ABSTRACT

BACKGROUND: Primary care clinical pharmacy specialists (PCCPSs) are positioned to promote effective, safe, and affordable medication use. Documentation of performed interventions is difficult because the diversity of performed interventions in a variety of disease states in some practice settings. Validation of cost-avoidance projections is also difficult because traditional projection methods have several limitations.

OBJECTIVE: To (1) compare projected medication cost avoidance (MCA) to actual MCA for medication conversions related to hyperlipidemia, hypertension, depression, and chronic pain initiated by PCCPSs, and (2) estimate medication discontinuation that might be attributable to serious adverse drug events (ADEs) possibly associated with medication conversions.

METHODS: This was a retrospective, longitudinal study conducted in a not-for-profit, integrated health system comprising approximately 470,000 members. Using a portable documentation tool, PCCPSs recorded projected annual MCA for medication conversions in 4 disease conditions (i.e., hypertension, dyslipidemia, depression, and chronic pain) in the 6-month period from December 1, 2003, through May 31, 2004. Actual annual MCA for these interventions for a 1-year follow-up period was calculated using integrated, electronic data from an administrative pharmacy database. Comparisons were made between projected MCA and actual MCA. Cost was defined as actual drug acquisition cost. In addition, an assessment of serious ADEs potentially related to the conversions was undertaken by reviewing electronic medical records of converted, nonpersistent patients.

RESULTS: There were 704 medication conversions for 656 patients, of which 47 (6.7%) were for members who disenrolled in the health plan during the 12 months following the medication conversion date. The total projected MCA was $327,337 in 2004 dollars, or an average of $465 per conversion. For the 657 evaluable medication conversions with complete cost information (n = 278), the projected MCA ($160,225) was not significantly different compared with the actual MCA ($166,546, P = 0.477). For medication conversions that reverted to previous therapy (n = 53), the projected MCA ($41,644) overestimated by 4-fold the actual MCA ($10,435, P < 0.001). There were no emergency department visits or hospital admissions related to nonpersistent medication conversions. Compared with patients who were either nonpersistent or disenrolled at the 12-month follow-up, persistent patients did not significantly differ in chronic disease score but were slightly older (mean = 62.6 years, standard deviation = 13.1) for persistent patients vs. 59.2 [SD = 15.5] for nonpersistent or disenrolled patients.

CONCLUSIONS: Projected medication cost avoidance for pharmacist-initiated medication conversions is valid for the 66% of medication conversions that persist but not for nonpersistent conversions or for patients who leave the health care system. The projected medication cost avoidance overestimated the actual cost avoidance by approximately 14%, suggesting that there is opportunity for improvement in the tool used to document medication conversions to more accurately measure cost outcomes from clinical pharmacy interventions.

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What is already known about this subject

- Customary methodologies for calculating cost avoidance for clinical pharmacist-initiated changes in chronic daily medications rely on specific assumptions, such as supposition that the patient persists on the new medication for a full year. Confirming the validity of these assumptions and measuring the error in them is essential.
- Most published research on drug therapy conversions describes within-class interchanges, such as one statin for another or one calcium channel blocker for another.
- Studies of within-class interchanges report 3- to 15-month persistence rates of 37% to 93%, associated with overestimations of cost avoidance ranging from 6.5% to 25.0%.

What this study adds

- Of medication conversions initiated by primary care clinical pharmacy specialists, 6.7% were for patients who disenrolled during the subsequent 12 months. Among patients who remained enrolled, 70.9% of conversions persisted at 12 months.
- The projected medication cost avoidance overestimated the actual medication cost avoidance by 14.1% or $75 per conversion in the first year.
- The projected medication cost avoidance was not different from the actual medication cost avoidance for the conversions that persisted at 12 months of follow-up, but the actual annual cost avoidance was overestimated by $589 (74.9%, $786 vs. $197) per conversion for the 8.1% of medication conversions that reverted to original therapy.
The pharmacist is an important member of the primary care team. Primary care clinical pharmacy specialists (PCCPSs) are in a unique position to promote effective, safe, and affordable use of medications for many indications. They have the necessary specialized training and skills to perform medication interventions, including medication conversions (i.e., changes from high-cost to lower-cost therapeutic alternatives). Some medication conversion efforts, such as changes between therapeutic classes used to treat a particular condition, are more complex than traditional therapeutic interchange programs. Historically, assessing the impact of such services has been difficult. The diversity of interventions performed in a primary care setting makes data capture and retrieval difficult. Most attempts to document the impact of medication conversions by clinical pharmacists in an ambulatory setting have limited their scope to a single pharmacologic class or indication (e.g., a calcium channel blocker switched to another calcium channel blocker for the treatment of hypertension or one statin switched to another statin for hyperlipidemia). The implementation of a portable, easy to use documentation tool (PharmDoc) has allowed for the capture and quantification of the diverse clinical activities performed by PCCPSs within our health care system. Briefly, PharmDoc can be accessed from a desktop computer or personal digital assistant (PDA) and is used to record PCCPSs’ clinical activities that are also documented in the electronic medical record. Patient demographics, indication, referral source, action (e.g., adjusted medication dosage, started medication, converted medication, stopped medication), and any cost avoidance anticipated as a result of a medication conversion or discontinuation are documented.

