ORIGINAL RESEARCH

# Quality of Best Possible Medication History upon Admission to Hospital: Comparison of Nurses and Pharmacy Students and Consideration of National Quality Indicators

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## ABSTRACT

**Background:** Medication reconciliation at transitions of care increases patient safety. Collection of an accurate best possible medication history (BPMH) on admission is a key step. National quality indicators are used as surrogate markers for BPMH quality, but no literature on their accuracy exists. Obtaining a high-quality BPMH is often labour- and resource-intensive. Pharmacy students are now being assigned to obtain BPMHs, as a cost-effective means to increase BPMH completion, despite limited information to support the quality of BPMHs obtained by students relative to other health care professionals.

**Objectives:** To determine whether the national quality indicator of using more than one source to complete a BPMH is a true marker of quality and to assess whether BPMHs obtained by pharmacy students were of quality equal to those obtained by nurses.

**Methods:** This prospective trial compared BPMHs for the same group of patients collected by nurses and by trained pharmacy students in the emergency departments of 2 sites within a large health network over a 2-month period (July and August 2016). Discrepancies between the 2 versions were identified by a pharmacist, who determined which party (nurse, pharmacy student, or both) had made an error. A panel of experts reviewed the errors and ranked their severity.

**Results:** BPMHs were prepared for a total of 40 patients. Those prepared by nurses were more likely to contain an error than those prepared by pharmacy students (171 versus 43 errors, $p = 0.006$). There was a nonsignificant trend toward less severe errors in BPMHs completed by pharmacy students. There was no significant difference in the mean number of errors in relation to the specified quality indicator (mean of 2.7 errors for BPMHs prepared from 1 source versus 4.8 errors for BPMHs prepared from ≥ 2 sources, $p = 0.08$).

**Conclusions:** The surrogate marker (number of BPMH sources) may not reflect BPMH quality. However, it appears that BPMHs prepared by pharmacy students had fewer errors and were of similar quality (in terms of clinically significant errors) relative to those prepared by nurses.

## RÉSUMÉ

**Contexte :** L'établissement du bilan comparatif des médicaments au moment du transfert des soins accroît la sécurité des patients. L'obtention d'un meilleur schéma thérapeutique possible (MSTP) exact à l'admission en est une étape clé. Des indicateurs nationaux de la qualité sont utilisés comme critères de substitution pour évaluer la qualité des MSTP, mais il n'y a pas de documentation se penchant sur leur exactitude. Obtenir un MSTP de grande qualité est souvent exigeant sur le plan du personnel et des ressources. Des étudiants en pharmacie se voient maintenant confier l'élaboration de MSTP, une façon peu coûteuse d'accroître les taux de réalisation de MSTP; or, il n'y a que peu d'information pour valider le degré de qualité des MSTP obtenus par des étudiants en comparaison avec ceux produits par d'autres professionnels de la santé.

**Objectifs :** Déterminer si l'indicateur national de qualité basé sur le recours à plus d'une source de renseignements pour réaliser un MSTP est un vrai marqueur de qualité et évaluer la qualité relative des MSTP de la part des étudiants en pharmacie et du personnel infirmier.

**Méthodes :** Dans la présente étude prospective réalisée sur une période de deux mois (en juillet et en août 2016), les chercheurs ont comparé les MSTP recueillis auprès du même groupe de patients par du personnel infirmier et par des étudiants en pharmacie qualifiés dans les services des urgences de deux établissements faisant partie d'un important réseau de santé. Un pharmacien relevait les divergences entre les deux versions du MSTP et imputait l'erreur soit au personnel infirmier, soit à l'étudiant en pharmacie ou soit aux deux parties. Un groupe d'experts a étudié les erreurs et leur a accordé une cote selon leur degré de gravité.

**Résultats :** Des MSTP ont été réalisés auprès de 40 patients. Ceux préparés par le personnel infirmier étaient plus susceptibles de contenir une erreur que ceux établis par les étudiants en pharmacie (171 contre 43 erreurs, $p = 0{,}006$). On a noté une tendance non significative selon laquelle les erreurs commises par les étudiants en pharmacie étaient moins graves. Aucune différence significative n'a été relevée quant au nombre moyen d'erreurs par rapport à l'indicateur de qualité (2,7 pour les MSTP provenant d'une source contre 4,8 pour les MSTP provenant de deux sources ou plus, $p = 0{,}08$).

