Role of Pharmacist Counseling in Preventing Adverse Drug Events After Hospitalization

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Background: Hospitalization and subsequent discharge home often involve discontinuity of care, multiple changes in medication regimens, and inadequate patient education, which can lead to adverse drug events (ADEs) and avoidable health care utilization. Our objectives were to identify drug-related problems during and after hospitalization and to determine the effect of patient counseling and follow-up by pharmacists on preventable ADEs.

Methods: We conducted a randomized trial of 178 patients being discharged home from the general medicine service at a large teaching hospital. Patients in the intervention group received pharmacist counseling at discharge and a follow-up telephone call 3 to 5 days later. Interventions focused on clarifying medication regimens; reviewing indications, directions, and potential side effects of medications; screening for barriers to adherence and early side effects; and providing patient counseling and/or physician feedback when appropriate. The primary outcome was rate of preventable ADEs.

Results: Pharmacists observed the following drug-related problems in the intervention group: unexplained discrepancies between patients' preadmission medication regimens and discharge medication orders in 49% of patients, unexplained discrepancies between discharge medication lists and postdischarge regimens in 29% of patients, and medication nonadherence in 23%. Comparing trial outcomes 30 days after discharge, preventable ADEs were detected in 11% of patients in the control group and 1% of patients in the intervention group ($P = .01$). No differences were found between groups in total ADEs or total health care utilization.

Conclusions: Pharmacist medication review, patient counseling, and telephone follow-up were associated with a lower rate of preventable ADEs 30 days after hospital discharge. Medication discrepancies before and after discharge were common targets of intervention.

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DRUG-RELATED PROBLEMS (DRPs), including treatment failures and adverse drug events (ADEs), are a pervasive patient safety issue.[1-3] They are particularly common after hospitalization,[4] when multiple changes to patients' medication regimens[5] may be accompanied by inadequate patient education,[6,7] follow-up, and continuity of care.[8] These factors commonly result in inappropriate medication prescribing, discrepancies between prescribed and actual regimens, poor adherence, and inadequate surveillance for adverse effects.[9-15] These problems may cause preventable ADEs and increased health care utilization. An estimated 12% to 17% of general medicine patients experience ADEs after hospital discharge, more than half of them judged preventable or ameliorable (ie, duration or severity could have been decreased)[4,16]; 6% to 12% of ADEs result in emergency department (ED) visits and 5% in hospital readmissions.[3]

Hospital pharmacists have the expertise to address DRPs during and after hospitalization. They can counsel patients at discharge, detect and resolve medication discrepancies, and screen for nonadherence and ADEs after discharge. Data suggest that counseling patients before discharge reduces medication discrepancies[17,18] and improves adherence.[17-19] Pharmacist follow-up after discharge has mixed effects on ED visits, hospital readmissions, and costs,[18-21] and effects of pharmacist interventions on ADEs after discharge are unknown. The objectives of this study were to identify DRPs during and after medical hospitalization and to evaluate the effects of counseling and follow-up by pharmacists on the rate of preventable ADEs, health care utilization, medication nonadherence, and medication discrepancies 30 days after discharge from an acute care hospital. We hypothesized that pharmacist interventions would reduce the rate of preventable ADEs.

METHODS

SETTING AND PARTICIPANTS

This randomized controlled trial was conducted at Brigham and Women's Hospital (BWH), Boston, Mass, from April 1, 2002, through March 20, 2003.[22] Eligible subjects were patients admitted to 1 of 4 teams on the general medicine service who were being discharged home and who could be contacted 30 days after discharge, spoke English, and were cared for by a BWH primary care physician or internal medicine resident. Patients provided informed written consent unless cognitively impaired. If impaired, they were included if they lived with someone who administered their medications regularly, could provide consent, and was willing to be the recipient of pharmacist interventions. To improve the consistency of interventions, patients were enrolled when 1 of 3 study pharmacists was assigned to the general medicine service and available for inpatient counseling (most weekdays). This study was approved by the BWH institutional review board.