Although medication conversions are only one role for PCCPSs, accurate assessment of economic outcomes from medication conversions is a critical element in measuring the value of this pharmacy service. Cost avoidance for changes in chronic daily medications is traditionally projected for a period of 1 year by comparing the cost of a 365-day supply of the original medication with a 365-day supply of the new medication. However, cost avoidance calculated using this methodology depends upon the following assumptions: (1) the patient is a continuous member of the health plan for 1 year, (2) the patient persists on the new medication for 1 year, (3) the patient is 100% adherent to the prescribed medication, and (4) the patient does not utilize additional health care resources attributable to the medication conversion. Unfortunately, studies evaluating outcomes from medication conversions for more than 6 months are limited.

The objective of this study was to examine the validity of the traditional methodology for documenting medication cost avoidance (MCA) described above by comparing the projected MCA with the actual MCA for patients undergoing a medication conversion. In addition, medical records were reviewed to assess whether medication conversions potentially contributed to serious adverse drug events (ADEs) manifest as hospitalizations or emergency room (ER) visits.

### Methods

#### Setting and Study Design

This retrospective, longitudinal study was conducted at Kaiser Permanente Colorado (KPCO), a group model, not-for-profit health maintenance organization that provides health care services to more than 470,000 members at 16 primary care medical offices in the Denver-Boulder metropolitan area. The study was reviewed and approved by the KPCO Institutional Review Board.

Each KPCO clinic is staffed with 1 or more PCCPSs who are located within the primary care area(s) of the clinic. There are approximately 26 clinical full-time equivalents allocated to the KPCO Primary Care Clinical Pharmacy Services. All PCCPSs in KPCO have a doctor of pharmacy degree and are residency-trained. Ninety-seven percent of KPCO PCCPSs are board certified as pharmacotherapy specialists; those who are not certified are expected to achieve certification within 3 years of employment. PCCPSs collaborate with primary care physicians, nurse practitioners, and physician assistants on a daily basis to promote appropriate, safe, and cost-effective medication use and assist in resolving drug-related problems. Patients cared for by PCCPSs may be referred by primary care providers, nurses, or other pharmacists for a variety of drug-related problems that may result in medication conversion. They may also be identified through region-wide quality improvement or drug conversion programs. Any clinical activities that PCCPSs document in the electronic medical record are also documented in a Microsoft Access 2000 (Microsoft Corp., Redmond, WA) database called PharmDoc, which has been previously described in detail. All medication conversions, taking into account patient-specific information, are performed in collaboration with the prescriber who cosigns the medication order in the electronic medical record.

Patients for whom a PCCPS documented a medication conversion associated with a projected MCA from December 1, 2003, through May 31, 2004 (study period) in PharmDoc were assessed for inclusion. Patients for whom medication conversions occurred were referred by primary care providers, new member transition processes, KPCO quality or affordability initiatives, or patients directly. In any of these cases, no medication conversions were performed without prior consent and approval of the change by the primary care provider.

Medication conversions can be differentiated from traditional therapeutic interchanges because they can involve between-class conversions (Table 1). The medication conversions in the present study were made in the primary care clinics in collaboration with the primary care provider based on patient-specific factors (i.e., individual conversions). The indications for medication conversion were restricted to the 4 clinical conditions with the highest projected MCA: hypertension, dyslipidemia, depression,
and chronic pain. Gastroenterology was excluded because omeprazole became available over-the-counter during the study period, resulting in a drug benefit change. To allow for the accounting of all conversion dispositions, KPCO members who terminated their membership within 1 year after the conversion date (index date) were included in the projected MCA total but were excluded from the cost analyses.

