Evaluation of patient care interventions and recommendations by a transitional care pharmacist

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Abstract: A "transitional care pharmacist" (TCP) was deployed within an acute care setting to identify opportunities for improved continuity of care. The provision of medication reconciliation services, drug consultation, patient counseling and planning for after-hospital care was time consuming but also fruitful, resulting in roughly nine interventions per patient. Areas with the greatest potential for morbidity reduction were the resumption of home medications during the acute stay and at discharge. Allergy identification was a key contribution at admission, as was the provision of a detailed follow-up plan at discharge. Targeting high-risk patients and spreading portions of the work to other disciplines could achieve added efficiency in this service. Results have value to hospitals implementing medication reconciliation programs.

Keywords: patient safety, medication reconciliation, transitional care, pharmacist

Patient transitions across settings of care are a major cause of medication errors and adverse drug events (ADEs) (Forster et al 2003; Boockvar et al 2004). An important component of these transitions is the accurate and complete transfer of a patient's medication information (Sexton et al 2000). In 2005, the Joint Commission on the Accreditation of Health Care Organizations (JCAHO) made "medication reconciliation" a national patient safety goal (JCAHO 2005). However, no direction in accomplishing this goal is widely available (Barnsteiner 2005) and limitations exist for many of the current localized attempts at safe practice (Gleason et al 2004).

One potential approach to improving medication safety during transitions in care is the development of integrated information systems. However, earlier work suggests that there are vulnerabilities in the care process despite attempts to smooth transitions using electronic medical record systems (Bayley et al 2003b). To address these vulnerabilities requires more than a conduit for the transmission of an improved care plan; it requires the use of a "linking agent" to bridge the gap across settings (Bayley and Savitz 2004).

A number of studies have explored the use of pharmacists at various points in the acute care stay. For example, admission medication histories taken by pharmacists have proved more accurate and complete than those taken by nurses (Gleason et al 2004), and pharmacy technicians are effective in the role of reconciling medication information (Michels and Meisel 2003). Pharmacists participating in medical rounds reduce medication errors in the ordering stage as well as acute care costs (Leape et al 1995, 1999; Boyko, Jr. et al 1997; McMullin et al 1999; Scarsi et al 2002; Kucukarslan et al 2003). Pharmacists provide effective discharge education (Cameron 1994) and can reduce later emergency department visits by making follow-up phone calls to patients post-discharge (Dudas et al 2001).

One area not studied is the role and impact of a pharmacist focused on transitional care issues. Transitional care is a set of actions designed to ensure the coordination and continuity of health care as patients transfer between different locations and different levels of care (Coleman and Berenson 2004). A "transitional care pharmacist" (TCP) would therefore do much more than gather a patient's current and past medical history. The TCP would evaluate the appropriateness and effectiveness of each medication, uncover adherence issues and potential medication injuries, and provide plans for appropriate monitoring by following providers. Pharmacists, through the nature of their training, are uniquely positioned to customize drug regimens based on each patient's individual situation and to impact medication-related problems that occur during care transitions.

The present study describes the role of a TCP. We also describe the specific improvement opportunities available throughout a hospital stay and upon discharge.

Methods
Setting and subjects
The study was carried out at a 483-bed, tertiary care community hospital in Portland, Oregon. The study hospital is part of a fully-integrated delivery system that also includes health plans, medical group, and home and community services. Eligible participants in the study were HMO Medicare patients whose primary care physician was employed by the hospital system and who had an in-patient stay of at least one day during the period Feb 10, to October 31, 2004. Overnight "observation" patients, patients with documented memory or mental health issues that might prevent informed consent, and patients on hospice were excluded. Potential study subjects were identified from the hospitalist admitting census list, and were assigned for evaluation and follow-up by a TCP. The local Institutional Review Board approved the study.