**Keywords:** medication reconciliation, best possible medication history, quality indicators, medication safety, medication history, pharmacy students, nurses

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**Conclusions :** Le critère de substitution (nombre de sources pour le MSTP) pourrait ne pas être représentatif de la qualité du MSTP. Cependant, il semble que les MSTP préparés par les étudiants en pharmacie comportaient moins d'erreurs et étaient de qualité comparable (quant aux erreurs cliniquement significatives) à ceux établis par le personnel infirmier.

**Mots clés :** bilan comparatif des médicaments, meilleur schéma thérapeutique possible, indicateurs de la qualité, sécurité des médicaments, historique des médicaments, étudiants en pharmacie, personnel infirmier

## INTRODUCTION

Medication reconciliation is beneficial for both patients and health care systems. At transitions of care, medication reconciliation increases patient safety through the reduction of medication errors, as well as through reduction of potential and actual adverse drug events.[1,2] It also decreases health care utilization by reducing hospital visits, emergency department visits, and hospital readmissions related to adverse drug events.[3]

A key step in the medication reconciliation process is obtaining a best possible medication history (BPMH), which involves interviewing the patient or a caregiver to obtain a list of the patient's home medications, and then verifying this information against at least one other reliable source, such as the patient's medication vials or the community pharmacy record.

The Safer Healthcare Now! campaign of the Canadian Patient Safety Institute, which was started in 2011, is a national program to increase the safety of health care in Canada.[4] One of the campaign's initiatives is medication reconciliation. Data from across Canada are being collected to allow comparison of local outcomes on a national basis. These data include surrogate measures of the quality of medication reconciliation, specifically BPMH quality, also known as BPMH quality indicators. These indicators include using more than one information source, using a patient or caregiver interview as one source, and ensuring that all pertinent information is available for each medication (i.e., name, strength, dose, route, and frequency).[4] Although these indicators are used by the Safer Healthcare Now! campaign, there is no literature supporting them as accurate measures of quality, nor are there any studies comparing these indicators with an independent BPMH audit.

Therefore, to determine the quality of medication reconciliation, both the National Quality Forum[5] and the Safer Healthcare Now! campaign[4] recommend the independent double-check process of comparing a sample of BPMHs with a "gold standard" BPMH compiled by an independent reviewer (a trained pharmacist or other trained person familiar with the medication reconciliation process). The National Quality Forum recommends that information for 25 patients from each facility be sampled per month (about one patient per weekday) for such comparisons.[5]

Over the 2 years preceding the study, medication reconciliation on admission was implemented in the emergency departments of 2 hospitals in a Canadian health network, and was mainly performed by nurses (i.e., registered nurses [RNs] and licensed practical nurses [LPNs]). These sites were collecting data for the Safer Healthcare Now! quality indicators, but staff members had expressed concern that there were still problems with incomplete or inaccurate BPMHs. Furthermore, before the current study was undertaken, the quality of BPMHs obtained by nursing staff had not been assessed using the independent double-check method at these sites.

Challenges to obtaining a high-quality BPMH, such as lack of clinician training, time, and resources, can often be limiting factors. Studies indicate that BPMHs prepared by pharmacists are more accurate and more complete than those prepared by physicians[6] and other health care professionals,[7] whereas their quality is equal to that of BPMHs prepared by pharmacy assistants.[8] However, because of workload constraints and resource limitations, it is not feasible to have all BPMHs and medication reconciliations performed by a pharmacist, a pharmacy assistant, or a technician. As a result, performing a complete medication reconciliation, including BPMH, is typically a multidisciplinary process. The BPMH may be obtained by an RN, LPN, pharmacist, pharmacy assistant, pharmacy technician, and/or physician.