After providing consent, patients were randomized to receive usual care or the interventions described in the next section. Randomization was by a computer-generated algorithm, and treatment assignments, kept in sealed opaque envelopes, were opened only after patient consent was obtained; pharmacists carried out enrollment and patient assignment. Although patients and pharmacists were not blinded to the interventions, outcomes were assessed by research assistants and 3 of us (J.L.S., A.K., and M.H.) blinded to treatment assignment.

Patients assigned to usual care received routine review of medication orders by a ward-based pharmacist and medication counseling by a nurse at the time of discharge. Nursing discharge counseling typically focused on medication directions and may have included a discussion of indications or potential side effects, especially for new medications. These sessions sometimes included informal medication reconciliation, such as comparing discharge medications with those currently prescribed in the hospital.

PHARMACIST INTERVENTIONS

The pharmacist intervention on the day of discharge consisted of several parts. First, discharge medication regimens were compared with preadmission regimens and all discrepancies were reconciled with the medical team's help. Patients were screened for previous DRPs, including nonadherence, lack of efficacy, and side effects. The pharmacist reviewed the indications, directions for use, and potential adverse effects of each discharge medication with the patient and discussed significant findings with the medical team.

During the follow-up telephone call, the pharmacist compared the patient's self-reported medication list with the discharge list, exploring any discrepancies. The pharmacist also asked about medication adherence, possible ADEs, and adherence with scheduled follow-up and laboratory appointments. Significant findings were entered into the electronic medical record used by all BWH outpatient practices and communicated to the patient's primary care physician via a standard e-mail template.

MEASUREMENTS

For patients randomized to the intervention group, observational process-of-care measurements included frequency of various DRPs detected by pharmacists (eg, medication nonadherence, possible adverse effects) and recommended actions (eg, changes to discharge medications) at discharge and follow-up. All recommendations were recorded on a standardized form and confirmed by 2 of us (J.L.S. and J.L.K.); disagreements were resolved by consensus.

To assess the primary outcome, all patients in the trial were contacted 30 days after discharge (±3 days) by a research assistant blinded to treatment assignment. The primary outcome was the presence of a preventable ADE in patients 30 days after hospital discharge. Secondary outcomes were all ADEs (preventable or not), patient satisfaction, health care utilization, medication adherence, and medication discrepancies.

Preventable ADEs were assessed with a modified version of the method developed by Bates and colleagues[23] and their group.[4,24] Patients were asked a screening question for new or worsening symptoms since hospital admission. In the case of an affirmative response, follow-up questions elicited details about these symptoms and their relation to medications. Case summaries were prepared from these responses, medication lists at admission and discharge, the hospital discharge summary, any available outpatient visit notes, discharge summaries from ED visits or hospital readmissions, and laboratory test results in the month since discharge.

From these summaries, 2 of 3 physician adjudicators blinded to treatment group independently determined whether an ADE had occurred, using the Naranjo algorithm,[25] a validated scoring system to assess causality. Disagreements were resolved by consensus between the 2 adjudicators and with the third if necessary. Blinded adjudicators independently evaluated ADE severity, preventability, and, if not preventable, ameliorability.

For all hospital admissions or ED visits, blinded physician adjudicators assessed any relationship to medication use or preventability. Preventable medication-related ED visits or readmissions were considered to be preventable ADEs. If patients could not be contacted by telephone 30 days after discharge but had been readmitted to the hospital or visited the ED, case summaries were prepared and ADEs assessed as described in the preceding paragraph but without the patients' responses. This improved our ability to detect serious and preventable ADEs while minimizing bias due to loss to follow-up. Because ADE assessment without patient responses is less well established than assessment using patient interview, all ED visits or readmissions that were at least possibly medication related were automatically reviewed by an independent, blinded expert in drug safety at BWH.

Satisfaction with hospitalization and discharge processes was assessed with a standard questionnaire (Press Ganey Associates, South Bend, Ind). Health care utilization measures, including scheduled and unscheduled office visits, urgent care and ED visits, and hospital admissions, were assessed by survey questions and hospital administrative data. Administrative data from BWH were subsequently chosen as the gold standard for hospital admission and ED visits because we found evidence of patient underreporting and minimal evidence of readmissions to other hospitals (ie, no hospital readmissions and only 3 self-reported ED visits, all in the intervention group, that could not be confirmed by BWH administrative data). Medication adherence was assessed by asking patients whether they had taken each medication exactly as prescribed during the previous day and on how many days during the previous week. We collected pharmacy refill data for a subset of patients who used the hospital outpatient pharmacy, to confirm the validity of this approach. Medication discrepancies were determined by comparing the discharge medication regimen with the medications reported by each patient at 30 days. Differences not attributable to a physician's order or completion of a prescribed course of treatment were considered discrepancies.

