-centered medical home (PCMH) status recognition from the National Committee on Quality Assurance. MCHS utilizes an in-house developed electronic prescribing platform, Clinical Medications Manager™, that is used to perform computerized medication order entry and documentation of prescription medications, over-the-counter (OTC) medications, and herbal/dietary supplements. Pharmacy services are provided in all settings of care, including but not limited to outpatient, inpatient (hospital), sterile products, and specialty.

CMM Program Design

Five MCHS outpatient pharmacists who had previously completed an in system MTM curriculum volunteered to perform MTM services for patients recruited in the CMM program. The MTM curriculum sought to enhance pharmacist skills in evaluating complicated drug regimens and identifying opportunities to improve drug therapy through completion of self-study modules, case studies, and hands on training. The CMM program service included reviewing patient medication lists, identifying areas of medication discrepancy, assessing for potential drug therapy opportunities (DTOs), providing recommendations to prescribers on DTOs, and providing patient education for medication administration and disease management. In this study, we define "drug therapy opportunities" (DTOs) as areas where a patient's drug regimen could be modified to better align with the patient and provider's therapeutic goals. This is similar in concept to the "drug therapy problem" described by Cipolle et al.[7] where "drug therapy problem" is a discrepancy in a patient's drug regimen with the potential for interfering with the patient's therapeutic goals.

Target Population

Clinic employees and/or their spouses insured through the MCHS-affiliated Security Health Plan (SHP) insurance plan who were diagnosed with at least one chronic medical condition and spent at least $10,000/year on medical expenses were eligible for participation per SHP directive. Diagnosis of a chronic medical condition was determined by cross-referencing the electronic health records (EHR) of patients with International Classification of Diseases (ICD) codes 9 and 10 for asthma, atherosclerosis, chronic obstructive pulmonary disease (COPD), congestive heart failure

TABLE 2. Categories of Drug Therapy Opportunities

Effectiveness	*Safety*	*Patient Variables*	*Miscellaneous*
• Dose not at target • Dose too low • Drug not effective for • condition • Duration – too short • Frequency – too low • More effective drugs available • Needs additional drug therapy • Needs additional vaccine	• Adverse drug reaction • Allergic reaction • Contraindication • Dose too high • Drug-disease interaction • Drug-drug interaction • Duplicate therapy • Duration – too long • Frequency – too high • Needs additional lab work • No medical indication • Renal dosing adjustment	• Non-adherence (adherence support) • Incorrect dosage form • Incorrect route of administration	• Generic/alternative available • Less expensive alternatives • Medication coordination • Patient education • Provider education

(CHF), osteoporosis, and rheumatoid arthritis (RA). Patients who were less than 18 years of age and/or had limited English proficiency were excluded from participation.

Recruitment

Representatives from SHP provided pharmacists with a list of 593 potential patients meeting inclusion criteria to contact. Pharmacists contacted patients via telephone or email to determine whether or not they would like to enroll in the CMM program. A second email was sent citing potential cost savings associated with MTM review to patients who were non-responders or who declined enrollment upon first contact as a way to increase enrollment.

Implementation Phase I: Pharmacists set up a time to perform an initial patient interview to identify any areas of discrepancy between information in the medical record and patient reports. To facilitate information collection from patients and the EHR, a CMM template was developed which listed all data points to collect from the patient and the patient's EHR. Prior to the interview, pharmacy technicians pre-populated the CMM template with pertinent vitals, labs, vaccinations, drug allergies, and active medications from the EHR. Interviews were conducted telephonically but, per patient request, could be conducted face-to-face. During the interview, the pharmacist compared medication information from the EHR with the patient to identify and address any discrepancies between the EHR and the patient's self-reported medication regimen. This included reviewing medication name, dose, route, and frequency. Next, the pharmacist completed an MTM review. Drug therapy opportunities (i.e., areas for medication management/optimization) were identified based on the reconciled medication list, laboratory data, and EHR review. The pharmacist documented any DTOs or MRDs in the CMM template. The DTOs were categorized and given a severity rating as well as a recommended action for the provider; MRDs were also reported based on the following categories: unrecorded medications that the patient is taking, recorded medications that are not taken by the patient, and dose/frequency of medications.

