Pharmacist Medication Assessments in a Surgical Preadmission Clinic

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Background: In the hospital setting, postoperative admission is a key vulnerable moment when patients are at increased risk of medication discrepancies. This study measures the reduction of medication discrepancies associated with a combined intervention of structured pharmacist medication history interviews with assessments in a surgical preadmission clinic and a postoperative medication order form.

Methods: In the Surgical Pharmacist in Preadmission Clinic Evaluation (SPPACE) study, patients who had a preadmission clinic appointment before undergoing surgical procedures were eligible for inclusion. Patients were excluded if they were scheduled for discharge the same day as their surgery. Eligible patients were randomly assigned to the intervention arm (structured pharmacist medication history interview with assessment and generation of a postoperative medication order form) or to the standard care arm (nurse-conducted medication history interview with assessment and generation of a postoperative medication order form) or to the surgical arm (the multidisciplinary health care team has a patient's decreased postoperative cognitive status, which may result in a delay in clarifying and administering home medications.

Conclusion: A combined intervention of pharmacist medication assessments and a postoperative medication order form can reduce postoperative medication discrepancies related to home medications.

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Medication errors most commonly occur at the time of medication prescribing and frequently occur on the day of hospital admission. A recent study indicated that 54% of patients admitted to an inpatient unit had at least 1 unintended medication discrepancy between the patient's home medication regimen and the admission orders. A major reason for this problem is the difficulty that the multidisciplinary health care team has in accessing a complete and accurate home medication list. Therefore, hospital admission is an interface in the process of care at which there is a potential gap in the transfer of medication-related information. This gap can lead to an increased risk of medication errors and to potentially adverse drug events.

For the surgical patient, successful transfer of information about the patient's home medication regimen to hospital prescribers can be particularly challenging. First, information about home medications may be unintentionally omitted at hospital admission. Dutchie et al reported that 29% of patients receiving cardiovascular medications had these medications inadvertently stopped on hospital admission for surgery. Second, medication errors generated at admission may be perpetuated through the hospital stay and beyond as it may be difficult to obtain information from patients to clarify home medication regimens after surgery. Because surgeons are usually not the original prescribers for home medications, clarifications regarding home medication regimens are often deferred to the inpatient pharmacist. A key challenge is the communication gap that occurs as a result of a patient's decreased postoperative cognitive status, which may result in a delay in clarifying and administering home medications.

Medication reconciliation, the process of “creating the most complete and accurate list possible of all pre-admission medications for each patient” and “comparing...
ing the list against the physician's admission, transfer and/or discharge orders" has been demonstrated to reduce patient medication errors at transition points.\(^5\)\(^\text{[p37]}\) Specifically, studies\(^6\)\(^-\)\(^11\) have shown that pharmacist involvement in the preadmission clinic may reduce the need for medication clarifications during the postoperative period. However, these studies are limited by their nonrandomized design. It is hypothesized that a system that incorporates the concept of medication reconciliation and involves the pharmacist as part of a multidisciplinary team in the surgical preadmission clinic to support medication prescribing at admission will reduce the frequency of postoperative medication discrepancies related to home medications and improve patient safety. Using a randomized controlled trial, the primary objective of the Surgical Pharmacist in Preadmission Clinic Evaluation (SPPACE) study was to evaluate whether structured pharmacist medication history interviews with assessments in the surgical preadmission clinic and the use of a postoperative medication order form reduces the number of patients with at least 1 postoperative medication discrepancy related to home medications.

**METHODS**

The study was conducted at a tertiary care university-affiliated teaching hospital in Toronto, Ontario. Between April 19, 2005, and June 3, 2005, all consecutive patients who had a surgical preadmission clinic visit before undergoing surgical procedures from the urology, plastic surgery, general surgery, thoracic surgery, gynecology oncology, and ear, nose, and throat services were eligible for inclusion. Patients were excluded if they were scheduled for discharge on the same day as their surgery. Eligible patients were centrally randomized by an independent ward clerk to the intervention or standard care arm using a random number computer generator in blocks of 24 (the daily maximum number of patients seen at the clinic). The treatment assignments were sealed in sequentially numbered, identical, opaque envelopes according to the allocation sequence. For practical reasons, the patients and clinicians were not blinded to treatment assignment.