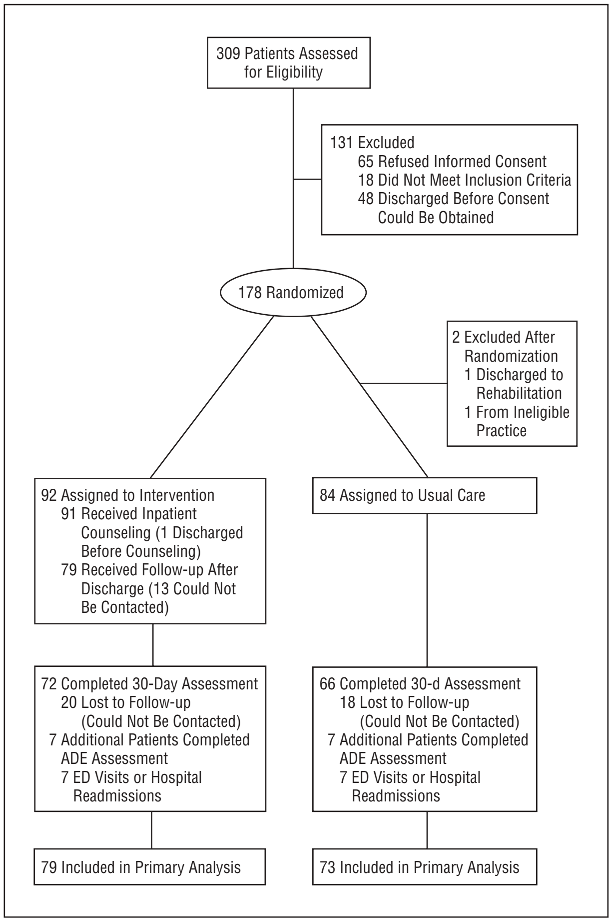

Figure. Flow of participants through the trial. ADE indicates adverse drug event; ED, emergency department.

STATISTICAL ANALYSIS

Dichotomous outcomes (eg, preventable ADEs) were assessed by Fisher exact test. Pseudocontinuous variables such as patient satisfaction score and medication adherence score (adherent medication days divided by all possible medication days) were analyzed with the Wilcoxon rank sum test. Multiple regression was not used to analyze preventable ADEs because of the small number of events and concern for overfitting. Interrater reliability for all adjudicated outcomes was assessed with the κ statistic. All analyses followed the intention-to-treat principle. The study, with 85 patients per arm, had 80% power to detect an absolute difference in preventable ADEs of 12% (13% vs 1%). Two-sided *P* values less than .05 were considered significant. SAS statistical software, version 8.1 (SAS Institute Inc, Cary, NC) was used for all analyses.

RESULTS

The study enrolled 178 patients; after 2 postrandomization exclusions, 92 received pharmacist interventions and 84, usual care. The **Figure** illustrates the flow of subjects through the trial. Whether a preventable ADE had occurred could be assessed in 152 patients (85%), including 138 who could be contacted 30 days after discharge and 14 patients who could not but who visited the ED or were readmitted to the hospital. At baseline, there were no significant differences between patients in the 2 study arms (**Table 1**). The mean age of participants was 58.4 years; 66% were women. The median number of medications at discharge was 8.