Clinical pharmacist role
The TCP was doctoral prepared with residency training in internal medicine. Their role was developed from two pilot projects and an FMEA (Failure Mode and Effects Analysis) on medication information transfer across care settings. Pharmacy residents in the study hospital conducted both pilot projects. In the first pilot, a clinical pharmacist rounded with hospitalists to consult on medications, and was found to be quite helpful to them. In the second, a pharmacist focused on patient discharge education, much to the appreciation of inpatient nurses. The FMEA was conducted as part of a study on health information

technology and medication information transfer (Bayley et al 2003a). Based on both the value perceived from the pilot projects and the risks identified in the FMEA, the TCP role was focused on six major activities: 1) reconciling all information sources to produce an accurate list of patients' medications on admission; 2) providing drug selection, dosing, and other recommendations to the hospitalists during the hospital stay (see below); 3) developing a comprehensive discharge medication list; 4) conducting patient discharge education; 5) transmitting the discharge medications information, including follow-up monitoring plan to the primary care provider; and 6) contacting the patient by telephone within 3–5 days of discharge to confirm their understanding of their medications and answer any questions. Prior to the onset of the study, the pharmacist rounded with each hospitalist for two successive days and became formally integrated into the hospitalist team.

Classification of interventions
Interventions made by the pharmacist were classified using a scheme adapted from Hatoum et al (1988), similar to the classification used by the ADE Prevention Study Group (Leape et al 1991; Bates et al 1995). The classification categories are reproduced in Table 1 with examples of each. Each category is mutually exclusive to ensure consistent coding of similar interventions.

In addition to these categories, each intervention was rated as having a short-term or long-term impact, and an importance ranging from simple cost savings to prevention of mortality. Short-term impacts were classified as those having to do with the pharmacotherapeutics and/or injury avoidance during the current admission; long-term impacts were classified as those interventions affecting chronic disease care and/or prevention practice (eg, pneumonia vaccine). The importance ratings were intentionally made into four broad categories to simplify the classification task and reflect the predictive rather than actually observed degree of harm. Classification into the "prevented serious morbidity" versus "prevented potential ADE" was based on the pharmacist's judgment as to both the severity of potential harm to the patient and the probability that a specific medication would result in harm for a specific patient, given their current health condition.

The clinical pharmacist performed all of these ratings. To verify the reasonableness of the ratings, ratings for the first 20 patients in the study were independently reviewed by the pharmacy manager and study author (SS). Few differences were

Table 1 Classification, definition and example of pharmacist interventions

Intervention topic	Definition	Example
Add/change/delete medication		
Duplicate therapy	Discontinue one of two or more medications that have similar effects	Patient taking both niacin and lovastatin. Discontinue niacin – patient with good lipid control.
Guideline adherence	Recommend lab tests consistent with current international guidelines	Check lipid panel for patient with history of acute myocardial infarction.
Indication without a medication	Patient has a diagnosis for which a medication is known to be appropriate	Heart failure patient needs beta-blocker therapy.
Medication selection	Change medication to one with fewer side effects, greater chance of patient compliance, or substitute for two other medications.	Change glyburide to glipizide for patient with renal insufficiency who has experienced early morning hypoglycemic events.
Medication without indication	Discontinue a medication because a patient no longer has symptoms, or lab values obviate the need	Discontinue oral pantoprazole in patient no longer at risk for gastric stress ulcers.
Notable adverse drug reaction	Recommend discontinuing or changing a medication due to a moderate-severe reaction	Discontinue bedtime temazepam & as-needed lorazepam for patient who is over-sedated.
Potential drug/food/disease interaction	Discontinue drug which has propensity to worsen a patient co-morbidity, eg, likelihood of fall	Discontinue diazepam in 93 year-old female who has recently experienced falls and a head contusion. Use trazodone for sleep.
Allergies		
Allergy information updated/deleted	Change allergy record to reflect current status of allergies, including updates from patient	Remove meclizine allergy – patient takes at home without problem.
Existing allergy reaction	Identify the exact type of reaction to a known allergy	Sulfa causes hives and shortness of breath.
New allergy identified	Patient exhibits an allergy that has not been documented elsewhere	Penicillin causes rash.
Patient allergic to original medication ordered	Change an ordered medication when documentation shows an existing patient allergy.	Patient allergic (rash) to ciprofloxacin that was ordered for enterbacter cloacae in the urine. Change to ceftriaxone.
Cost		
Nonformulary/insurance issue	Change a medication to the formulary agent covered by a patient's insurance.	Change pantoprazole back to over-the-counter omeprazole at discharge.
Patient cannot afford original medication	Change to a less expensive medication	Change pantoprazole to over-the-counter omeprazole.
Dosing		
Appropriate dosing	Change medication dose based on patient age, comorbidities, or other medications	Change ophthalmic drops, Xalatan, from both eyes to right eye only.
Dose adjustment for drug interaction	Increase or decrease medication dose in consideration of other medications	Decrease weekly warfarin dose in response to added amiodarone therapy.
Renal/hepatic dosing	Change medication dose based on renal function	Decrease dose of allopurinol to 150 mg/d (from 300 mg/d) for estimated creatine clearance of 20 ml/min.
Sub-therapeutic dosing	Increase medication dose in order to achieve benefit, or resume previous levels at discharge to what the patient had prior to admission.	Atenolol dose reduced from 100 mg/d to 50 mg/d upon admit. Now BP to 171/99. Recommend resume home dose of 100 mg.