The pharmacists also documented whether or not the patient was at goal and receiving optimal therapy per current clinical guidelines for their chronic condition. Drug therapy opportunities and MRDs were then electronically communicated to the medical support staff to be presented to the primary care provider for review prior to the next scheduled patient visit. All CMM program pharmacists met via teleconference monthly to solicit feedback and ideas for streamlining processes. At the completion of Phase I, a pharmacy resident reviewed the EHR to assess provider acceptance of DTO recommendations and MRD updates. Any changes or updates as well as the type and number of changes made to patient medications by providers were recorded and tabulated by the pharmacy resident.

Implementation Phase II: Pharmacists contacted patients previously enrolled in Phase I via telephone or email to arrange for a follow-up appointment. Prior to follow-up, pharmacy technicians pre-populated the CMM template with updated pertinent vitals, labs, vaccinations, drug allergies, and active medication list from the EHR. Again, these interactions were conducted telephonically but, per patient request, could be conducted face-to-face. During follow-up, the pharmacist completed medication reconciliation with the patient and utilized MTM techniques to assess whether or not the patient was at goal and receiving optimal therapy per current clinical guidelines for their chronic condition as a result of Phase I recommendations. The pharmacists then documented their findings in the CMM template.

Data Collection & Analysis

The number and type of DTOs and MRDs as well as progression of clinical parameters throughout Phase I and Phase II of the CMM program were recorded by

FIGURE 1. Medication Possession Ratio (MPR) Calculation.

$$MPR = \frac{\text{Total Days Supply in Period}}{\text{Last Fill Date - First Fill Date + Last Fill Days Supply}}$$

a pharmacy resident. MRDs were classified as unrecorded medications, recorded medications that were not taken, or taken at the inappropriate dose/frequency. Drug therapy opportunities were categorized into four overall categories: effectiveness, safety, patient variables, and miscellaneous and were further classified by type (Table 2).

Severity ratings were also assigned to DTOs and MRDs (Table 3). Severity level 1 DTO/MRD is deemed "contraindicated" based on information determined to be life-threatening. Severity level 2 was assigned to a DTO/MRD associated with potential or existing major organ dysfunction. Severity level 3 was assigned to a DTO/MRD if the recommendation would bring care to a more acceptable and appropriate level. Finally, severity level 4 was given to DTOs/MRDs where the benefit of the recommendation to the patient could be neutral depending on clinical interpretation(s). Medication possession ratios (MPRs) were also calculated for patients enrolled in the program and patients who declined to participate in the program populations over two different time frames to assess the impact of MTM review on adherence. Medication possession ratio was calculated using the equation in Figure 1.

Data recorded on the CMM templates were entered into a Microsoft® Access 2010 database. Descriptive statistics of patient characteristics were generated to define the study population. The data from Phase I was compared to Phase II of the CMM program to assess the impact of pharmacist intervention on patient medication adherence. The following data were collected and analyzed:

- Percent change in patients at blood pressure (BP) goal per the Eighth Joint National Committee (JNC-8) guidelines
- Percent change in patients who are on optimal anti-hyperglycemic agents based on pharmacist and provider discretion
- Percent change in patients who are on optimal agents for heart failure per 2013 American College of Cardiology Foundation (ACCF)/American Heart Association (AHA) guidelines
- Percent change in patients who are on optimal agents for asthma per 2007 National Heart, Lung, and Blood Institute (NHLBI) guidelines
- Percent change in patients who are on optimal agents for COPD per 2017 Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines
- Percent change in patients who are on the correct anti-hypertensive medication class per the JNC-8 guidelines as well as pharmacist and provider discretion
- Percent change in patients at or below individualized goal HbA1c
- Percent change in patients who meet

TABLE 3. Definition of Terms and Classification of Severity for Medication Reconciliation Discrepancies

Severity Ratings and Examples	*Definition*	*Examples*
Level 1 **Contraindicated** (Extremely Significant)	Information qualified by life and death situation	• Omission of medication that is contraindicated • Level 1 drug-drug interaction • Medication allergy
Level 2 **Severe** (Very Significant)	Recommendation qualified by a potential or existing major organ dysfunction	• Omission of frequency or dose for chronic disease states • Maximum dosage of acetaminophen exceeded
Level 3 **Moderate** (Significant)	Recommendation would bring care to a more acceptable and appropriate level (standard of practice)	• Omission of frequency or dose for disease states not listed in level 2 • Indication for vaccine
Level 4 **Minor** (Somewhat Significant)	Benefit of the recommendation to the patient could be neutral depending on the clinical interpretation	• Medication completed, but remains on list • No medical indication for OTC/Herbal