The intervention consisted of pharmacists in the preadmission clinic conducting a standardized comprehensive medication history interview and assessment focusing on the patient’s current home medication regimen. This was documented in the health record, and the results were used by the pharmacist to generate a preprinted postoperative medication order form for preoperative home medications (Figure 1). Through the use of check boxes, the surgeon indicated on this medication order form after surgery which home medications were to be reordered. Home medications that required further clarification before being ordered on hospital admission (eg, conflicting information between patient report vs medication vials) or that required special management in the postoperative setting (eg, anticoagulants, antiplatelets, analgesics, and hypoglycemic agents) were listed in the bottom section of the form. A detailed description of the issue was written in the medical record to be considered by the surgeon at hospital admission. On reassessment, the continuation of medications listed in this section required that the physician write a separate medication order. Pharmacists conducted telephone interviews with patients they were unable to see in the clinic. If needed, the pharmacist contacted the patient’s community pharmacy or family physician to clarify the medication regimen. After postoperative admission, the pharmacist also attempted to verify with the patient if any medication changes had been made since the clinic assessment. Before study implementation, nurses and participating physicians were instructed on the proper use of the new medication order form.

Standard care consisted of nurses conducting medication histories with patients at the surgical preadmission clinic or occasionally over the telephone. Medication history information was entered in the hospital electronic health record and printed. Surgeons could refer to this printout to generate their postoperative medication orders. The patient’s community pharmacy or family physician was contacted for additional medication clarifications if needed. It was not standard practice to routinely follow-up after surgery to clarify medication changes since the clinic assessment.

The effect of the intervention was assessed primarily by comparing the number of patients with at least 1 postoperative medication discrepancy related to home medications. Secondary outcomes were the characteristics and clinical severity of these postoperative medication discrepancies. A postoperative medication discrepancy was defined as any medication clarification related to home medications that was made during the postoperative period. Medication discrepancies could be associated with any of the following: drug, dosage, duration, frequency, formulation, route of administration, appropriateness of restarting medications, orders requesting the pharmacist to clarify medications, illegible orders, and miscellaneous items. On admission of study patients to the participating surgical inpatient units, the pharmacists prospectively identified patients’ medication discrepancies. Medication discrepancies were detected using a systematic approach whereby the patients’ home medications were compared with the admission medication orders. If an incongruity was detected and the reason was not documented in the medical record, this was clarified with the medical team and patient. Medication discrepancies included unintentional and undocumented intentional discrepancies. An undocumented intentional discrepancy is one in which the physician has made an intentional choice to add, change, or discontinue a medication but is not clearly documented.\(^12\) These discrepancies were recorded because they can lead to confusion for the health care team and to potential medication errors.\(^13\)

The clinical effect of the postoperative medication discrepancies was assessed independently by 3 pharmacy clinician evaluators (O.A.F., J.J.N., and G.G.W.). For each postoperative medication discrepancy, the degree of effect was based on the potential that the discrepancy could result in “unlikely,” “possible,” or “probable” patient discomfort and/or clinical deterioration if the discrepancy was not identified and addressed. This ranking system was adapted from the method used by Cornish et al. Each evaluator independently reviewed blinded patient data collection forms, pharmacy patient profiles if available, and medical record orders if needed. The reviewers then rated the medication discrepancies and voted; if disagreements occurred, discussion ensued until a consensus was reached. Standardized assumptions were applied, including the following: (1) home medications that were unintentionally omitted would not have been ordered for 7 days (estimated mean length of patient stay at our institution) and (2) there would be a 24-hour delay in the patient receiving the medication if the discrepancies involved the need for clarification.

