Medication errors occur regularly in hospitalized patients, with reported frequencies of up to 59%. A substantial number of errors occurs when drugs are prescribed. Prescriptions by surgeons and continuation of preadmission medicines are potential risk factors for prescribing errors.

In general, up to 27% of prescribing errors in hospital are caused by incomplete medication records at the time of admission, and approximately 54% of patients are reported to have at least one unintended discrepancy in their admission medication record. Prescribing is not a routine task of surgeons and is generally limited to a few analgesics, antibiotics, antithrombotics, and sedatives. This limited experience may explain the increased risk for prescription errors among surgical specialties.

In elective surgery, preoperative screening can be carried out by anesthesiologists and surgeons; often, they prepare their own preoperative medication history of the patient. These separate histories should, of course, be identical, but one study showed that 73% of patient records contained at least one discrepancy. The authors suggested that medication reconciliation by a pharmacist could be a solution to this problem. Indeed, several medication reconciliation performed by pharmacy technicians at the time of preoperative screening

**BACKGROUND:** Medication errors occur regularly in surgical patients, especially due to transfer problems at the time of hospital admission. A method for decreasing the error rate is medication reconciliation by hospital pharmacists as part of a preoperative clinic. The role of pharmacy technicians in this process has not been studied.

**OBJECTIVE:** To study the use of pharmacy technicians in medication reconciliation by measuring the effect of early reconciliation in the preoperative clinic on medication and allergy discrepancies and on inadvertent continuation of antithrombotics. A secondary objective was to study the effect of community pharmacist follow-up on recommendations to discontinue antithrombotic therapy.

**METHODS:** During the preintervention measurement period, patients received usual care by anesthesiologists, who recorded the medication and documented allergies of the patient. The intervention consisted of the addition of a pharmacy technician to the preoperative screening clinic to perform the same tasks as anesthesiologists as related to medication reconciliation. If necessary, the patient was advised on stopping the antithrombotic. On the day that the patient was supposed to stop the antithrombotic, that person's community pharmacist contacted the patient to determine whether this had been done. The main outcome measures were the proportions of patients with one or more medication discrepancy, one or more allergy discrepancy, and one or more antithrombotic error.

**RESULTS:** In the preintervention period, 204 patients were evaluated; 93 were included in the postintervention analysis. The proportion of patients with one or more medication discrepancy (RR 0.29; 95% CI 0.12 to 0.71) was statistically significantly reduced in the postintervention group. The proportions of patients with one or more allergy discrepancy (RR 0.76; 95% CI 0.35 to 1.64) and one or more antithrombotic errors (RR 0.18; 95% CI 0.02 to 1.33) were reduced, but not significantly. Follow-up by the community pharmacist did not identify any patients who had not followed the preoperative clinic's advice on temporarily withholding their antithrombotics.

**CONCLUSIONS:** The results of this study show that pharmacy technicians can be successfully assigned to a preoperative clinic, resulting in a statistically significant decrease in medication discrepancies.

**KEY WORDS:** allergy discrepancies, anesthesiologists, antithrombotic use, elective surgery, medication discrepancies, medication reconciliation, pharmacy technicians.


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studies have shown the benefit of pharmacist medication reconciliation in preadmission clinics. These studies were performed in countries in which the number of hospital pharmacists is generally higher than it is in the Netherlands. In Dutch hospitals, it is common for pharmacists to delegate tasks to pharmacy technicians because of their high-quality education and additional in-hospital training courses. The supervision of these delegated tasks remains the responsibility of hospital pharmacists. Medication reconciliation is perceived to be a task that could be performed by pharmacy technicians, but evidence in international literature is limited. Within the Netherlands, there is evidence from projects of medication reconciliation by pharmacy technicians indicating that technicians may have the capacity to reduce unintended medication discrepancies at the time of hospital admission as effectively as other healthcare professionals. Because surgeons are more likely to commit prescribing errors, these projects are mostly performed in surgical wards. A problem often encountered in these projects is the fact that antithrombotic therapy must be withheld for a few days preceding surgery; however, many patients have continued their antithrombotics. This may lead to postponement of surgery or a higher risk of bleeding. By means of earlier medication reconciliation, namely, at the time of preoperative screening, this problem could be solved. Improved communication of these instructions to the patient by skilled pharmacy technicians and follow-up by the patient’s community pharmacist may increase the proportion of patients who correctly withhold their antithrombotic drugs preceding elective surgery.