(continued)

Table 1 (*continued*)

Intervention Topic	Definition	Example
Supra-therapeutic dosing	Decrease medication dose in patient when warranted by lab results or patient side-effects	Decrease dose of glyburide 3 mg bid to daily for blood glucose of 38 this am.
Other		
Patient counseling	Explain to patient or family the importance of a medication, reasons for changes, or how to take a medication	Counsel patient on inhaler technique and provided a visual aid for appropriate inhaler technique steps at discharge.
Route change	Any change in the medication's route of administration based on the patient's clinical status	Change IV to oral ciprofloxacin – patient able to take oral medications.
Vaccines missing	Order a guideline-indicated vaccine and there is no recent documentation	Pneumovax.

noted. These were discussed with the pharmacist, changed, and henceforth became the standard rating practice.

A database was developed to document all interventions. Data collected included patient identifiers, date, type of recommendation (dosing, medication change, etc), the timing of the recommendation (admission, discharge, follow-up), the expected time-frame of impact (short-term or long-term), the estimated significance of the intervention, and whether the recommendation was accepted by the hospitalist.

Time spent on TCP interventions was assessed mid-point in the study period using two methods. First, the TCP was queried to estimate the time spent on each of the above activities in a typical day. She reviewed her work over a 1-week time period and approximated the amount of time on each activity, providing a range, eg, 30 to 45 minutes. Second, a trained observer shadowed the TCP for a day to understand these estimates and identify any time commitments the TCP had overlooked. Time estimates were revised at study close, to take into account feedback from these observations and also the increased efficiency with the maturation of the TCP program.

Results

During the course of the study, 105 patients were eligible for treatment by the transitional care pharmacist. Ninety-nine (99) of these patients were seen by the TCP, and 91 had at least one intervention. Six patients were deemed eligible but were discharged too quickly for the TCP to play a role. Eight patients did not need pharmacy intervention. Demographics of the study population are provided in Table 2.

In total there were 927 interventions performed, an average of 9.4 per patient seen. The attending physician accepted approximately 96 percent of the TCP recommendations, and recommended changes were implemented by that physician or by the pharmacist.