In our study, a baseline medication discrepancy rate of 30% was used for the sample size calculation. Using a 2-tailed test (\(\alpha = .05\) and \(\beta = .20\)) and assuming the intervention arm would reduce 50% of postoperative medication discrepancies related to home medications, a minimum enrollment of 133 patients in each arm was necessary for the study to have sufficient power. An exact \(\chi^2\) test was used to investigate differences in the proportion of patients with at least 1 medication discrepancy between treatment groups. Inter-rater reliability for assessing the severity of the medication discrepancy was analyzed using the mean of Cohen's kappa statistic.
Post-operative Doctor’s Order Sheet for Pre-operative HOME Medications

- Physician must check off either YES or NO or HOLD for each medication.
- Orders are not active until checkboxes are filled and order sheet is dated and signed by the physician.
- Any medications put on HOLD should be reassessed in 72 hours.

Pre-operative Home Medications that Require Clarification or Special Management in the Post-operative Setting

Should the following medications be ordered, the orders need to be written on a separate doctor’s order sheet.

Generated by Pharmacist: Date and Time Generated: Physician’s Signature: Date and Time Ordered:

Physician’s Name (Print): Physician’s Pager Number:

Please note that the patient’s pre-operative home medications may have changed from the time these orders were generated by the pharmacist in the pre-admission clinic.

Copies: Original – Retain in Chart Yellow – Floor Pharmacist Pink – Clinic Pharmacist

Figure 1. Postoperative medication order form.

\( \kappa \) scores. Baseline characteristics were compared using the Kruskal-Wallis test or exact \( \chi^2 \) test as appropriate. Univariate and multivariate logistic regression analyses were used to investigate predictors of at least 1 medication discrepancy. To ensure that bias was not present with per-protocol analysis of the primary outcome, a sensitivity analysis was conducted using an exact \( \chi^2 \) test. All tests were 2-sided, and a test result was deemed statistically significant at \( P \leq .05 \). Descriptive and statistical analyses were performed using SAS software (version 9 for Windows; SAS Institute, Cary, NC). The study protocol was approved by the hospital research ethics board.

RESULTS

In the study, 464 patients were enrolled, with 227 randomly assigned to the intervention arm and 237 to the stan-
standard care arm. Forty-seven patients had their plan of care changed after randomization and were not admitted to a postsurgical unit participating in the study during the study period; therefore, they were excluded from the main study analysis. One same-day-discharge patient was incorrectly randomized into the study and was also excluded from the main study analysis. Figure 2 shows the flow of participants through the trial. Per-protocol analysis was performed among the remaining 416 patients. Table 1 gives baseline patient characteristics in the intervention and standard care arms. There were no statistically significant differences between the 2 treatment arms except for the number of home medications. Patients in the intervention arm vs the standard care arm had a greater number of home medications (4 vs 3, \( P = .001 \)).

For the primary end point, 41 (20.3%) of 202 patients had at least 1 postoperative medication discrepancy in the intervention arm, compared with 86 (40.2%) of 214 patients in the standard care arm \( (P < .001) \) (odds ratio, 0.38; 95% confidence interval, 0.24-0.59). The most common postoperative medication discrepancy was omission of reordering home medications. This was the case in the standard care arm among 73 (46.5%) of 157 medication discrepancies and in the intervention arm among 22 (36.7%) of 60 medication discrepancies. Table 2 summarizes the characteristics of medication discrepancies.

The probability that a medication discrepancy might have caused discomfort and/or clinical deterioration was assessed and categorized. The results of the assessment are summarized in Table 3. There was very good or substantial agreement among evaluators in judging the potential clinical effect of the medication discrepancies. Pairwise \( \kappa \) scores for a sample of 46 medication discrepancies were calculated and ranged from 0.78 to 0.89; the mean \( \kappa \) score was 0.84. In the standard care arm, 104 (66.2%) of 157 medication discrepancies had the potential to cause possible or probable patient discomfort and/or clinical deterioration, compared with 35 (38.3%) of 60 medication discrepancies in the intervention arm. Twenty-six (12.9%) of 202 patients in the intervention arm had at least 1 postoperative medication discrepancy with the potential to cause possible or probable patient discomfort and/or clinical deterioration, compared with 64 (29.9%) of 214 patients in the standard care arm \( (P < .001) \). Examples of the medication discrepancies are summarized in the table.