Therefore, we set up an interventional study aimed at determining the frequency of medication and allergy discrepancies before and after implementation of medication reconciliation by pharmacy technicians at the time of preoperative screening. This medication reconciliation also involved communication to the patient of instructions on temporarily withholding antithrombotics, as well as follow-up by the community pharmacist.

**Methods**

**SETTING**

A prospective intervention study was conducted in the preoperative screening clinic of the TweeSteden hospital in Tilburg and Waalwijk, the Netherlands. The TweeSteden hospital is a 500-bed general teaching hospital, consisting of 2 locations; the main location is situated in Tilburg and a smaller location is in Waalwijk. In the preoperative screening clinic, anesthesiologists screen a patient’s medical condition and history (including medication) to determine whether surgery can be performed safely; this preoperative screening takes place in both locations. Surgery is performed at the main location in Tilburg.

The study did not need institutional review board approval. According to Dutch medical ethics law, only research that influences the integrity of study participants (ie, has a substantial impact on patient care) is subjected to medical ethical approval. This is not the case in our study because the intervention consists of advice on the correct drug by the pharmacist to the anesthesiologist, who is free to correct this list according to his or her beliefs. Therefore, the integrity of the patient is not influenced by the intervention (the impact on patient care is low). The study complied with Dutch privacy regulations.

**STUDY POPULATION**

Included were patients who planned to undergo elective general surgery and were seen at the preoperative screening clinic by the anesthesiologist. Patients planning for other types of surgical procedures (eg, orthopedic) were excluded. Patients in the preintervention period were seen by the anesthesiologist at both locations of the hospital. The same anesthesiologists work at both locations. In the postoperative period, only the patients seen in Tilburg were included, for logistical reasons (the hospital pharmacy is located only in the Tilburg location).

**STUDY PERIOD**

The study was performed from March to December 2007 and consisted of a 4-month preintervention measurement period (March–June 2007), a 2-month period in which the new medication reconciliation process was implemented (July and August 2007), and a 4-month postintervention measurement period.

**USUAL CARE**

During the preintervention measurement period, patients received usual care by anesthesiologists at the preoperative screening clinic. Anesthesiologists recorded the patient’s medication history (generally using patient-provided information, without using records of the community pharmacy) and documented drug allergies. When it was necessary that antithrombotics be withheld for a few days preceding surgery, the anesthesiologist communicated this to the patient. The protocol indicates that coumarins are to be withheld for a few days and that aspirin and/or clopidogrel are withheld only in certain types of surgery (with high risk of bleeding). For patients undergoing vascular procedures or in those with stents, antiplatelet medication was never withheld. Adherence to anesthesiologist advice in preintervention screening regarding antithrombotic use was not checked.
INTERVENTION

The intervention consisted of the addition of a pharmacy technician to the preoperative screening clinic. Before the intervention started, the pharmacy technician was trained regarding communication skills, definitions of allergic reactions, and pharmacotherapy in general and anticoagulants in specific. This specialized training was provided by the hospital pharmacists.