The TCP role with these patients is best characterized by describing ongoing daily tasks and time spent with each patient (Table 3). Roughly one-quarter (26%) of TCP time was spent at admission on the dual tasks of gathering historical medication information and conducting a comprehensive patient medication history. At times, this included phone calls to community pharmacists or family members for additional information, as well as research to verify the appropriateness of current medications. These tasks consumed roughly 83 minutes per patient, on average. Another 22% of time (75 minutes) was spent rounding on patients, reviewing lab work, and consulting with hospitalists on the medication regimens. Thirty-eight percent of time (roughly two hours per patient) was spent at discharge, in preparation of the

Table 2 Description of study population

Descriptor	Percentage or value
Average age	78.9
Age range	60 to 94
Age > 85	31%
Male	33%
Avg. number of medications	
Currently taking	9.8
3+ prior inpatient admissions in prior year	38%
Cardiac DRG	11%
Neuromusculoskeletal DRG	19%
Medical-GI DRG	20%
Medical-respiratory DRG	19%
Discharge to SNF or foster care	33%

Table 3 Time estimates for transitional care pharmacist tasks

TCP Task	Estimated time required (minutes)		
	Range	Avg	Percent
Admission			
Collect historical data	30–60	45	13%
print/read H&Ps			
print/reconcile EHR			
draft care plan			
review/document pertinent labs			
Medication history by patient	30–45	37.5	11%
interview			
patient interview			
review paper chart data			
In-hospital			
Daily Rounding	60–90	75	22%
update new labs/culture			
information			
assess current progress			
ascertain discharge plan			
follow-up on interventions made			
Discharge			
Type discharge medication list	15–30	22.5	7%
Counsel patient	20–40	30	9%
Write follow-up care plan	60–90	75	22%
write care plan			
update EHR flowsheet			
update EHR medication list			
update EHR allergies			
route final document to PCP			
Other			
Identify patients from daily	30–45	37.5	11%
printouts			
Enter data on all	10–15	12.5	4%
recommendations made			
Total time per patient (min)	255–415	335	100%
Total time per patient (hr)	4.3–6.9	5.6	
Patients per 40 hour week	9.4–5.8	7.2	

discharge medication list, patient counseling, and detailed follow-up plans of care sent to primary care providers.

The remaining time was required for properly identifying patients for intervention and documenting all interventions, tasks required by the study. Daily print-outs of hospitalist patients needed to be screened for the HMO Medicare patients and to eliminate patients already approached for participation. In addition, the patient chart was reviewed to note any mention of dementia or cognitive issues that would make study informed consent impossible.

The TCP could not provide accurate estimates of the total time spent on patient follow-up calls. While each call was brief (3–5 minutes), the calls were interspersed with other activities and often involved multiple calling attempts to reach the patient.

Nature of recommendations

Roughly equal numbers of recommendations were given at admission, during the hospitalization, and at discharge (Table 4).

The type of recommendations varied over the course of the stay. At admission, over two-thirds (196/285, 69%) of the interventions dealt with allergies: clarifying, adding, or deleting allergy information. Recommendations involving medication additions or deletions tended to occur either at a later point within the stay or at discharge (Table 4).

Pharmacist interventions involved long-term benefit as well as short-term impact. In fact, almost as many recommendations addressed ongoing chronic disease issues as the more short-term issues such as symptom relief (Table 5). The most frequent type of recommendations were those deemed to have both short- and long-term impacts, such as acid-reducing strategies for gastroesophageal reflux disease or medications for seasonal allergies.

The pharmacist rated close to 30% of her recommendations to have prevented serious morbidity (Table 6). Not surprisingly, the specific recommendations thought to achieve the greatest morbidity avoidance were those involving the addition of a medication. Thirty-one percent of all morbidity-reducing recommendations involved adding a medication as warranted by the patient's indications (Table 7).

The addition of a medication occurred most frequently during the hospital stay, and included four types of recommendations. First, the pharmacist recommended resuming home chronic disease medications where these had been held at admission (44% of the recommendations). These medications included antidepressants as well as statins, insulin, and antihypertensives. Next most frequently (37% of recommendations) the pharmacist recommended new chronic disease medications that had potential long-term value and were not contraindicated in the hospital setting. A third set of recommendations (11%) was for symptom relief, such as for constipation due to narcotic use or saline nasal spray for irritation due to oxygen tubes. Finally, the pharmacist recommended substitution of one medication for another, to enhance cost-effectiveness.