OTC = over the counter

TABLE 4. Baseline Patient Characteristics

Patient Demographics	*Characteristic*	*Enrolled in Phase I (n=83)*	*Enrolled in Phase II (n=58)*
Age (years)	Mean age	54	55
	Age range	25-74	25-74
	≥60	40 (48.2%)	28 (48.3%)
	<60	43 (51.8%)	30 (51.7%)
Gender	Male	34 (41.0%)	25 (43.1%)
	Female	49 (59.0%)	33 (56.9%)
Medications (%, mean)	Medication Range	4-28	4-28
	All Medications (Rx+OTC+Dietary/Herbal)	1,191 (14)	863 (15)
	Rx	826 (69.4%, 10.0)	572 (66.3%, 9.9)
	OTC+Dietary/Herbal	365 (30.6%, 4.4)	291 (33.7%, 5.0)

Rx = prescription; OTC = over the counter

TABLE 5. Classification, Tabulation, and Provider Acceptance of DTOs in Phase I

DTO Type	Total DTOs Identified (% (N))	Total Accepted DTOs	Percent Accepted (%)
Need for additional drug therapy	21.4% (41)	19	46.34
Less expensive alternatives exist	15.1% (29)	26	89.66
Non-adherence	14.6% (28)	23	82.14
Needs additional vaccine	7.3% (14)	14	100.00
Drug not effective for condition	3.6% (7)	5	71.43
Dose too high	3.6% (7)	4	57.14
Generic/alternative product available	3.1% (6)	5	83.33
Inappropriate frequency	3.1% (6)	4	66.67
More effective drug available	3.1% (6)	4	66.67
Dose too low	3.1 % (6)	2	33.33
Inappropriate dosage form	2.6% (5)	5	100.00
Duplicate therapy	2.6% (5)	3	60.00
Need for medication coordination	2.1% (4)	3	75.00
Need for patient education	2.1% (4)	3	75.00
Inappropriate duration	2.1% (4)	2	50.00
Medication reconciliation error	1.6% (3)	3	100.00
No medical indication	1.6% (3)	3	100.00
Dose not at target	1.6% (3)	2	66.67
Needs additional lab work	1.0% (2)	2	100.00
Safer alternatives exist	1.0% (2)	2	100.00
Need lab/Appointment coordination	1.0% (2)	1	50.00
Contraindication	0.05% (1)	1	100.00
Drug interaction	0.05% (1)	1	100.00
Other - cost savings opportunity	0.05% (1)	1	100.00
Other - inappropriate dosage form	1.0% (2)	2	100.00
Cumulative	**192**	**140**	**72.90**

DTO = drug therapy opportunities

criteria for 2013 AHA statin benefit group and are on a statin
- Percent of patients using short-acting beta-agonist (SABA) two days per week or less
- Percent change in patients with RA that are on a disease-modifying anti-rheumatoid drug (DMARD)
- Percent change in cumulative MPR
- Percent change in patients who are eligible for a bisphosphonate and are prescribed one
- Reduction in number of MRDs

Two additional parameters were calculated to assess the economic impact of pharmacist CMM program DTO recommendations. Cost effectiveness figures were calculated based off direct cost savings of the interventions, average patient copay, and SHP cost savings per month per patient. Indirect cost savings for SHP achieved through reduction of future healthcare-associated costs for the patient, health system, and third-party payers (reduced hospitalizations, etc.) was estimated at the conclusion of Phase I. Estimated longitudinal cost avoidance for SHP was calculated by assigning OutcomesMTM®[8] severity levels (1-7) to all accepted DTOs.

Results

Participants and Participant Characteristics

A total of 83 healthcare system employees and their spouses were enrolled in Phase I of the CMM program between August 2017 and February 2018. A total of 58 patients were enrolled in Phase II of the CMM program between November 2017 and April 2018. The pharmacists were unable to contact 25 patients after completing Phase I. In the enrolled population, the mean age was 54 years, 52% were less than age 60, and there was a mean of 14 medications per patient (Table 4).

Drug Therapy Opportunities

During Phase I of the CMM program, pharmacists identified a total of 192 DTOs (Table 5). Twenty-five different types of DTOs were identified with "need for additional drug therapy" being the most frequently documented (21.4%). The

TABLE 6. Phase I DTOs by Severity Level

Severity Level	Total DTOs
Level 1 **Contraindicated** (Extremely Significant)	1.0% (2)
Level 2 **Severe** (Very Significant)	38.5% (74)
Level 3 **Moderate** (Significant)	34.9% (67)
Level 4 **Minor** (Somewhat Significant)	25.6% (49)

DTO = drug therapy opportunities

DTOs were further categorized by severity level (Table 6) with Level 2 (severe) DTOs being most commonly identified. Of 192 DTOs identified, 140 (72.90%) were accepted by providers.