Data Collection
Information on patient demographics (i.e., age at time of conversion, gender), indication (i.e., hypertension, dyslipidemia, depression, pain), and projected MCA were downloaded from the PharmDoc database for all patients who underwent a medication conversion during the study period. Health record numbers of included patients were used to query the KPCO integrated electronic prescription medication claims database to identify pharmacy dispensings (including the medication name, Medi-Span Generic Product Identifier, date of service, and acquisition cost) for the 6 months preceding and 12 months following each patient’s medication conversion index date (i.e., the date the PCCPS performed and documented the conversion). The membership database was queried to identify dates of KPCO membership initiation and termination.

Outcomes
The primary outcome was the validity of the cost avoidance documentation utilizing the PharmDoc tool. Measurement of this outcome was accomplished by: (1) determining and comparing overall projected MCA to actual MCA, (2) comparing projected MCAs and actual MCAs among conversions that persisted for 1 year with the new medication (newmed) versus those that reverted to the original medication (stoppedmed), and (3) comparing the projected MCAs to the actual MCAs among the 4 indications.

For the cost analyses, only those conversions with complete cost information were included. Because pharmacy data were collected administratively, information about the stoppedmed was irretrievable for patients (such as some new members) with no KPCO pharmacy purchase history, making actual MCA impossible to calculate. However, for some new patients, stoppedmed information was available, either administratively if they had a previous claim for the stoppedmed or using chart review when feasible. Patients who terminated membership within the follow-up year had an incomplete refill history for the newmed and were also excluded from the cost analyses. Projected MCA was still available for these individuals because this value was recorded manually by the PCCPS. The cost-avoidance analysis was performed primarily from the perspective of KPCO because cost was defined as actual drug cost before consideration of pharmacy dispensing cost or member copayment.

In addition, to estimate the serious adverse events that might be associated with medication conversions and that may be responsible for discontinuation of the medication, reviews of electronic medical records for nonpersistent patients were performed. ER visit and inpatient admission events occurring during the 6-month post-conversion follow-up period were identified, examined, and scored by 2 PCCPSs using the Naranjo Scale. The maximum score on this scale is 13 points, where a score of 1 to 4 is considered possibly drug-related, a score of 5 to 8 is probably drug-related, and a score ≥9 indicates a high probability that the event is drug-related. All events were reviewed independently, and any disagreements between adjudicators regarding event categorization were resolved by a third adjudicator.

Data Analysis
All conversions were assessed for persistence with the newmed at 1 year post conversion. Persistence was defined as having a supply on hand for the newmed at the 1-year anniversary of the index date. Conversions that did not persist at 1 year were categorized as either reverted to the stoppedmed or converted to alternative therapy, including non-drug therapy, within that indication. The rate of persistence for each indication was calculated by dividing the total count of persistent conversions at the 1-year anniversary by the total number of newmeds initiated during the study period. The rate of reversions for each indication was calculated by dividing the total count of reversions to stoppedmeds by the total number of newmeds initiated during the study period. The remaining patients were categorized as switches to alternative therapy or discontinued medications.

The projected MCA was annualized for chronic medications based on the KPCO acquisition cost as shown below:

Projected MCA = (daily cost for stoppedmed - daily cost for newmed) × 365

To assess the accuracy of the projected MCA, several calculations were performed. An actual MCA was calculated to determine the true costs avoided for each medication conversion performed. The actual MCA was calculated by (a) summing the 1-year KPCO acquisition cost of the newmed plus any
medication cost incurred if the patient reverted to the stoppedmed and (b) subtracting the annual KPCO acquisition cost of the stoppedmed based upon the actual days supply filled over the 1-year follow-up period, with a maximum of a 365-day supply. For patients who later reverted to the stoppedmed, the reversion date was defined as the first date the patient received the stoppedmed after the index date.

\[ \text{Actual MCA} = \left( \text{daily cost for stoppedmed} - \text{daily cost for newmed} \right) \times \text{actual days supply filled for both meds after the index date} \]

Membership data were assessed to determine if a patient was a new or established KPCO member at the time of the medication conversion. A new member was defined as a patient who initiated pharmacy or medical benefits at KPCO in the 120 days prior to
the medication conversion. A Chronic Disease Score (CDS) was calculated for each included patient. The CDS is a risk adjustment score that indicates health status at the time of medication conversion and was calculated using the 6 months of medication dispensings after the medication conversion. Chronic disease scores can range from 0 to 35, with increasing scores indicating an increasing burden of chronic diseases under treatment.