The pharmacy technician collected, by fax, community pharmacy medication records of the patients on the day of the preoperative screening. When the patient came to the clinic, he or she was first seen by the pharmacy technician. The technician spoke with the patient and reconciled the drug therapy by verifying the medication record from the community pharmacy against information provided by the patient. Most importantly, the community pharmacy records were checked against information given by the patient to identify recent therapy discontinuations or other changes. The same was done for drug allergies documented in the community pharmacy records. Based on the patient’s therapy, the technician prepared a recommendation on antithrombotics for the anesthesiologist. A hospital pharmacist supervised these actions (checked the reconciled medication list, reconciled allergies, and advised on antithrombotics), made corrections and, when necessary, provided additional advice to the anesthesiologist (number of corrections was not documented). After the checks by the hospital pharmacist, the pharmacy technician delivered the reconciled medication list, including allergies and advice on antithrombotics, to the anesthesiologist. The anesthesiologist could modify the drug and allergy list and the antithrombotic advice when this was considered necessary.

After this medication reconciliation, the patient saw the anesthesiologist, who did the medical screening. The final antithrombotic decision was reported to the pharmacy technician by the anesthesiologist. Before leaving the preoperative screening clinic, the patient was informed of this decision by the pharmacy technician and given written instructions. Additionally, the patient’s community pharmacist was informed regarding the antithrombotic recommendation. On the day that the patient was supposed to withhold the antithrombotic, the community pharmacist contacted the patient to check whether this was done.

GOLD STANDARD

In both measurement periods, medication and allergy reconciliation was performed at the time of hospital admission by the pharmacy technician under supervision of the hospital pharmacist. This reconciliation resulted in a list of drugs that was accepted by the treating surgeon; it was then considered the gold standard with which the drug and allergy histories documented by the anesthesiologist and the pharmacy technician at the preoperative screening clinic were compared. At the time of hospital admission, the patient was asked whether he had stopped or continued the antithrombotic.

DEFINITIONS AND CLASSIFICATION

Medication discrepancy was defined as any deviation in the drug regimen from the gold standard as noted by the anesthesiologist (preintervention measurement period) or by the pharmacy technician at the preoperative clinic (postintervention measurement period). Discrepancies were classified into 9 subtypes: (1) wrong name of the drug, (2) wrong strength, (3) wrong dosage, (4) wrong dosage form, (5) wrong administration route, (6) not documented on the anesthesiologist’s list, compared with the gold standard, (7) on the anesthesiologist’s list but should not be, compared with the gold standard, (8) not documented on the pharmacy technician’s list from the preoperative clinic, compared with the gold standard, (9) on the pharmacy technician’s list from the preoperative clinic but should not be, compared with the gold standard.

An allergy discrepancy was defined as any deviation from the gold standard in the allergy history as noted by the anesthesiologist (preintervention measurement period) or by the pharmacy technician at the preoperative clinic (postintervention measurement period). Allergy discrepancies were classified into 4 subtypes: (1) missing on the anesthesiologist’s list, compared with the gold standard, (2) on the anesthesiologist’s list but should not be, compared with the gold standard, (3) missing on the pharmacy technician’s list in preoperative clinic, compared with the gold standard, and (4) on the pharmacy technician’s list in preoperative clinic but should not be, compared with the gold standard.

An antithrombotic error was defined as either incorrect continuation of the antithrombotic when it should have been withheld, or incorrect withholding of the antithrombotic when it should have been continued.

The medication was classified according to the Anatomical Therapeutic Chemical classes.9

DATA COLLECTION

Data on patient characteristics (age, sex, duration of hospital admission, number of drugs per patient) were collected. The medication list from the anesthesiologist (preintervention measurement period) and the medication list from the pharmacy technician in the preoperative clinic (postintervention measurement period) were collected. The same was done for the allergy history lists. Finally, the drug and allergy lists made by a pharmacy technician on hospital admission of the patient (gold standard) were collected. At the time of hospital admission, orders to stop or continue antithrombotic use were also noted.
OUTCOME MEASURES

The main outcome measure was the proportion of patients with one or more medication discrepancy. Secondary outcomes were the proportion of patients with one or more allergy discrepancy and the proportion of patients with one or more antithrombotic error in the postintervention period compared with the preintervention period (as defined in Definitions and Classification). For calculation of the proportion of patients with one or more antithrombotic error, only patients using an antithrombotic medication were included.