Pharmacy students are now being incorporated into the medication reconciliation process. They are being assigned to collect BPMH information, resolve discrepancies (instances of disagreement between a patient's home medications and the patient's medications ordered in hospital), and perform medication counselling activities.[9-12]

Available research suggests that pharmacy students are capable of obtaining high-quality BPMHs. In a study by Lancaster and Grgurich,[13] pharmacy students identified more medications per patient than did nurses or physicians. The agreement rate between BPMHs collected by pharmacy students and those collected by nurses and physicians was 57.6%, with 90% of the discrepancies

being related to errors of omission by nurses and physicians (either omission of a medication entirely or omission of dosage form, strength, and/or frequency).[13] In a pilot study conducted in one emergency department, pharmacy students who completed a BPMH identified medication discrepancies for 75% of patients for whom a medication history had already been completed by other clinicians.[14] Similarly, in another study, student-obtained medication histories resulted in the addition of previously undocumented prescription and nonprescription medications for more than 50% of patients for whom medication reconciliation had already been completed by another health care professional, which improved the accuracy of the medication history for 67% of patients.[15] In a retrospective study of BPMHs completed by pharmacy students compared with the usual institutional practice of electronic medication review conducted by physicians and nurses, 27.8% of the BPMHs identified discrepancies, and 49.3% of these required intervention by a pharmacist.[11] Together, these studies suggest that BPMHs collected by pharmacy students may be more complete than those collected by other health care professionals; therefore, involving pharmacy students may alleviate time and resource pressures on nursing and pharmacy professionals. However, these studies did not necessarily specify whether clinicians had been trained to complete the BPMH, a factor that may have confounded the results. Therefore, research that directly compares the quality of BPMHs collected by pharmacy students and by other trained health care professionals is required.

In addition to a potential increase in quality with student-prepared BPMHs, there may be a cost benefit. A study published in 2015 estimated that having a pharmacy student collect BPMHs would save the West Florida Hospital (in Henry Pass, Florida) more than US$2 million per year relative to the current standard of care (with nurses collecting BPMHs), based on the number of patients admitted in 2013, a saving of US$8750 per preventable adverse drug event.[11] Within the health network where the current study was conducted, pharmacy students were not involved in completing BPMHs in emergency departments. Employing this free resource and utilizing pharmacy students' full potential could be a cost-effective means to increase the quality of BPMHs.

The current study had 2 objectives: (1) to determine whether the national quality indicators currently being collected are predictive of the quality of medication reconciliation, regardless of the professional group completing the BPMH, and (2) to determine whether BPMHs collected by pharmacy students had quality equal to that of BPMHs collected by nurses.

## METHODS

This study was a prospective comparison of BPMHs obtained by nurses and by trained pharmacy students in the emergency departments at 2 sites within a Canadian health network, a 314-bed urban regional hospital and a 52-bed rural hospital. At the 2 study sites, the process for medication reconciliation on admission had been rolled out in the previous 2 years.

During the months of July and August 2016, a convenience sample of 40 patients newly admitted to the emergency department on weekdays (Monday to Friday) and for whom nursing staff had completed a BPMH, was selected. The total number of patients represented about one patient per workday at each site, based on pharmacy student availability. Selected patients were interviewed twice for their BPMH: the initial BPMH was obtained by nursing staff, as per current practice, with a second BPMH subsequently obtained by a pharmacy student.

Nursing staff consisted of both LPNs and RNs who had completed BPMH training as provided by the health network. Two third-year pharmacy summer students (one at each site) obtained the second BPMH. The students underwent the same training as nursing staff, as part of the health network's medication reconciliation initiative.

In this health network, both RNs and LPNs complete BPMHs in routine care; however, for every patient included in the current study, an RN completed the initial BPMH and a trained pharmacy student completed the second BPMH. The nursing BPMH was conducted first to ensure that physicians would have timely access to the BPMH and to facilitate the prospective medication reconciliation process upon patient admission to hospital. The 2 BPMHs for each patient were obtained independently: the pharmacy students did not review the nursing BPMH before completing their own independent BPMH. Both pharmacy students and nursing staff had access to the patient chart before completing the BPMH.

### Intervention

Nursing staff and pharmacy students prepared separate, comprehensive BPMHs. The use of at least 2 sources of information, one of which had to be a patient or caregiver interview, was required by institutional guidelines. Other potential sources of information included the community pharmacy, the family physician, medication administration records from another facility, and prescription vials (i.e., physical evidence of home medications).

For each patient, the 2 BPMH versions were compared, within 24 h of the second BPMH being completed, by an independent reviewer to determine the presence of discrepancies (i.e., differences between the 2 BPMH versions). Several staff pharmacists (including A.S.), all of whom had experience performing medication reconciliation at their respective sites, served as independent reviewers. Any discrepancies between the 2 BPMH versions were investigated by the pharmacist, through review of the patient's medication vials or the community pharmacy medication list/profile, discussion with the community pharmacist, and/or a third interview with the patient or caregiver. The pharmacist then determined the party (nurse, pharmacy student, or both) who had made an error (i.e., had recorded incorrect information) and documented this information, along with a description of the discrepancy.