A small (n = 27) but potentially important set of pharmacist interventions in the hospital setting involved deleting medications that were no longer indicated for the patient. Over one-half of these (52%) involved situations

Table 4 Timing of interventions

Intervention	Phase of care				
	Admission	In-hospital	Discharge	Follow-up	Total
Add/change/delete medication					
Duplicate therapy	4	19	9	2	34
Guideline adherence	4	23	1	0	28
Indication without a medication	33	103	147	9	292
Medication selection	3	23	11	2	39
Medication without indication	6	27	11	0	44
Notable adverse drug reaction	3	9	0	0	12
Potential drug/food/disease interaction	9	17	11	1	38
Allergy					
Allergy Information updated/deleted	27	1	0	0	28
Existing allergy reaction	120	4	0	0	124
New allergy identified	49	4	1	1	55
Patient allergic to ordered medication	0	1	0	0	1
Cost					
Nonformulary/insurance issue	0	0	6	0	6
Patient can't afford original medication	0	6	10	0	16
Dosing					
Appropriate dosing	5	20	31	3	59
Dose adjustment for drug interaction	1	1	1	0	3
Renal/hepatic dosing	0	17	3	1	21
Sub-therapeutic dosing	5	20	9	0	34
Supra-therapeutic dosing	1	11	2	1	15
Other					
Patient counseling	6	23	9	3	41
Route change	0	15	1	0	16
Vaccines missing	9	10	2	0	21
Total	285	354	265	23	927
Percentage by phase of care	31%	38%	29%	2%	100%

where either lab data or improved patient symptoms warranted discontinuation and one-third (33%) involved medications that simply appeared inappropriate or unnecessary (eg, estrogen replacement therapy in an 83-year old). A small number of medications (n = 4) were discontinued upon finding that the patient had not been taking the medication at home as previously thought and it was no longer deemed clinically necessary to continue therapy.

The discharge role of the pharmacist was focused on returning the patient to a longer-term medication regimen, with the resumption of medications previously held during the hospital stay. Over half (147 of 265) of the recommendations at this stage were to add a medication, and 85% of these (125) involved resumption of a previous home medication. Also seen at discharge were a few more recommendations (10 of 265, 4% of all discharge recommendations) involving insurance or cost issues for the patient.

Discussion

A clinical pharmacist focusing on medication reconciliation issues in a community hospital setting will find many opportunities for improvement, effectively combining transitional care with more traditional clinical pharmacy consultation (Jacobson 2002). However, doing this work in thorough fashion takes a great deal of time – between three to four hours per patient. It should be noted that the interventions of this pharmacist went far beyond simple reconciliation of medication names and doses on lists, but included extensive research on current medications, advising the hospitalist physicians, development of customized pharmaceutical care plans, patient education, and communication of the post-discharge treatment and monitoring plan to the ambulatory care provider. Each of these transitional care activities can be time-consuming in an elderly population with complex medication regimes.

If the TCP approach were considered for more widespread adoption, it would require greater efficiency and targeting. Based on our work, we would recommend that the most appropriate patients for this service are those who take multiple medications, take high-risk medications, who are inexperienced with their medication regime, or whose reason for hospitalization was medication

Table 5 Expected temporal impact of interventions

Expected temporal impact	Number	Percentage
Short-term	190	20.5%
Long-term	151	16.3%
Both short-term and long-term	583	62.9%
Not rated (inadvertently)	3	0.3%
Total	927	100%

related. Many times these patients are those with multiple chronic conditions. This would imply differing levels of medication reconciliation with the greatest resources devoted to the patients at greatest risk. A more general approach to the greater population might target those areas that were most frequently identified as problematic.

Efficiency in the service could be achieved by making it a team effort rather than dependent on a single pharmacist. While much of the work done in this study would require pharmacy expertise – to recommend resumption of medications, delete medications, change doses, or identify critical lab work that needed to be done – a different discipline (eg, nursing) could handle a portion of the allergy clarification, conduct the patient counseling, and ensure preventive care like pneumonia vaccination.