Table 1. Characteristics of Patients*

Characteristic	Pharmacist Intervention (n = 92)	Usual Care (n = 84)
Sex, No. (%) female	62/92 (67)	55/84 (65)
Age, mean (SD), y	60.7 (17.2)	57.7 (15.9)
No. of medications at discharge, median (IQR)	8 (5.5-10)	8 (5-13)
Hospitalized in past year, No. (%)	33/72 (46)	40/66 (61)
Charlson score, median (IQR)†	2 (1-5)	3 (1-6)
Education, No. (%)		
<High school graduate	13/67 (19)	7/60 (12)
High school graduate but not college graduate	29/67 (43)	32/60 (53)
College graduate	25/67 (37)	21/60 (35)
Married or living as if married, No. (%)	30/68 (44)	27/64 (42)
Living with someone, No. (%)	52/70 (74)	50/64 (78)
Someone to help when patient returns home, No. (%)	50/72 (69)	54/66 (82)
Living in own home, No. (%)	57/69 (83)	51/64 (80)

Abbreviation: IQR, interquartile range.
*$P>.10$ for all comparisons.
†Upper estimate of patient self-reported Charlson comorbidity score.[26]

DRUG-RELATED PROBLEMS OBSERVED IN THE INTERVENTION GROUP

During the interventions, pharmacists identified many types of DRPs. At discharge counseling (n=91), pharmacists discovered that the medical team had often misunderstood the patient's preadmission medication regimen and carried through these inaccuracies to the discharge medication orders. These included 34 missing medications, a different dose or frequency of a medication in 12 cases, and a different medication in the same class in 11 cases (**Table 2**); 45 patients (49%) had 1 or more unexplained discrepancies in their discharge medication orders. Pharmacists also found that 15 patients (16%) admitted to having had problems with their medication regimens before admission, including possible side effects and difficulties with adherence. Pharmacists suggested 23 changes to discharge medications on other clinical grounds (eg, to simplify a medical regimen or avoid a drug interaction). Overall, pharmacists recommended 80 changes in 55 patients (60%).

During follow-up telephone calls 3 to 5 days after discharge (n=79), pharmacists noted discrepancies between the discharge medication list and the patient's reported home regimen in 56 patients (71%). In 33 patients (42%), discrepancies were accounted for by reported changes by the patients' physicians or were changes in "as-needed" or over-the-counter medications only. Of more concern were the 28 remaining discrepancies in 23 patients (29%) that remained unexplained (Table 2). Most discrepancies involved changes in dose or frequency or

Table 2. Drug-Related Problems Detected by Pharmacists During Intervention

Problem	No. (%)
At discharge (n = 91)	
Patients with ≥1 unexplained discrepancy between preadmission regimen and discharge medications	45 (49)
Previously taking medication unknown to team	34*
Previously taking different dose or frequency	12*
Previously taking different medication in class	11*
Patients with previous problems with medications taken before admission	15 (16)
During follow-up (n = 79)	
Patients with ≥1 unexplained discrepancy between discharge medications and reported regimen	23 (29)
Taking additional medication not on discharge medication list	3*
Not taking a medication on discharge medication list	12*
Taking different dose or frequency	11*
Taking different medication in the same class	2*
Patients with possible early medication side effects	29 (37)
Patients nonadherent to medication regimen	18 (23)
Patients with difficulty obtaining refills	14 (18)
Patients with difficulty with medication costs	9 (11)

*Total number of problems exceeds number of patients because patients may have had more than 1 type of problem or more than 1 medication per problem.

complete omission of a prescribed medication. In addition, possible medication side effects were noted in 37% (29 patients), medication nonadherence in 23% (18), difficulty obtaining refills in 18% (14), and difficulty with medication costs in 11% (9).

TRIAL RESULTS: PRIMARY AND SECONDARY OUTCOMES

Thirty days after discharge, preventable ADEs had occurred in 1 patient in the intervention group and 8 in the usual-care group (1% vs 11%; $P=.01$; unadjusted odds ratio, 0.10; 95% confidence interval, 0.013-0.86) (**Table 3**). The rate of preventable, medication-related ED visits or hospital readmissions was 1% in the intervention group and 8% in those assigned to usual care ($P=.03$). The groups did not differ significantly with respect to total ADEs, total health care utilization, patient satisfaction, medication adherence (Table 3), or duration or severity of ameliorable ADEs (data not shown). Unexplained discrepancies between discharge medication regimens and self-reported medications 30 days after discharge were common in both control and intervention groups (65% and 61%, respectively).

Preventable ADEs were due to a number of factors, including discrepancies and inappropriate prescribing before discharge, as well as discrepancies, lack of medication access, nonadherence, and inadequate drug monitoring after discharge (see **Table 4** for a description of all preventable ADEs).