To ensure that bias was not present as a result of using the per-protocol method, a sensitivity analysis was conducted for the primary outcome (Table 4). In this analysis, the difference between the 2 treatment arms in the number of patients with at least 1 postoperative medication discrepancy remained statistically significant.

The association between baseline patient characteristics and medication discrepancies was also evaluated (Table 5). The number of home medications was a weak univariate (odds ratio, 1.09; 95% confidence interval, 1.03-1.15) and multivariate (odds ratio, 1.11; 95% confidence interval, 1.04-1.18) predictor of medication discrepancies, while increasing age was a weak predictor of having a medication discrepancy in the univariate model only (odds ratio, 1.02; 95% confidence interval, 1.01-1.04). The effect of the intervention remained statistically significant \( (P < .001) \) after adjustment for all other predictor variables.

To our knowledge, our study is the first randomized controlled trial to evaluate the effectiveness of a pharmacist in-
intervention in a predmission clinic that supports subsequent physician medication prescribing for surgical patients on hospital admission. Our model uses a combined intervention of the pharmacist as part of the multidisciplinary team completing structured medication assessments and a postoperative medication order form in the surgical preadmission clinic. In the intervention arm, 41 patients (20.3%) had at least 1 postoperative medication discrepancy related to home medications, compared with 86 patients (40.2%) in the standard care arm (P < .001).

Our results are consistent with previous studies that reported that medication discrepancies at the time of hospital admission are frequent and are clinically significant. These studies reported that 38.0% to 54.4% of patients had at least 1 medication discrepancy at the time of hospital admission, which is comparable to the rate of 40.2% in the standard care arm of our study. As in our study, the most common medication discrepancy identified in previous studies was omission of reordering home medications. In addition, our findings confirm the

Table 2. Characteristics of Medication Discrepancies

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Intervention Arm (n = 60)</th>
<th>Standard Care Arm (n = 157)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug omission</td>
<td>22 (36.7)</td>
<td>73 (46.5)</td>
</tr>
<tr>
<td>Orders requesting pharmacy to clarify medications (no medication orders or incomplete medication orders written)</td>
<td>4 (6.7)</td>
<td>28 (17.8)</td>
</tr>
<tr>
<td>Incorrect or omitted dose</td>
<td>5 (8.3)</td>
<td>14 (8.9)</td>
</tr>
<tr>
<td>Omission of drug formulation</td>
<td>1 (1.7)</td>
<td>9 (5.7)</td>
</tr>
<tr>
<td>Incorrect or omitted frequency</td>
<td>0</td>
<td>7 (4.5)</td>
</tr>
<tr>
<td>No indication†</td>
<td>1 (1.7)</td>
<td>6 (3.8)</td>
</tr>
<tr>
<td>Slow to restart drug therapy‡</td>
<td>9 (15.0)</td>
<td>5 (3.2)</td>
</tr>
<tr>
<td>Drug interaction§</td>
<td>3 (5.0)</td>
<td>3 (1.9)</td>
</tr>
<tr>
<td>Omission of drug name</td>
<td>2 (3.3)</td>
<td>2 (1.3)</td>
</tr>
<tr>
<td>Inappropriate route</td>
<td>3 (5.0)</td>
<td>2 (1.3)</td>
</tr>
<tr>
<td>Therapeutic duplication¶</td>
<td>3 (5.0)</td>
<td>0 (0.6)</td>
</tr>
<tr>
<td>Misspelled drug name</td>
<td>1 (1.7)</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Too soon to restart drug therapy</td>
<td>1 (1.7)</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Illegible order</td>
<td>0</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Allergy or intolerance¶</td>
<td>0</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>5 (8.3)</td>
<td>3 (1.9)</td>
</tr>
</tbody>
</table>

*General blanket order of “pharmacy to clarify medications.” There were no specific home medications listed in these orders (no medication orders), or there was no dose or frequency attributed to the medication order (incomplete medication orders [eg, fluoxetine—pharmacy to clarify]). Pharmacists were not available 24 hours daily on-site to clarify medications.