There are advantages to having pharmacists conduct medication histories, since they can use their expertise to check for adherence issues, clarify doses based on knowledge of available medication strengths, differentiate true drug allergies from other intolerance issues, and provide an evidence resource to the clinical team. The pharmacist in the present study was also able to identify medications and doses using the patient's lay knowledge (eg, "my water pill") and a description of the actual tablet. At the same time, the expense of a clinical pharmacist would warrant that these tasks be done for the most high-risk patients, and also that this work substitute for the time of nurses and physicians.

The greatest area for morbidity reduction appears to be the resumption of beneficial medications that have been held at admission (31% of all morbidity-reducing interventions). In the present study, the pharmacist tended to add back home medications during the hospital stay (ie, after the 2nd or 3rd hospital day), addressing a potentially important problem for longer acute stays. The Institute for Safe Medication Practices has issued an "alert" on this issue (ISMP 2005). Many types of medications cannot be held for more than a few days without impacting patient health. Unless the patient's medication administration record is compared each day with the previous home medications, these medications will be missed. In addition, there are medications (eg, beta-blockers, clonidine, benzodiazepines) that should be tapered, not completely held at admission.

The analysis offers confirmation that good discharge orders are dependent upon thorough admission data collection. The principal task at discharge was to resume home medications that may have been left off discharge orders (approximately 85% of the recommendations to add medications at discharge). Only 10% of added medications were new medications and a small fraction (5%) involved additions for symptom relief or the substitution of a new medication for something else. We would suspect that the number of medications resumed at discharge in this study might be less than usual, given that many medications were already re-started within the stay.

One unexpected study finding was the high frequency of allergy-related recommendations at admission. Over two-thirds (69%) of interventions at admission dealt with allergies – clarifying, adding or deleting allergy information.

Table 6 Importance of interventions as rated by pharmacist

Rating	Importance	Number	Percentage	Examples
1	Prevented Mortality	0	0.0%	Avoided administration of a medication listed as an allergy with an anaphylactic reaction in medical record.
2	Prevented Serious Morbidity	273	29.2%	Held a medication in response to supratherapeutic drug levels, ie, digoxin, theophylline, warfarin, etc.
3	Prevented *Potential* ADE or Standard of Practice	626	67.7%	Lowered warfarin dose empirically in response to addition of amiodarone. Added ACEI therapy to patient with both diabetes and hypertension.
4	Cost or Product Selection	27	2.9%	Switch PPI therapy from esomeprazole to pantoprazole per approved therapeutic interchange. Adherence to an established outpatient medication formulary.
	Not Rated	1	0.1%	(Inadvertently not rated)
Total		927	100.0%	

Table 7 Interventions with an impact on decreasing morbidity

Intervention	Number of recommendations estimated to decrease morbidity	% of all morbidity reducing recommendations
Indication w/o a medication	85	31%
Existing allergy, reaction	22	8%
Vaccines missing	21	8%
Med w/o indication	15	5%
Potential drug/food/disease interaction	15	5%
Patient counseling	15	5%
Medication selection	15	5%
Appropriate dosing	13	5%
Duplicate therapy	13	5%
Subtherapeutic dosing	11	4%
Supratherapeutic dosing	10	4%
Renal/hepatic dosing	10	4%
Guideline only	9	3%
Notable adverse drug reaction	8	3%
New allergy identified	4	1%
Dose adjustment for drug interaction	2	1%
Route change	2	1%
Allergy Information updated/deleted	1	0%
Patient allergic to original med	1	0%
Patient cannot afford original med	1	0%
Nonformulary/insurance issue	0	0%
Total	273	100%

This emphasis was based on both the clinical importance to pharmacist as well as the generally low prevalence of allergy information available from admission information sources – nursing forms, physician orders, and even ambulatory data. Although the pharmacist had access to a primary care electronic health record (EHR), these records often lacked information on allergic reactions. This may have been because of simple oversight or because the medications prescribed in the hospital setting are rarely prescribed by primary care physicians and the allergies may not be documented in the ambulatory chart. Problems with allergy information have been reported elsewhere in the literature and some have suggested that pharmacists by given the primary role in allergy identification (Geibig et al 1991; Shenfield et al 2001).