Statistical Analysis
Patient characteristics were reported by cohort as means and standard deviations or proportions. Projected versus actual MCA values were compared using paired sample $t$-tests. The alpha level was set at 0.05 for all tests, and SAS software, version 9.1 for Windows (SAS Institute, Cary, NC) was used to perform statistical analyses.

Results
Six hundred fifty-six patients with 704 medication conversions that resulted in cost avoidance and were used to treat hypertension, dyslipidemia, depression, or pain were identified over the 6-month study period (Figure 1). Total projected medication cost avoidance per conversion was $465 ($327,337/704). Forty-seven interventions (6.7%) were for patients who disenrolled from KPCO during the 12-month follow-up period. Of the remaining 657 conversions, 296 (45.1%) occurred in males and 361 (54.9%) in females; 300 (45.7%) occurred in patients new to KPCO, and 357 (54.3%) occurred in established patients (Table 2). The mean age of the subjects was 61.6 (standard deviation = 14.2) years, and the mean chronic disease score was 5.1 (SD = 3.1).

For those interventions where it was clear which medication was started and stopped, 45% of conversions occurred between drug classes. Examples include a change from a calcium channel blocker (CCB) to a diuretic for the treatment of hypertension or a change from gabapentin to a tricyclic antidepressant like amitriptyline or nortriptyline for chronic pain (Table 1). Medication conversions between drug classes occurred most frequently for antihypertensive medications (65%) and least frequently for medications to treat dyslipidemia (4%) where one statin was usually converted to another statin (data not shown).

Four hundred sixty-six medication conversions persisted at 1 year, representing 66.2% of all newmeds and 70.9% of newmeds initiated in patients who remained enrolled throughout 12 months of follow-up; 191 (27.1%) newmeds did not persist (Figure 1). Of the 466 persistent conversions, 278 (59.7%) had complete cost information available. Of the 191 nonpersistent conversions, 138 (72.3%) switched to a therapy that was not readily discernible from the pharmacy database or discontinued the medication completely, and 53 (27.7%) reverted to the original prescription medication with complete cost information available.

Of the 331 conversions with complete cost information available (331/704 or 47.0% of all conversions initiated), the total projected MCA was $201,869 ($160,225 + $41,644) or $610 (SD = $528) per conversion, and the total actual MCA was $176,981 ($166,546 + $10,435) or $535 (SD = $782) per conversion ($P<$0.001). Overall, the total projected MCA overestimated the total actual MCA by $24,888 (14.1%). For patients who persisted with their medication conversion(s) (n = 278), the mean projected MCA ($576, SD = $831) and the actual MCA ($599, SD = $510) per conversion did not differ ($P=0.477$). For patients who reverted to the original medication (n = 53), the projected MCA overestimated actual MCA by nearly 4-fold ($41,644 [$786 per conversion] vs. $10,435 [$197 per conversion], Figure 1).

When comparing the total projected MCA to actual MCA by indication, the projected MCA accurately predicted actual MCA for persistent patients undergoing hypertension and depression conversions but overestimated savings for lipid conversions and underestimated savings for medication conversions involving chronic pain therapy (Figure 2). For conversions that reverted to their original medication(s), the total projected MCAs were consistently greater than the actual MCAs across all 4 indications ($P<$0.05, Figure 2).