### Outcomes

Errors were classified into 3 categories: errors involving allergies or intolerances, errors involving prescription medications, and errors involving nonprescription medications. In keeping with the Safer Healthcare Now! guidelines, the number of errors recorded was not affected by the number of doses of a medication administered per day.[4] For example, if the dosage was recorded incorrectly in the BPMH, and the drug was ordered for administration 3 times daily, only a single error was recorded, not 3. If the dose to be administered was recorded incorrectly in the BPMH, but the frequency was correct, the error was classified as "incorrect dose"; if the individual dose was recorded correctly, but the frequency was not, the error was recorded as "incorrect frequency".

Once the errors had been identified, a panel of practitioners who were not involved in obtaining or comparing the BPMHs (one pharmacist, one physician, and one nurse) independently determined the potential severity of each error according to the classification of Cornish and others.[16] A class 1 error is defined as unlikely to cause discomfort to the patient or clinical deterioration; a class 2 error has the potential to cause moderate discomfort or clinical deterioration; and a class 3 error has the potential to result in severe discomfort or clinical deterioration. Disagreements were resolved by group discussion, and the consensus severity class of each error was recorded.

The following Safer Healthcare Now! quality indicators were also collected: use of more than one source of information and use of a patient or caregiver interview.

### Statistical Analysis

Before comparing the number of errors by nursing staff in relation to the number of information sources used to compile the BPMH (1 source versus 2 or more sources), a Shapiro–Wilk normality text was performed, which showed that data for BPMHs using 2 or more sources were not normally distributed. Therefore, the Kruskal–Wallis nonparametric test was used for this part of the analysis, followed by a Dunn post hoc test. The selection of appropriate statistical tests to analyze the data at hand (i.e., the Kruskal–Wallis nonparametric test and the Dunn post hoc test) ensured that the calculated 90% or 95% confidence intervals represented relatively small errors, acceptable for the true values of the parameters of interest.

Numbers of errors were compared between nursing staff and pharmacy students using a Q–Q plot, which indicated $\chi^2$ distribution of the data. The Kruskal–Wallis test based on pooled variance was used to determine whether types of errors were significantly different. An $\alpha$ value of 0.05 was used for all analyses.

## RESULTS

A total of 80 BPMHs (for 40 patients) were evaluated, and pharmacists reviewed discrepancies between the paired BPMHs for 39 of these 40 patients. One participant was discharged before the discrepancy review, and data for this patient were excluded from analysis.

With 95% confidence, the number of information sources used for BPMHs collected by nurses did not affect the total number of errors, the number of errors related to allergy or intolerance, or the number of errors for nonprescription medications. However, the mean number of errors for prescription medications was significantly higher with use of 2 or more sources than with use of 1 source (2.1 versus 0.7 per patient, $p = 0.032$) (Table 1).

When the number of sources used for the BPMH was analyzed, 2 outliers were detected; the first outlier was in the total number of errors with 2 or more sources (with one BPMH having 18 errors), and the second outlier was in the number of errors involving nonprescription medications with 2 or more sources (with one BPMH having 11 errors). Fortunately, as shown in Table 1, the test results were not influenced by keeping or removing these outliers.

It was not possible to determine whether using a patient or caregiver interview as a source of information had any effect on quality of the BPMH, because interviews were used as an information source for all of the BPMHs included in this study.

**Table 1. Errors in the Best Possible Medication History in Relation to Number of Information Sources***

| Error Category | No. of Sources; Mean Value | | *U* Test Value† | $\chi^2$ (df = 1) | *p* Value |
|---|---|---|---|---|---|
| | 1 Source (*n* = 10) | ≥ 2 Sources (*n* = 29) | | | |
| All errors | 2.7 | 4.8 | With outliers: 3.17<br>Without outliers: 2.79 | With outliers: 3.84<br>Without outliers: 2.71 | With outliers: 0.08<br>Without outliers: 0.09 |
| Allergy errors | 0.3 | 0.8 | 0.82 | 2.78 | 0.36 |
| Prescription errors | 0.7 | 2.1 | 4.578 | 3.14 | 0.032 |
| Nonprescription errors | 1.7 | 1.9 | With outliers: 0.035<br>Without outliers: 0.002 | With outliers: 4.16<br>Without outliers: 3.66 | With outliers: 0.85<br>Without outliers: 0.97 |

df = degrees of freedom.
*Data in this table are based on best possible medication histories collected by nurses.
†Based on Kruskal–Wallis test.