DATA ANALYSIS

All data were entered into a Microsoft Access 2000 (Microsoft Corp., Redmond, WA) database and were analyzed using SPSS version 14.0 (SPSS Inc., Chicago, IL).

Sample size was calculated using α level of 0.05, power of 0.80, estimated proportion of medication discrepancies in the preintervention period of 0.35, and in the postintervention period of 0.15. This resulted in a sample size of 144 (72 in each group). Therefore, the length of the pre- and postintervention measurement periods was set at 4 months, which should make it possible to include this number of patients. The study periods were determined to last exactly 4 months, whether or not more than 72 patients would be included.

Differences in patient characteristics between the pre- and postintervention measurement periods were analyzed using the t-test for comparing means (continuous variables; for data without a normal distribution, either the t-test after log-transformation or the Mann-Whitney U test was used) or the χ² test (dichotomous variables).

For the primary and secondary outcome measures (medication discrepancy proportion, allergy proportion, antithrombotic error proportion) relative risks with 95% confidence intervals were calculated for the postintervention period compared with the preintervention period.

Results

In the preintervention period, 204 patients (64 of whom used antithrombotic medications) and, in the postintervention period, 93 patients (36 of whom used antithrombotic medications) were included. Postintervention inclusion was lower, because patients were preoperatively screened by anesthesiologists at both locations of the hospital, while pharmacy technicians saw patients only at the main location in Tilburg. Table 1 shows the main patient characteristics for both measurement periods. These characteristics did not differ statistically significantly between the pre- and postintervention measurement periods, although there was a trend toward the use of more drugs per patient in the postintervention period.

In the postintervention period, the pharmacist did not have to correct the medication verification list. However, his or her supervision led to identification of 15 drug-related problems that resulted in recommendations given to the anesthesiologist.

The relative risks for the main outcome measures in patients with one or more medication discrepancy, allergy discrepancy, and antithrombotic error, comparing the postintervention period with the preintervention period, can be found in Table 2. The proportion of patients with one or more medication discrepancy was significantly reduced in the postintervention group. The proportions of patients with one or more allergy discrepancy and one or more antithrombotic error were reduced, but not significantly.

In the preintervention period, the following medication discrepancy subtypes occurred: wrong name of medication (n = 28; 10.3% of all discrepancies); wrong strength (n = 3; 1.1%); medication missing from the list of the anesthesiologist compared with the gold standard (n = 209; 76.8%); and medication on the list of the anesthesiologist but should not be, compared with the gold standard (n = 32; 11.8%). In the postintervention period these subtypes were: wrong strength (n = 1; 1.6%); medication missing from the list of the pharmacy technician in preoperative

| Table 1. Patient Characteristics in Pre- and Postintervention Measurement Periods |
|----------------------------------|------------------|------------------|------------------|
| Characteristic                  | Preintervention (n = 204) | Postintervention (n = 93) | Statistical Analysis |
| Age (y), mean ± SD              | 59.1 ± 14.8       | 60.6 ± 16.7       | −1.5 (−5.3 to 2.3) |
| Sex (% female)                  | 63               | 62               | 1.0 (0.6 to 1.6)  |
| Duration of hospital stay (days), mean ± SD | 9.6 ± 12.0       | 8.5 ± 7.7        | −0.0 (−0.2 to 0.2) |
| Drugs per pt. (n), mean ± SD    | 3.9 ± 3.2        | 4.5 ± 3.1        | p = 0.05         |

a t-test; mean difference (95% CI).

b χ² test; OR (95% CI).

c t-test after log-transformation (difference of means of log-transformed values, with 95% CI).

d Mann-Whitney U test.
Our study confirms that a major reduction of medication discrepancies can be achieved by use of pharmacy technicians supervised by hospital pharmacists. The supervision was not necessary to correct mistakes in the actual medication verification process by the pharmacy technician, because the technicians already had long-term experience with medication verification at the time of hospital admission. For this project, only the time of verification was shifted. However, the hospital pharmacist identified additional drug-related problems.