### Table 2: Characteristics of Patients With Persistent and Non-persistent Medication Conversions

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Conversions*</th>
<th>Persistent$^b$</th>
<th>Non-persistent or Disenrolled</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years [SD]</td>
<td>61.6 [14.2]</td>
<td>62.6 [13.1]</td>
<td>59.2 [15.5]</td>
<td>0.008</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>45.1%</td>
<td>45.9%</td>
<td>42.9%</td>
<td>0.569</td>
</tr>
<tr>
<td>Female</td>
<td>54.9%</td>
<td>54.1%</td>
<td>57.1%</td>
<td></td>
</tr>
<tr>
<td>Member status</td>
<td></td>
<td></td>
<td></td>
<td>0.595</td>
</tr>
<tr>
<td>New</td>
<td>45.7%</td>
<td>46.4%</td>
<td>44.0%</td>
<td></td>
</tr>
<tr>
<td>Established</td>
<td>54.3%</td>
<td>53.6%</td>
<td>56.0%</td>
<td></td>
</tr>
<tr>
<td>Chronic disease score [SD]</td>
<td>5.1 [3.1]</td>
<td>5.2 [3.1]</td>
<td>4.8 [3.3]</td>
<td>0.214</td>
</tr>
<tr>
<td>Indication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic pain</td>
<td>47 (6.7%)</td>
<td>24 (5.2%)</td>
<td>51.1%</td>
<td></td>
</tr>
<tr>
<td>% persistent$^c$</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Depression</td>
<td>114 (16.2%)</td>
<td>58 (12.4%)</td>
<td>50.9%</td>
<td></td>
</tr>
<tr>
<td>% persistent$^c$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>189 (26.8%)</td>
<td>126 (27.0%)</td>
<td>66.7%</td>
<td></td>
</tr>
<tr>
<td>% persistent$^c$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>354 (50.3%)</td>
<td>258 (55.4%)</td>
<td>72.9%</td>
<td></td>
</tr>
<tr>
<td>% persistent$^c$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*All conversions: n = 704 conversions for 656 patients.
$^b$Persistent was defined as remaining on the new medication at 1 year of follow-up.
$^c$% persistent calculated based on intent to treat (n = 704), including the conversions for patients disenrolled (n = 47, 6.7%).

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**Results**

Six hundred fifty-six patients with 704 medication conversions that resulted in cost avoidance and were used to treat hypertension, dyslipidemia, depression, or pain were identified over the 6-month study period (Figure 1). Total projected medication cost avoidance per conversion was $465 ($327,337/704). Forty-seven interventions (6.7%) were for patients who disenrolled from KPCO during the 12-month follow-up period. Of the remaining 657 conversions, 296 (45.1%) occurred in males and 361 (54.9%) in females; 300 (45.7%) occurred in patients new to KPCO, and 357 (54.3%) occurred in established patients (Table 2). The mean age of the subjects was 61.6 (standard deviation = 14.2) years, and the mean chronic disease score was 5.1 (SD = 3.1).

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Four hundred sixty-six medication conversions persisted at 1 year, representing 66.2% of all newmeds and 70.9% of newmeds initiated in patients who remained enrolled throughout 12 months of follow-up; 191 (27.1%) newmeds did not persist (Figure 1). Of the 466 persistent conversions, 278 (59.7%) had complete cost information available. Of the 191 nonpersistent conversions, 138 (72.3%) switched to a therapy that was not readily discernible from the pharmacy database or discontinued the medication completely, and 53 (27.7%) reverted to the original prescription medication with complete cost information available.

Of the 331 conversions with complete cost information available (331/704 or 47.0% of all conversions initiated), the total projected MCA was $201,869 ($160,225 + $41,644) or $610 (SD = $528) per conversion, and the total actual MCA was $176,981 ($166,546 + $10,435) or $535 (SD = $782) per conversion ($P<$0.001). Overall, the total projected MCA overestimated the total actual MCA by $24,888 (14.1%). For patients who persisted with their medication conversion(s) (n = 278), the mean projected MCA ($576, SD = $831) and the actual MCA ($599, SD = $510) per conversion did not differ ($P=0.477$). For patients who reverted to the original medication (n = 53), the projected MCA overestimated actual MCA by nearly 4-fold ($41,644 [$786 per conversion] vs. $10,435 [$197 per conversion], Figure 1).

When comparing the total projected MCA to actual MCA by indication, the projected MCA accurately predicted actual MCA for persistent patients undergoing hypertension and depression conversions but overestimated savings for lipid conversions and underestimated savings for medication conversions involving chronic pain therapy (Figure 2). For conversions that reverted to their original medication(s), the total projected MCAs were consistently greater than the actual MCAs across all 4 indications ($P<$0.05, Figure 2).
A possible concern with medication conversions is that such an intervention may occasionally result in ADEs requiring more than a simple switch back to the original medication, such as admission to the ER or hospital. For this study, there were 22 ER visits and 22 inpatient admissions within 6 months after the medication conversion for 36 (19%) of the 191 non-persistent conversions. None of these was determined to have had a significant probability of being related to the medication conversion on the 11-point Naranjo scale.