†Home medications that the patient was no longer taking at the time of the surgical procedure but that had been reordered by the physician on hospital admission.

‡Home medications on hold whose regimens should have been restarted earlier based on clinical appropriateness as determined by the physician. These medications would appear on the medication administration record and pharmacy clinical profile to prompt nurses and pharmacists to have the physician reassess or restart the medication.

§Orders for new postoperative medications that interact with home medications.

¶Orders for new postoperative medications that are therapeutic duplications of home medications.

Variable | Intervention Arm | Standard Care Arm
---|------------------|------------------|
All eligible patients | 227 | 237 |
Cancelled or delayed surgical procedures | 7 | 6 |
Changed to same-day discharge status after surgery | 3 | 9 |
Admitted to nonparticipating inpatient units | 15 | 7 |
Randomization error | 0 | 1 |
Sensitivity analysis of patients with at least 1 postoperative medication discrepancy, No./total No. (%) | 56/227 (24.7) | 86/237 (36.3) |
Assumption 1* | 56/227 (24.7) | 86/237 (36.3) |
Assumption 2† | 41/227 (18.1) | 94/237 (39.7) |
Per-protocol analysis | 202 | 214 |
No./total No. (%) of patients with at least 1 postoperative medication discrepancy‡ | 41/202 (20.3) | 86/214 (40.2) |

*Assumption that all 15 ineligible patients randomized to the intervention arm (admitted to nonparticipating inpatient units) had a medication discrepancy but that none of the 8 ineligible patients randomized to the standard care arm (admitted to nonparticipating inpatient units and randomization error) had a medication discrepancy (P = .009).

†Assumption that none of the 15 ineligible patients randomized to the intervention arm (admitted to nonparticipating inpatient units and randomization error) had a medication discrepancy and that all 8 ineligible patients randomized to the standard care arm (admitted to nonparticipating inpatient units and randomization error) had a medication discrepancy (P < .001).

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benefit reported in some earlier nonrandomized analyses that pharmacist-conducted medication histories and assessments before admission for surgery can reduce medication order clarification and the number of interventions during the postoperative stay.10

The intervention in our study incorporated the concept of medication reconciliation whereby the pharmacist strived to gather an accurate and complete medication history to proactively generate postoperative medication orders to support surgeon prescribing. Medication reconciliation at the time of hospital admission is a useful process to improve patient safety through the reduction and rectification of medication errors before patient harm occurs.6,10 According to the Joint Commission on Accreditation of Healthcare Organizations,13 medication reconciliation across the continuum of care is an expectation for all accredited hospitals.

The reduction of medication discrepancies in the intervention arm reflects the importance of obtaining accurate and complete medication histories. A review of published studies indicated that errors in prescription medication histories occurred in up to 67% of cases.14 Pharmacists are in a potentially ideal position to support the multidisciplinary team in obtaining accurate and complete medication histories because of their increased familiarity with medications.5,15 Despite the randomized nature of our study, patients who were interviewed by the pharmacists had a statistically significant higher median number of home medications than those in the standard care arm. This is consistent with findings from other studies15,16 that suggest that during medication history taking pharmacists identify more medications per patient than physicians or nurses. The estimated time required for each pharmacist to complete the medication record review for each patient in our study was approximately 20 minutes. Furthermore, by placing a pharmacist upstream in the process of care to proactively take a medication history and generate medication orders to support the surgeon, the need for reactive time-consuming postadmission order reconciliation is minimized.

Despite the combined intervention, there were 41 patients (20.3%) in the intervention arm who had at least 1 postoperative medication discrepancy related to home medications. Key reasons for these medication discrepancies included patients reporting new medications after surgery that were not captured at the surgical preadmission clinic, inadvertently missed postoperative medication order forms, or medications that were added by other medical consultation services after the pharmacist surgical preadmission clinic interview. Other reasons for medication discrepancies included duplication of home medications with other postoperative medications or home medications that had been placed on hold and not restarted. It is important that pharmacists check after surgery whether any changes to the medication regimen have occurred since the presurgical visit, which the surgical pharmacists attempted to do in our study. Although clinicians were in-service on the proper use of the medication order form before study implementation, frequent reminders on the use of the form may be necessary until this becomes part of routine practice. Furthermore, it is important to validate patient home medication regimens with other sources and to reconcile medication discrepancies at the surgical preadmission clinic whenever possible.