Two additional areas suggest themselves for refinement in this service. First, less than 5% of all recommendations at any point in the stay involved deleting a medication. Study patients averaged just over 11 medications (including over-the-counter and nutritional medications) due to the prevalence of chronic disease. However, polypharmacy is an important problem in the elderly, and earlier studies have demonstrated that more medications increase the risk for ADEs (Gandhi et al 2003). A pharmacist checking lab data and assessing patient symptoms on a daily basis provides a great opportunity to reduce unnecessary medications, thereby reducing the chance for medication errors, potential side effects, and complex medication regimens that lead to poor patient adherence. Pharmacists have been shown to be effective in this type of role (Phillips and Carr-Lopez 1990). and it is not clear why more medication deletions were not recommended within the present study.

Second, there were also few route changes, an area that others have found to represent both cost savings and quality improvement (Bunz et al 1990; Przybylski et al 1997; Goldwater et al 1997). In this case, it is likely that few recommendations of this nature were needed, because protocols for changing intravenous to oral routes have already been well established within this institution.

The long-term impact of clinical pharmacy transitional care services in the hospital deserves further study. The majority of interventions in this study were done for long-term benefit to the patient, rather than short-term symptom relief or safety concern. These benefits would not be captured in a cost-benefit study that was limited to the duration of the hospital stay. Rather, a long-term study would be needed that addresses the continuity of adherence with chronic disease medications in this population, as well as the impact of this continuity on further hospital utilization, morbidity, and mortality.

The current study had several limitations, including the fact that a single pharmacist collected the data and rated the interventions as to type and impact. Although this increased

the consistency of data collection, other coders might have interpreted the interventions differently. The four broad categories used to estimate impact could benefit from further refinement. Also, the pharmacist's estimate of the impact of the intervention assumed that others would not detect a potential ADE, an assumption that is not always true. A dispensing pharmacist through automated or manual error checking routines might have caught some errors and prevented harm to the patient at a later step in the process. Time estimates were approximate and not corroborated via intensive time study. It is likely that certain care coordination tasks and consultations with other staff make up some of the time allocated to the time categories used by the TCP to estimate her work.

Finally, this study focused on the elderly population, and rates of intervention would likely vary for other inpatient sub-populations at greater risk (eg, HIV) or lower risk (eg, healthy obstetrical patients). While stratified analyses will provide a more in-depth understanding, results from this study document the need for targeted, in-depth medication reconciliation efforts. Such an approach would benefit from a controlled trial, with comparison to usual care, and an economic evaluation that considers both the costs and the areas of cost savings.

References

Barnsteiner JH. 2005. Medication reconciliation: transfer of medication information across settings-keeping it free from error. *J Infus Nurs,* 28:31–6.

Bates DW, O'Neil AC, Petersen LA, et al. 1995. Evaluation of screening criteria for adverse events in medical patients. *Med Care,* 33:452–62.

Bayley K, Savitz, L. 2004. Conduits & Links that promote knowledge utilization [abstract]. TRIP: Advancing excellence from discovery to delivery Washington, DC on July 13, 2004.

Bayley K, Savitz L, Logsdon K. 2003a. IDS solutions for transferring medication information across the care continuum [abstract].

Bayley K, Savitz L, Logsdon K. 2003b. IDS solutions for transferring medication information across the care continuum [abstract].

Boockvar K, Fishman E, Kyriacou CK, et al. 2004. Adverse events due to discontinuations in drug use and dose changes in patients transferred between acute and long-term care facilities. *Arch. Intern Med,* 164:545–50.

Boyko WL Jr., Yurkowski PJ, Ivey MF, et al. 1997. Pharmacist influence on economic and morbidity outcomes in a tertiary care teaching hospital. *Am J Health Syst Pharm,* 54:1591–5.

Bunz DM, Frighetto L, Gupta S, et al. 1990. Simple ways to promote cost containment. *DICP,* 24:546.