**Discussion**

This study examined the validity of a documentation system to project annual MCA for patients undergoing a medication conversion for 4 chronic diseases initiated by PCCPSs within the...
primary care setting of a managed care organization. We found that this documentation system overestimated actual MCA by approximately 14%. However, for patients who persisted with medication conversions, the projected MCA accurately approximated actual MCA. Conversely, we found that the tool overestimated the actual MCA by approximately 4-fold when patients reverted to their original medication. When comparing projected with actual MCA by indication, we found similar results in that persistent conversions were more likely than reverted conversions to have valid MCA projections. Overestimates of projected MCA and persistence with medication conversions have been previously reported to range from 6.5% to 25.0%; however, these overestimates were confined to a single pharmacologic class.9,11,15,19,20

Projected versus actual MCA varied by indication, and the reasons for these differences are unclear. The overestimate of savings with lipid therapy may be because adherence with lipid-lowering medication is notoriously low: only a little over half of the patients initiating statin therapy continue to fill at least 80% of the medicine prescribed at 6 months.21

To our knowledge, this is the first evaluation of general medication conversions initiated by a team of PCCPSs in an ambulatory setting. Stebbins et al. reported on pharmacist-directed services for low-income elderly in a managed care clinic.22 In contrast with our study, medication conversions across multiple medication classes accounted for only 8% of all interventions22 and were not described in detail because they were not the focus of the study. In another investigation, 6 clinical pharmacy specialists at a large university hospital recorded patient-specific recommendations for 30 days.23 Twenty-one percent of these interventions provided equivalent quality of care at less expense, 39% of which involved medication conversions to less expensive agents. Targeted medications in this inpatient setting were primarily from the anti-infective or gastrointestinal drug classes versus the focus in our study on 4 disease conditions (i.e., hypertension, dyslipidemia, depression, and chronic pain) in an ambulatory setting.

In our study, the majority of medication conversions persisted for at least 1 year. However, a sizeable proportion of conversions switched to other drug options or discontinued therapy, and a small proportion of conversions (7.5% of all conversions) reverted to the original medication. Persistence varied by indication, with approximately 73% of antihypertensive and 66% of dyslipidemic medication conversions persisting compared with approximately half for antidepressants and chronic pain medications. Long-term persistence rates for medication conversions for depression were not located in the published literature; however, reports on conversions involving medications used for chronic pain demonstrate similar persistence rates (41%-46%) to those reported in our analysis.11,24 The persistence rates for medication conversions for hypertension (73%), and dyslipidemia (66%) in the present study are marginally lower than in other published reports (80%, and 88% for a CCB-to-CCB and CCB-to-CCB+diuretic combination conversions, respectively, and 78% for a statin conversion program), but the follow-up period for these studies was 3 to 6 months instead of 12 months.13,14,25

Our somewhat lower persistence rates for these indications may have occurred because we (1) examined all conversions across pharmacologic classes, not just a single class; (2) converted outside of the pharmacologic class 45% of the time (e.g., conversion to a diuretic from a calcium channel blocker, conversion to a tricyclic antidepressant like amitriptyline from gabapentin, data not shown); and (3) converted formulary medications to formulary medications without a copayment incentive for patients.

The effect of pharmacist-initiated medication conversions on patient safety is of paramount importance. It was reassuring that our study did not identify associations between medication conversions and ER visits or inpatient admissions in nonpersistent patients, consistent with the results reported in 2 other published studies.7,10 In a third study, Clay et al.13 reported 1 ER visit out of 113 patients reviewed that was probably related to a therapeutic conversion from amlodipine to felodipine.

Given the rising cost of medications and the availability of multiple medications to treat the same disease, medication conversion programs will continue to be emphasized in an attempt to reduce medication costs while attaining similar or better therapeutic outcomes. Clinical pharmacy specialists will likely continue to lead such efforts.