Medication Reconciliation Discrepancies

During Phase I of the CMM program, pharmacists identified 195 total MRDs between the 83 patients' reported medication regimen and the EHR (average of 2.3 MRDs per patient). These MRDs were further delineated by both category and severity level (Table 7). During Phase II of the CMM program, pharmacists identified 27 total MRDs between the 58 patients' reported medication regimen and the EHR (average of 0.47 MRDs per patient). These MRDs were further delineated by both category and severity level (Table 7). An example of a frequency discrepancy was scheduled dosing versus "as needed" dosing for a medication.

TABLE 7. Phase I and II MRDs by Category and Severity Level

Phase I MRDs	
Category	**Total MRDs (% (N))**
Unrecorded medications that the patient is taking	29.7% (58)
Recorded medications that are not taken by the patient	38.5% (75)
Dose/frequency	31.8% (62)
Severity Level	**Total MRDs (% (N))**
Level 2 **Severe** (Very Significant)	13.8% (27)
Level 3 **Moderate** (Significant)	20% (39)
Level 4 **Minor** (Somewhat Significant)	66.2% (129)
Total Phase I	**195 (2.3/patient)**
Phase II MRDs	
Category	**Total MRDs (% (N))**
Unrecorded medications that the patient is taking	14.8% (4)
Recorded medications that are not taken by the patient	14.8% (4)
Dose/frequency	70.4% (19)
Severity Level	**Total MRDs (% (N))**
Level 3 **Moderate** (Significant)	3.7% (1)
Level 4 **Minor** (Somewhat Significant)	26 (96.3%)
Total Phase II	**27 (0.47/patient)**

MRD = medication reconciliation discrepancies

Patients at Goal for Management of Chronic Conditions

Phase I results represent baseline population data prior to MTM review. Phase II results reflect the effects of Phase I MTM review. During Phases I and II of the CMM program, pharmacists documented the number of patients with chronic conditions who were currently at goal and/or receiving optimal therapy (Tables 8).

A pre/post comparison was done at the conclusion of Phase II of the CMM program to assess the percentage change in the above parameters following completion of pharmacist MTM review. Increases in percentages of patients at goal and/or on optimal therapy were observed in patients with hypertension, diabetes, asthma, and RA. No changes were observed in the number of patients who were eligible and taking a statin or were on optimal medication regimens for heart failure and/or COPD:

- Percent change in patients at BP goal per JNC-8: (+8)
- Percent change in patients who are on the correct anti-hypertensive medication class per JNC-8: (+8)
- Percent change in patients at or below goal HbA1c: (+20)
- Percent change in patients who are on optimal anti-hyperglycemic agents: (+37)
- Percent change in patients who are on optimal agents for asthma per 2007 NHLBI guidelines: (+2)
- Percent change in patients using SABA two days per week or less:

TABLE 8. Management of Chronic Conditions in Phase I and II

Phase I Results (Baseline) (n=83)		
Chronic Condition	***At Goal (% (N))***	***Receiving Optimal Therapy (% (N))***
Hypertension (SBP) (n=61)	89% (54)	89% (54)
Diabetes (HbA1c) (n=36)	44% (16)	47% (17)
Hypercholesterolemia (LDL-C) (n=15)	--	67% (10)
Asthma (n=22)	--	91% (20)
COPD (n=2)	--	100% (2)
Congestive Heart Failure (n=3)	--	100% (3)
Osteoporosis (n=5)	--	40% (2)
Rheumatoid Arthritis (n=6)	--	83% (5)
Phase II Results (n=58)		
Chronic Condition	***At Goal (% (N))***	***Receiving Optimal Therapy (% (N))***
Hypertension (SBP) (n=43)	97% (42)	97% (42)
Diabetes (HbA1c) (n=25)	64% (16)	84% (21)
Hypercholesterolemia (LDL-C) (n=15)	--	67% (10)
Asthma (n=15)	--	93% (14)
COPD (n=1)	--	100% (1)
Congestive Heart Failure (n=1)	--	100% (1)
Osteoporosis (n=2)	--	50% (1)
Rheumatoid Arthritis (n=4)	--	100% (4)

(+12)