The finding that pharmacy technicians can perform medication verification is important for countries that have relatively low numbers of hospital pharmacists per hospital, as is the case in the Netherlands. Furthermore, given that pharmacy technician salaries are generally lower than salaries of hospital pharmacists, this approach may result in a more cost-effective intervention. This topic should be the subject of specific pharmacoeconomic evaluations, which we did not include in our study. Of course, hospital pharmacists are still needed for identification of drug-related problems, but by delegating the task of medication reconciliation, substantial cost reductions seem possible.

Besides a reduction in medication discrepancies, this study also indicated that the number of patients with one or more discrepancy in their allergy history decreased from 7 (11.3%) to 8 (8.6%) due to the intervention by pharmacy technicians, but this reduction was not statistically significant (probably due to the fact that the study was not powered for this outcome). Kwan et al. also looked into discrepancies in allergy history and showed a reduction from one to no discrepancies. Allergies are potentially life-threatening, especially allergies to antibiotics that are known to cause anaphylactic shock. Our study showed that the number of discrepancies regarding allergies to antibiotics was reduced from 7 to 0, which may indicate a clinically relevant intervention.

Although the proportion of patients with one or more antithrombotic error was reduced, this reduction was not statistically significant. This was probably due to the fact that the study was not powered for the number of antithrombotic users. The errors that were identified did not concern the use of coumarins. These errors would have

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<th>Table 2. Relative Risks for Main Outcome Measures*</th>
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*One or more medication discrepancy, one or more allergy discrepancy, and one or more antithrombotic error.
*Calculated for subpopulation using antithrombotic medication (n = 64 in preintervention period and n = 36 in postintervention period).

Discussion

Previous studies have shown that medication reconciliation performed by a pharmacist in the preoperative clinic results in a substantial number of pharmaceutical interventions or in a reduction of medication discrepancies from about 40% to 20%. A reduction of discrepancies by half was also identified in a study in which pharmacy technicians were used to obtain medication histories, suggesting for the first time that technicians could have such a role.
been the most clinically relevant, because inadvertently not withholding coumarin use may lead to postponement of surgery or the use of expensive antidotes (prothrombin complex). The errors that did take place (and that were reduced by the intervention) mainly concerned the use of aspirin. In the literature, no consensus exists on the temporary withdrawal of aspirin preceding elective surgery, but recent articles show a tendency to continue antiplatelet therapy.\(^1\)

Community pharmacist follow-up did not seem to be necessary for patients to adhere to the instructions to stop use of antithrombotics (although, as mentioned before, the study was not powered to make definite conclusions). Because we did not validate actual patient follow-up by community pharmacists (we relied on community pharmacists’ statements that they had contacted the patients), this result needs to be interpreted with caution. Nevertheless, it seems that if it were for this reason only, advancement of the medication reconciliation to the time of preoperative screening is not necessary. However, providing anesthesiologists with a correct and up-to-date list of drugs is also very valuable. For example, our study indicated that 77% of the medication discrepancies in the preintervention period were due to drugs not being present on the anesthesiologist’s list because anesthesiologists generally use only patient-provided information rather than the histories documented by community pharmacies. Therefore, this medication is not taken into account for determination of the risks involved in the elective surgery; this may have clinical implications.

The study has a few limitations. First, the number of patients in the postintervention period was smaller than expected. This probably contributed to a decrease in power, but, as the pre- and postintervention patients were found to be comparable, we do not think that this has influenced the study results. A second limitation is the lack of powering on the number of patients with allergy discrepancies and the number of coumarin users. The negative finding of an effect of community pharmacist follow-up and the finding of nonstatistically significant trends for decreases in the proportion of patients with one or more allergy discrepancy and one or more antithrombotic error may be explained by this limitation. Third, a pharmacoeconomic evaluation was not part of the study, but this information is necessary to finally conclude whether the assignment of pharmacy technicians to medication reconciliation is cost-effective. Future studies should address the limitations of our study, in particular, with respect to statistical powering and to pharmacoeconomic evaluation.