We are in the process of enhancing the PharmDoc tool to incorporate what has been learned from this study. First, we are moving from the Microsoft Access 2000 database to an SQL server (Microsoft Corp., Redmond, WA), which will enable PharmDoc to interface with the KPCC pharmacy prescription (dispensing) database and allow PCCPSs to select the actual medications that were started or stopped and automatically calculate the projected MCA. We are exploring the possibility of programming PharmDoc to check for persistence of medication conversions, specifically including changes at 60 days because we found that the mean time to revert to an original medication was 56 days (median = 34 days) (the literature describing these data are limited13,15). In addition, we are considering adjusting the projected MCA by multiplying it by an appropriate factor,26 depending on estimated persistence for the indication recorded, to more accurately predict the actual MCA.

Limitations
Among the limitations of this study, we were unable to calculate the actual MCA for about half of the conversions. Most commonly, this was because the stopped medication could not be identified. The planned enhancements to the documentation tool for clinical interventions will enable us to capture these data in the future.

Second, we did not specifically assess the quality of care or patient satisfaction with conversions in this study. Previous studies of medication conversion programs within our organization have documented improved quality outcomes and high patient satisfaction with conversions in this study.
satisfaction with clinical pharmacy specialist interventions in statin conversions\textsuperscript{2} and triptan conversions for migraine syndrome.\textsuperscript{27} Additionally, patients receiving care from a clinical pharmacy specialist are encouraged to contact the clinical pharmacist with questions or problems and are provided with a contact telephone number. If an ADE resulting in a hospitalization or ER visit occurred, the patient may not have had the opportunity to contact the clinical pharmacy specialist. Review of these records found no such ADEs among the medication conversions evaluated in the present study. However, we evaluated the potential for ADEs for only those medication conversions associated with discontinuation of therapy and reversion to the original therapy; we did not examine potential less significant ADEs that did not result in either a change of medication or discontinuation.

Third, ADEs resulting in ER or hospital admission were examined only for subjects who did not persist on the newmed. Fourth, there was potential for variation in the projected MCA dollar value for the same drug-to-drug conversion because the projected MCA was entered manually by each PCCPS. However, PCCPSs at KPCO receive PharmDoc training, including how to determine the projected MCAs. Thus, variation in projected MCAs is believed to be negligible, but we did not assess variation among entries. Fifth, personnel cost for the PCCPSs was not measured because this was a fixed cost that would have occurred whether the conversion resulted in a MCA or not.

\section*{Conclusions}

Documentation of projected MCA for clinical pharmacy specialist-initiated medication conversions is valid for persistent medication conversions, which comprised about two thirds of the population in this study, but not for non-persistent conversions. The projected MCA was approximately $465 per conversion in the first year, and no major ADEs were found to be associated with discontinued medications or drug therapy that reverted to the original drug. However, the current tool used to capture medication conversions and their cost outcomes overestimated MCA by approximately 14%. Further development of such tools will continue to improve the ability to accurately monitor and measure cost outcomes resulting from clinical pharmacist interventions as well as promote the use of effective, safe, and affordable medications for patients.

\section*{DISCLOSURES}

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\section*{Authors}

BEVERLY A. KRONER, PharmD, BCPS, is chief of Primary Care Clinical Pharmacy Services, Pharmacy Department, Kaiser Permanente Colorado (KPCO), Aurora, and clinical assistant professor, School of Pharmacy, University of Colorado at Denver and Health Sciences Center (UCDHS). SARAH J. BILLUPS, PharmD, BCPS, is a clinical pharmacy specialist in Research, Pharmacy Department, KPCO, and clinical assistant professor, School of Pharmacy, UCDHSC. KATHLEEN M. GARRISON, PharmD, BCPS, is a clinical pharmacy specialist in primary care, Pharmacy Department, KPCO, and clinical assistant professor, School of Pharmacy, UCDHSC. ALFRED E. LYMAN, PharmD, BCPS, is supervisor of Primary Care Clinical Pharmacy Services, Pharmacy Department, KPCO, and clinical assistant professor, School of Pharmacy, UCDHSC. THOMAS DELATE, PhD, is a clinical pharmacy research scientist, Pharmacy Department, KPCO, and clinical instructor, School of Pharmacy, UCDHSC.

AUTHOR CORRESPONDENCE: Beverly A. Kroner, PharmD, BCPS, Chief of Primary Care Clinical Pharmacy Services, Kaiser Permanente Colorado Region, 16601 East Centretneck Pkwy., Aurora, CO 80011. Tel.: 303.739.3522, Fax: 303.739.3574; E-mail: beverly.kroner@kp.org

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