- Percent change in patients who are eligible for a bisphosphonate and are prescribed one: (+10)
- Percent change in patients with RA that are on a DMARD: (+17)
- Percent change in patients who are on optimal agents for heart failure per 2013 ACCF/AHA guidelines: (0)
- Percent change in patients who are on optimal agents for COPD per 2017 GOLD guidelines: (0)
- Percent change in patients who meet criteria for 2013 AHA statin benefit group and are on a statin: (0)

Changes in Patient Prescription Filling Practices and Changes in Patient Medication Possession Ratio

To assess patient compliance with prescription medications, MPRs were calculated and analyzed for Phase I and II at one year prior to enrollment and one year prior to the completion of the pilot program. Baseline adherence was analyzed by calculating the MPR for all medications in the year prior to program enrollment (08/01/16-07/31/17) for all patients enrolled in Phase I of the CMM; patient compliance after MTM review was assessed by calculating the MPR for all patients enrolled in Phase I of the CMM over the year prior to conclusion of Phase II (04/01/17-03/31/18). Baseline MPR for all medications was 83.51% for patients in Phase I and 81.93% in Phase II. After MTM review, the MPR slightly decreased to 83.17% for patients in Phase I and 81.75% in Phase II.

Cost Avoidance and Time Commitment

Accepted Phase I DTOs were assigned monetary values from Outcomes MTM©[8] based on the severity level of DTO performed in order to estimate the longitudinal cost avoidance for SHP of patients who would have been off-target for their therapeutic goals and/or not receiving optimal medications for their condition. A total of 201 interventions were identified for all 83 patients enrolled in Phase I. This resulted in a total estimated cost avoidance of $110,851 for SHP. To identify major contributors to overall cost avoidance for patients, DTOs were categorized by their contribution to SHP cost avoidance (Table 9). From the cumulative total of "less expensive alternatives exist," "generic/alternative product available," and "cost savings opportunity" interventions, a cost reduction of $20 per patient per month copay was calculated as well. In consideration of the healthcare costs associated with Phase I and II of the CMM program at the pharmacy level, pharmacist and technician time commitment estimates were also calculated (Table 10). Pharmacist time commitment averaged 89 minutes per patient in Phase I and decreased to 25 minutes in Phase II presumably due to a reduction in the number of DTO and MRDs requiring attention as well as pharmacist familiarity with the patient and his/her medical conditions. Technician time commitment was static (~15 minutes per patient). Total estimated cost of Phase I and II of the CMM program in its entirety to the healthcare system was $12,550 based on pharmacist and technician time alone.

Discussion

The goal of this pilot study was to begin to evaluate the impact of pharmacist-provided MTM services using a convenience sample of healthcare employees and their spouses in a rural ambulatory/outpatient setting. Analysis of patient EHR information indicate that

the majority of DTOs fell into the "need for additional drug therapy" category, and many of these medications were condition preventative in nature including angiotensin-converting enzyme inhibitor use in diabetes and statins for dyslipidemia. Another major contributor to DTOs was "less expensive alternatives exist." Drug therapy opportunities identified by the clinical pharmacists had an overall acceptance rate of approximately 73% by providers across the severity continuum. Of the most frequently identified DTOs, providers were most likely to accept "needs additional vaccine" recommendations (100%) for their patients specifically influenza and the new herpes zoster (Shingrix®) vaccines.

This study also evaluated the accuracy of the medication list within the EHR in place at MCHS. Medication list discrepancies are common and frequently occur during transitions across care settings.[9] The most common discrepancy in Phase I of the CMM program was "recorded medications that are not taken by the patient" while in Phase II, the most common discrepancy was "incorrect patient dose/frequency." In both Phase I and Phase II, MRDs were most often of level 4 severity. Old pain medications and antibiotic regimens comprised a large share of the total MRDs in Phase I.

Upon comparison of Phase I (baseline) and Phase II results (post-MTM review), there was a positive change in many of the parameters being assessed, particularly for patients with hypertension and diabetes. The percentage of patients at BP and HbA1c goal increased by 8% and 20%, respectively. The percentage of patients receiving optimal therapy for their chronic condition increased for all groups, with the exception of patients with heart failure, COPD, and atherosclerosis. Since pharmacologic management of heart failure and COPD is based on physician assessments which were not obtained during the time frame of this study, medication changes could not be made for these patients.