Finally, part of the results of the study may be explained by use of community pharmacy records. In other words, providing anesthesiologists with these records may produce the same results. However, due to time constraints, anesthesiologists are not likely to perform full medication reconciliations. Therefore, the pharmacy technician still seems to have an additional role.

Notwithstanding these limitations, we believe that this study is one of the first to indicate that pharmacy technicians can be successfully assigned to a preoperative clinic, resulting in a statistically significant decrease in medication discrepancies.

**References**


Reconciliación de la Medicación Realizados por los Técnicos de Farmacia al Momento Preoperatorio

PMLA van den Bent, S van den Broek, AK van Nunen, IBM Harbers, y AW Lenderink


**EXTRACTO**

**TRANSFONDO:** Los errores en medicamentos se producen regularmente en pacientes quirúrgicos, sobre todo debido a problemas de transferencia en el momento de ingreso al hospital. Un método para disminuir la tasa de errores es la reconciliación de medicación que ha sido realizado por farmacéuticos hospitalarios como parte de sus actividades en una clínica pre-operatoria. El papel de los técnicos en farmacia en este proceso no ha sido estudiado anteriormente.

**OBJETIVO:** El objetivo primario fue estudiar el papel de los técnicos de farmacia en la reconciliación de medicación, midiendo el efecto de la reconciliación temprana en la clínica pre-operatoria en cuanto a discrepancias en la documentación de medicamentos, alergias, y la continuación inadvertida de medicamentos antitrombóticos. El objetivo secundario fue estudiar el efecto del seguimiento del farmacéutico comunitario sobre la interrupción de la terapia antitrombótica.

**MÉTODOS:** Durante el período de medición antes de la intervención, los pacientes recibieron cuidado usual por anestesiólogos, quienes documentaron los medicamentos y las alergias del paciente. La intervención consistió en la adición de un técnico de farmacia a la clínica pre-operatoria que realizó las mismas tareas de los anestesiólogos. Si era necesario, el paciente fue informado sobre la necesidad de interrumpir la terapia antitrombótica. El día en que el paciente se suponía que detuviera el tratamiento antitrombótico, el propio farmacéutico comunitario se pusó contacto con el paciente con el fin de comprobar si éste era el caso. Las principales medidas de resultados que se tomaron fueron las proporciones de los pacientes con uno o más discrepancias en sus medicamentos, uno o más discrepancias en sus alergias y uno o más errores en el uso de los antitrombóticos.

**RESULTADOS:** Se incluyó 204 pacientes en el periodo antes y 93 en el periodo después de la intervención. La proporción de pacientes con uno o más discrepancias en sus medicamentos (riesgo relativo [RR] 0.29; intervalo de confianza [IC] 0.12 a 0.71) fue estadísticamente reducida en el grupo después que se introdujo la intervención. La proporción de los pacientes con uno o más discrepancias en sus alergias (RR 0.76; IC 0.35 a 1.64) y uno o más errores en el uso antitrombóticos (RR 0.18; IC 0.02 a 1.33) fueron reducidos, pero estos no alcanzaron ser estadísticamente significativos. El seguimiento de los farmacéuticos comunitarios no identificó ningún paciente que no obedeció el aviso de la clínica pre-operatoria de suspender temporalmente su terapia antitrombótica.

**CONCLUSIONES:** Estos resultados demuestran que los técnicos de farmacia pueden ser exitosamente asignados a la clínica pre-operatoria, resultando en una reducción estadísticamente significativa en las discrepancias de medicamentos.

Traducido por Carlos da Camara