Cameron B. 1994. The impact of pharmacy discharge planning on continuity of care. *Can J Hosp Pharm,* 47:101–9.

Coleman EA, Berenson RA. 2004. Lost in transition: challenges and opportunities for improving the quality of transitional care. *Ann Intern Med,* 141:533–6.

Dudas V, Bookwalter T, Kerr KM, et al. 2001. The impact of follow-up telephone calls to patients after hospitalization. *Am J Med,* 111:26S–30S.

Forster AJ, Murff HJ, Peterson JF, et al. 2003. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med,* 138:161–7.

Gandhi TK, Weingart SN, Borus J, et al. 2003. Adverse drug events in ambulatory care. *N. Engl J Med,* 348:1556–64.

Geibig CB, Mansur JM, Medema PG, et al. 1991. Pharmacy-controlled documentation of drug allergies. *Am J Hosp Pharm,* 48:260–4.

Gleason KM, Groszek JM, Sullivan C, et al. 2004. Reconciliation of discrepancies in medication histories and admission orders of newly hospitalized patients. *Am J Health Syst Pharm,* 61:1689–95.

Goldwater SH, Neal-Janifer A, Milkovich G, et al. 1997. Smoothing the path for i.v.-to-oral conversion. *Am J Health Syst Pharm,* 54:200.

Hatoum HT, Hutchinson RA, Witte KW, et al. 1988. Evaluation of the contribution of clinical pharmacists: inpatient care and cost reduction. *Drug Intell Clin Pharm,* 22:252–9.

[ISMP] Institute for Safe Medication Practices. 2005. Medication orders: don't put me on hold [online]. Accessed on July 6, 2006. URL: http://www.ismp.org/MSAarticles/20050324.htm.

Jacobson J. 2002. Ensuring continuity of care and accuracy of patients' medication history on hospital admission. *Am J Health Syst Pharm,* 59:1054–5.

[JCAHO] Joint Commission on the Accreditation of Health Care Organizations 2005. Proposed patient safety standards for 2005 [online]. Accessed April 5, 2005. URL: http://www.jcaho.org/accredited+organizations/patient+safety/npsg.htm.

Kucukarslan SN, Peters M, Mlynarek M, et al. 2003. Pharmacists on rounding teams reduce preventable adverse drug events in hospital general medicine units. *Arch Intern Med,* 163:2014–8.

Leape LL, Bates DW, Cullen DJ, et al. 1995. Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA,* 274:35–43.

Leape LL, Brennan TA, Laird N, et al. 1991. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N Engl J Med,* 324:377–84.

Leape LL, Cullen DJ, Clapp MD, et al. 1999. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. *JAMA,* 282:267–70.

McMullin ST, Hennenfent JA, Ritchie DJ, et al. 1999. A prospective, randomized trial to assess the cost impact of pharmacist-initiated interventions. *Arch Intern Med,* 159:2306–9.

Michels RD, Meisel SB. 2003. Program using pharmacy technicians to obtain medication histories. *Am J Health Syst Pharm,* 60:1982–6.

Phillips SL, Carr-Lopez SM. 1990. Impact of a pharmacist on medication discontinuation in a hospital-based geriatric clinic. *Am J Hosp Pharm,* 47:1075–9.

Przybylski KG, Rybak MJ, Martin PR, et al. 1997. A pharmacist-initiated program of intravenous to oral antibiotic conversion. *Pharmacotherapy,* 17:271–6.

Scarsi KK, Fotis MA, Noskin GA. 2002. Pharmacist participation in medical rounds reduces medication errors. *Am J Health Syst Pharm,* 59:2089–92.

Sexton J, Ho YJ, Green CF, et al. 2000. Ensuring seamless care at hospital discharge: a national survey. *J Clin Pharm Ther,* 25:385–93.

Shenfield GM, Robb T, Duguid M. 2001. Recording previous adverse drug reactions – a gap in the system. *Br J Clin Pharmacol,* 51:623–6.