Several limitations of the study in the context of cost avoidance should be acknowledged. Notably, cost avoidance was modeled in this study for each DTO at a very rudimentary level and was

TABLE 9. Phase I DTOs by Contribution to SHP Cost Avoidance

DTOs	*Frequency*	*Estimated Cost Avoidance (% of total ($))*
Need for additional drug therapy	19	31.4% (34,809)
Less expensive alternatives exist	25	29.3% (32,425)
Contraindication	1	12.0% (13,305)
More effective drug available	4	9.8% (10,896)
Generic/alternative product available	5	5.9% (6,485)
Inappropriate duration	2	1.9% (2,131)
Drug not effective for condition	5	1.8% (1,953)
Adherence support	66	1.2% (1,320)
Cost savings opportunity	1	1.2% (1,297)
Needs additional vaccine	14	1.1% (1,176)
Inappropriate frequency	4	1.0% (1,055)
Duplicate therapy	3	0.9% (1,002)
Non-adherence	21	0.4% (484)
Inappropriate dosage/form	6	0.4% (473)
Dose too high	3	0.2% (285)
No medical indication	3	0.2% (285)
Need patient education	3	0.2% (252)
Need medication coordination	3	0.2% (221)
Safer alternatives exist	2	0.2% (168)
Needs additional lab work	2	0.2% (168)
Dose too low	2	0.2% (168)
Dose not at target	2	0.2% (168)
Medication reconciliation error	3	0.1% (157)
Need lab/appointment coordination	1	0.1% (84)
Drug interaction	1	0.1% (84)
Total	**201**	**110,851**

DTO = drug therapy opportunities

TABLE 10. Cumulative Pharmacist Time Commitment

	Per patient average in minutes	*Total time*
Phase I	Preparation = 35 Intervention = 26 Documentation = 17 Provider Communication = 11 Total = 89 minutes	Pharmacists 1.5 hours/patient = 124.5 hours Technicians 15 minutes/patient = 20.75 hours
Phase II	Preparation = 7 Intervention = 10 Documentation = 7 Provider Communication = 1 Total = 25 minutes	Pharmacists 0.5 hours/patient = 29 hours Technicians 15 minutes/patient = 14.50 hours

exclusive of other factors that impact patient financial status or quality of life that are consequential to the DTO. Additionally, OutcomesMTM®[8] sets dollar amounts for each DTO/intervention based on a severity level calculated in 2017 which may be an underestimation of expense, as healthcare costs generally increase over time. Based on this billing model, significant contributors to cost avoidance were "need for additional drug therapy" and "less expensive alternatives exist." This was an expected finding given that the patient population consisted of individuals with a predicted annual health care spending greater than $10,000 with much of this spending coming from drug cost as well as hospitalizations due to inadequate maintenance therapy of their chronic conditions. A total estimated cost avoidance for SHP of $110,851 coupled with an estimated cost of $12,550 for both Phase I and Phase II together yields a staggering 8 to 1 return on investment. Not only do these interventions yield cost avoidance for SHP, but they also save patients money, too, as on average, there was a $20 per patient per month copay cost reduction.

Though this program was successful in improving medication management in patients with chronic medical conditions, aspects of this study limit its generalizability to other healthcare systems, specifically the sampled population and selection of outcome measures. This pilot study was performed with employees and their spouses from one healthcare system with a predominantly White/Caucasian population of patients with private insurance (SHP). Employees and their spouses were selected for enrollment in the pilot study to enhance program participation; since these patients are presumably more knowledgeable about their condition(s) and associated medications, they may be healthier and require less medication reconciliation than the general population. These factors, however, would skew the results to no change in cost savings which is not seen in our evaluation. Another limitation was the fact that 25 subjects (30%) could not be enrolled for follow-up. Although the Phase I results appeared similar for the 25 subjects, our Phase II results may be biased to the extent that the experiences of this group differed systematically from those followed. Furthermore, the outcome measures selected do not assess the patient's perspective for medication compliance which would provide additional insight into the underlying factors associated with medication non-compliance. Future developments of this program include expanding the eligibility criteria to patients with public insurance and incorporating patient-centered outcome measures for evaluation.

Conclusions

Our findings present preliminary data supporting the implementation of MTM review by a pharmacist in an outpatient ambulatory setting. This is based on increases in identification of DTOs, enhanced accuracy of the EHR through identification of MRDs, increased number of patients at goal and/or receiving optimal therapy for their chronic condition, and decreased healthcare costs in a rural setting. Larger, multi-system studies with more diverse populations are needed to produce results that are generalizable to a wider patient demographic in the U.S. healthcare system.

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