Interrater reliability for assessment of preventable ADEs was fair ($\kappa=0.59$). A validation of self-reported medication adherence with pharmacy refill rates in a sample of patients found inflation of patient estimates by as much as 40%, independent of treatment group.

Table 3. Primary and Secondary Study Outcomes*

Outcome	Pharmacist Intervention (n = 92)	Usual Care (n = 84)	*P* Value†
Adverse drug events, No. (%)			
All	14/79 (18)	12/73 (16)	>.99
Preventable	1/79 (1)	8/73 (11)	.01
Health care utilization, No. (%)			
Emergency department visit or readmission	28/92 (30)	25/84 (30)	>.99
Medication related	4/92 (4)	7/84 (8)	.36
Preventable medication related	1/92 (1)	7/84 (8)	.03
Patient satisfaction, No. (%)			
General‡	60/71 (85)	57/65 (88)	.63
With instructions regarding discharge medications‡	68/70 (97)	58/63 (92)	.48
Unexplained medication discrepancies, No. (%)			
Medication not taken by patient	32/67 (48)	28/62 (45)	.86
Additional medication taken without PCP's knowledge	11/72 (15)	12/66 (18)	.66
Any discrepancy in dose or frequency	17/72 (24)	19/66 (29)	.56
Any medication discrepancy	44/72 (61)	43/66 (65)	.72
Medication adherence			
Adherence score on previous day, median (IQR)§	88.9 (0.71-1.00)	87.5 (0.73-1.00)	.91
Nonadherent with at least 1 medication, No. (%)	36/67 (54)	33/62 (53)	>.99

Abbreviations: IQR, interquartile range; PCP, primary care physician.
*Values in parentheses are percentage of patients, except where noted.
†Using Fisher exact test for categorical variables and Wilcoxon rank sum test for adherence score.
‡Score of 4 or higher on a 5-point scale.
§Of 100, with 100 representing complete adherence with all medications.

COMMENT

Medication review, discharge counseling, and telephone follow-up by pharmacists were associated with a significantly lower rate of preventable ADEs 30 days after hospital discharge. Preventable, medication-related ED visits and hospital readmissions were similarly reduced. On the other hand, no differences were seen in total ADEs, total health care utilization, medication adherence or discrepancies, or patient satisfaction. On the basis of the drug-related problems addressed by pharmacists and the types of preventable ADEs seen among control patients, the lower rate of preventable ADEs in the intervention group may have been due to resolution of medication discrepancies and improvement in medication appropriateness before hospital discharge, and improved access to medications after discharge.

Medication discrepancies (ie, differences between what patients think they should be taking and regimens ordered by physicians) were common during and after hospital discharge. Discrepancies differ from problems of medication adherence (ie, differences between what patients think they should be taking and what they actually take) because the problem is one of communication and documentation rather than patient education or mo-