Our study had several limitations. For practical reasons, the treatment arm to which a patient was randomized could not be blinded from the patient or the clinicians. To minimize bias, a systematic approach was used to identify medication discrepancies in a reproducible format through the comparison of admission orders with the home medication regimens. The secondary analysis, the clinical effect of the medication discrepancies, was performed retrospectively, and interrater reliability of the assessments was analyzed using a subset of medication discrepancies. Although every effort was made to conceal the treatment arms during the clinical assessment, the assignment of the patient was unblinded if the independent assessors thought they needed to look into the medication discrepancy in more detail. For ethical rea-

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Univariate Logistic Regression</th>
<th>Multivariate Logistic Regression</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Odds Ratio (95% CI)</td>
<td>P Value</td>
</tr>
<tr>
<td>Age, y</td>
<td>1.02 (1.01-1.04)</td>
<td>.003</td>
</tr>
<tr>
<td>Female sex</td>
<td>0.96 (0.63-1.46)</td>
<td>.84</td>
</tr>
<tr>
<td>Length of stay</td>
<td>1.02 (1.00-1.05)</td>
<td>.10</td>
</tr>
<tr>
<td>Length of time between surgical preadmission clinic appointment and surgical procedure</td>
<td>1.02 (0.99-1.04)</td>
<td>.29</td>
</tr>
<tr>
<td>No. of home medications</td>
<td>1.09 (1.03-1.15)</td>
<td>.002</td>
</tr>
<tr>
<td>Surgical service</td>
<td>1.37</td>
<td></td>
</tr>
<tr>
<td>Ear, nose, and throat</td>
<td>1.39 (0.72-2.65)</td>
<td></td>
</tr>
<tr>
<td>General surgery</td>
<td>1.21 (0.61-2.40)</td>
<td></td>
</tr>
<tr>
<td>Gynecology oncology†</td>
<td>1.06 (0.52-2.24)</td>
<td></td>
</tr>
<tr>
<td>Plastic surgery†</td>
<td>1.02 (0.38-2.72)</td>
<td>1.10 (0.44-2.74)</td>
</tr>
<tr>
<td>Thoracic surgery†</td>
<td>2.01 (1.03-3.93)</td>
<td>2.01 (1.03-3.93)</td>
</tr>
<tr>
<td>Intervention arm randomization</td>
<td>0.38 (0.24-0.59)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.
*The urology surgical service is omitted from the table because it is the reference surgical service to which other surgical services are compared.
†Grouped in the multivariate logistic regression analysis.
The incidence and severity of adverse drug events and their potential impact on patient safety has been extensively studied. However, the focus has primarily been on inpatient units, and fewer studies have investigated the impact of such incidents on patients discharged from hospital.\(^ {17} \) Actual adverse drug events and cost-benefit analyses from implementation of such an initiative can also be further investigated.

**CONCLUSIONS**

Structured pharmacist medication history interviews with assessments and the generation of a postoperative medication order form can significantly reduce postoperative medication discrepancies related to a patient’s home medications. The involvement of a pharmacist as part of the multidisciplinary team in the surgical preadmission clinic can improve patient safety during hospital admission.

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**Author Contributions:** Study concept and design: Kwan, Fernandes, Nagge, Wong, Huh, Hurn, and Bajcar. Acquisition of data: Kwan, Fernandes, Wong, and Pond. Analysis and interpretation of data: Kwan, Fernandes, Nagge, and Bajcar. Drafting of the manuscript: Kwan, Fernandes, Pond, and Bajcar. Critical revision of the manuscript for important intellectual content: Kwan, Fernandes, Nagge, Wong, Huh, Hurn, and Bajcar. Statistical analysis: Pond. Administrative, technical, and material support: Kwan, Fernandes, Wong, Huh, and Hurn. Study supervision: Kwan, Fernandes, Nagge, and Bajcar.

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