Table 4. Preventable Adverse Drug Events

History	Type of Error
A patient admitted for an asthma flare was discharged home on a 7-d prednisone taper, inhaled corticosteroids, bronchodilators, and montelukast sodium. Nine days after discharge, she presented to the ED with increased shortness of breath. History indicated that she had been using her inhaled corticosteroids on an as-needed basis only, not regularly as prescribed, because of a misunderstanding. She was treated in the ED and discharged home.	Discrepancy after discharge
A patient admitted with abdominal pain of unknown origin was discharged home with oxycodone hydrochloride–acetaminophen, 1-2 tablets every 6 h as needed. She was not prescribed a stool softener or bowel regimen at discharge. On 30-d evaluation, she reported constipation of 7-d duration.	Failure to prevent predictable side effect
A patient was admitted for worsening shortness of breath and weakness. Evaluation showed ischemic heart disease, which was managed medically by changing her blood pressure regimen from metoprolol tartrate (50 mg bid) to metoprolol succinate extended release (100 mg/d), lisinopril, and isosorbide mononitrate. She presented to her nurse practitioner 8 d after discharge for a blood pressure check, complaining of 3 d of scalp paresthesias and headache; her blood pressure was markedly elevated. On questioning, she reported not taking the long-acting metoprolol prescribed at discharge, because of a misunderstanding. She was brought to the ED, where she was treated, observed for several hours, and discharged home.	Discrepancy after discharge
A patient with a history of asthma and previous venous thromboembolism was admitted for swelling of the left lower extremity, found not to have a deep venous thrombosis, and discharged home. She presented to the ED 7 d after discharge complaining of shortness of breath. She reported not having access to her albuterol and corticosteroid inhalers and, after finding the hospital pharmacy closed, reported to the ED to obtain her medications. She was given her inhalers and discharged home.	Nonadherence, lack of medication access
A patient was admitted with hyponatremia and seizure after resection of a recurrent pituitary adenoma. During the admission, her phenytoin level was noted to be low, leading to an increase in her dose at discharge. Her phenytoin level was to be checked by a visiting nurse every day for the next 3 d and then every 3 d afterward until stable. She was readmitted 12 d after discharge with decreased responsiveness. Her phenytoin level was found to be supertherapeutic, and her mental status gradually improved after reduction in the dose. No record of phenytoin levels or dose adjustments by her physicians could be found in the medical record.	Lack of therapeutic drug monitoring
A patient with coronary disease and sick-sinus syndrome was admitted with melena and dizziness. Upper and lower endoscopies did not disclose a source, her bleeding resolved, and she was discharged home. The patient was taking amiodarone before admission, but this medication was not prescribed during the admission or at discharge. The patient's PCP, in discussion with her outpatient cardiologist, restarted the amiodarone 14 d after discharge. Two days later, the patient was readmitted with chest pain and light-headedness. Evaluation showed episodes of nonsustained ventricular tachycardia. The patient received a loading dose of amiodarone.	Discrepancy before discharge, failure to identify preadmission medication regimen*
A patient with dilated cardiomyopathy was admitted with 2 wk of worsening dyspnea and diagnosed as having decompensated congestive heart failure. He received aggressive diuresis and was discharged home in a euvolemic state on a cardiac regimen including furosemide, 80 mg/d. Twenty days after discharge, the patient was readmitted with a recurrent CHF exacerbation. Further history showed that his furosemide dose before the first admission had been 160 mg bid.	Inappropriate dosing, failure to reconcile discharge and preadmission medications
A patient with coronary artery disease and end-stage renal disease receiving hemodialysis was admitted with 2 d of chest pressure and symptoms of congestive heart failure. The patient was treated with diuretics, brief use of IV nitroglycerin, and dialysis and discharged home in a euvolemic state on a regimen of furosemide, 200 mg bid. Her preadmission furosemide dosage had been 20 mg/d. She was readmitted 2 d after discharge with a near syncopal episode at home. She was found to be 2.25 kg below her baseline weight with orthostatic hypotension. Her condition improved with IV fluids and withholding of furosemide.	Inappropriate dosing, likely failure to reconcile discharge and preadmission medications
A patient was admitted for an asthma flare after leaving her albuterol inhaler at work. She was treated successfully and discharged home on a prednisone taper, bronchodilators, and an inhaled corticosteroid. She presented again to the ED 1 d after discharge complaining of shortness of breath. She had been unable to receive her prescriptions from the pharmacy the previous night. She was treated, given her inhalers, and discharged home.	Nonadherence, lack of medication access

Abbreviations: bid, twice daily; CHF, congestive heart failure; ED, emergency department; IV, intravenous; PCP, primary care physician.
*Patient in the intervention group. All other patients had been assigned to usual care.

tivation. Discrepancies have serious consequences, including prolonged periods of overtreatment or undertreatment. The problem has been demonstrated in recent studies,[9,15,27] including 2 of general medical inpatients showing discrepancies on hospital admission in 53.6% and 54.4% of patients,[13,28] similar to our finding of discrepancies in 49%. The magnitude of this problem is only beginning to be appreciated and to receive attention from health care agencies. The Joint Commission for Accreditation of Healthcare Organizations is now mandating medication reconciliation at the time of hospital admission and discharge,[29] although organizations are still struggling with implementation issues.

Medication discrepancies probably occur for a variety of reasons. Patients often incompletely understand their medication regimens, especially at hospital admission, when cognition may be impaired and medication lists, pill bottles, and knowledgeable family members may be unavailable. Medication information from primary care offices and community pharmacies is often unavailable, outdated, or underused. When writing discharge medication orders, physicians may rely solely on the patient's current medication list rather than also referring to the preadmission list. At discharge, patients may not understand the discharge medication orders. After discharge, inaccuracies in the discharge medication list, formulary restrictions, and lack of communication among a patient's many providers may also contribute to the problem.

Our results, like those of others,[28] suggest that hospital pharmacists can reconcile medication discrepancies before discharge. Considering the types of preventable ADEs detected in the control group, our intervention may also have resolved discrepancies immediately after discharge, although the discrepancy rate was similar in the 2 groups 30 days later. The high rate of discrepancies in both groups at 30 days raises the possibility that primary care physicians or other providers actually introduced new discrepancies after discharge. Similarly, our intervention may have improved short-term access and adherence to medications, although no differences were found at 30 days. This finding may have been due to patients' overreporting of adherence (of which we had evidence), or to an inability of our intervention to improve this outcome.

We found no evidence that our intervention lessened the severity or duration of ameliorable ADEs, perhaps because 1 follow-up telephone call 3 to 5 days after discharge is insufficient to detect the development of ADEs as they arise. Our intervention did not show an effect on total ADE rates or health care utilization, but our study was not powered to detect such effects.

Of note, the rate of nonpreventable ADEs was actually higher in the intervention group. Besides chance or confounding, possible reasons for this include a higher rate of reporting due to increased knowledge of potential side effects in the intervention group, or an actual increase in the prevalence of these side effects due to the power of suggestion (a variation of the "nocebo" effect[30,31]). Misclassification of preventable and nonpreventable ADEs is also a possibility, although our use of blinded, independent adjudicators makes this less likely. Further study is needed to distinguish among these possibilities.

This study has several implications for the design of future interventions to reduce DRPs during and after hospitalization. First, reconciling medications at admission and discharge, as now mandated by the Joint Commission for Accreditation of Healthcare Organizations, should improve patient outcomes. Interventions should also focus on minimizing unnecessary changes from preadmission regimens to discharge medication orders. After discharge, interventions should focus on identifying discrepancies between discharge medication orders and patients' self-reported regimens. Additional follow-up interventions may be necessary to provide sustained benefits in medication adherence and discrepancies and improve detection of ameliorable ADEs.

Several studies have shown that pharmacists can successfully implement medication reconciliation, but many hospitals may find this impossible because of the expense. Whether pharmacists need to be involved in the entire process of medication reconciliation for every patient remains to be seen. It may be possible to design reconciliation processes dependent on physicians and nurses in most cases, using pharmacists for patients at particularly high risk or when medication regimens are most in doubt. Similarly, other components of our intervention (patient counseling, early follow-up) might be reserved for patients at highest risk for ADEs (eg, older patients taking multiple medications[32,33]).

Our study also has implications for methods used to evaluate the impact of pharmacist interventions. To avoid social acceptability bias in self-reported outcomes such as adherence and discrepancies, future studies should attempt to independently assess these outcomes, eg, using pill counts, pharmacy refill rates, and confirmation of physician medication orders after discharge. Ideally, future studies should be large enough to evaluate total ADEs and allow for multivariable adjustment, subgroup analyses, and economic evaluation.

The results of this study should be viewed in light of its limitations, including single-site design, limited sample size, and fair interrater reliability of our primary outcome. However, all disagreements regarding preventable ADEs were resolved by consensus and with the use of a third adjudicator when necessary. Also, we cannot exclude the possibility that our results were due to a nonspecific effect of increased patient interaction in the intervention arm. However, the strong relationship between the types of actions taken by pharmacists and the types of preventable ADEs seen in the control arm make this unlikely.

In conclusion, pharmacist counseling and follow-up were associated with lower rates of preventable ADEs after discharge, likely through reduction in medication discrepancies. Greater roles for pharmacists in hospital care should be considered, especially as medication reconciliation becomes mandatory. Future studies should focus on optimizing these interventions, identifying patients most likely to benefit from pharmacist involvement, and studying and improving cost-effectiveness.

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