Nurses were more likely than pharmacy students to make an error in the BPMH (total number of errors 171 versus 43, $\chi^2_{(df\ 1)} = 7.456$, $p = 0.006$). In terms of error type, nurses made significantly more errors than pharmacy students with allergies and intolerances (27 versus 6, $\chi^2_{(df\ 1)} = 5.859$, $p = 0.015$) and with prescription medications (70 versus 16, $\chi^2_{(df\ 1)} = 6.822$, $p = 0.009$). There was no difference between groups in terms of errors with nonprescription medications (74 versus 21, $\chi^2_{(df\ 1)} = 1.207$, $p = 0.27$).

When the data were analyzed by subcategory of errors, pharmacy students were less likely than nursing staff to omit prescription medications (4 versus 24, $p = 0.036$) or nonprescription medications (10 versus 58, $p = 0.003$). However, there were no significant differences between pharmacy students and nursing staff for all other subcategories (Table 2).

When the data were considered in terms of the severity of errors (mild, moderate, or severe), there was a trend toward fewer errors in each category for BPMHs obtained by pharmacy students, but this trend was not statistically significant for any severity level (Table 3). However, after removal of outliers, nursing staff were more likely than pharmacy students to commit a class 1 error (101 versus 32, $\chi^2_{(df\ 1)} = 23.464$, $p < 0.001$) (Table 3).

## DISCUSSION

In this study of BPMH quality, the use of more than one source of information (which is one of the Safer Healthcare Now! quality indicators) did not affect the number of BPMH errors. More specifically, among BPMHs obtained by nurses, there was no significant difference in the number of errors between BPMHs based on 1 source and BPMHs based on 2 or more sources except for prescription medications, for which the number of errors increased when multiple sources were used. Given that the Dunn post hoc test showed conservation of power (i.e., 80%), using the Kruskal–Wallis test was unlikely to change the findings, even with an increased sample size.

Although the quality of information sources was not evaluated in this study, these results suggest that quality may be more important than quantity (i.e., number of sources). In an observational study of pediatric patients published in 2011, completeness scores for various sources used for the medication history ranged from 0% to 100%, with an informed interview determined to be the most complete source of medication information.[17] In a study published in 2009, Kalb and others[18] found that reliance on prescription databases resulted in an incorrect BPMH 60% of the time. Nurses are not exclusively focused on medications, and they face time constraints because of other patient care tasks; as such, they may be less likely to search for additional high-quality sources of medication information, opting to complete the task of BPMH quickly rather than accurately. Nursing staff may need supplementary training on how to identify a good-quality source of medication information and when to look for an additional source. Further research into the quality of information sources is required to test this hypothesis.

In this study, the patient or a caregiver was used as a source of information for all BPMHs, as recommended by another of the Safer Healthcare Now! quality indicators; nonetheless, there

**Table 2. Number and Types of Errors for Best Possible Medication Histories**

| Type of Error | Group; No. of Errors: Nurses | Pharmacy Students | *p* Value |
|---|---|---|---|
| **Allergies and intolerances** | | | |
| Omission of an allergy or intolerance | 8 | 6 | > 0.9 |
| Inclusion of allergen to which patient is *not* allergic or intolerant | 13 | 0 | 0.054 |
| Incorrect description of reaction to allergen | 1 | 0 | 0.85 |
| No description of reaction to allergen listed | 5 | 0 | 0.34 |
| Subtotal | 27 | 6 | 0.015 |
| **Prescription medications** | | | |
| Omission of medication | 24 | 4 | 0.036 |
| Incorrect medication (not being taken or wrong medication documented) | 14 | 2 | 0.16 |
| Incorrect dose | 26 | 7 | 0.13 |
| Discrepant frequency | 6 | 3 | 0.55 |
| Subtotal | 70 | 16 | 0.009 |
| **Nonprescription medications** | | | |
| Omission of medication | 58 | 10 | 0.003 |
| Incorrect medication (not being taken or wrong medication selected) | 4 | 4 | 0.71 |
| Incorrect total daily dose | 10 | 5 | 0.70 |
| Discrepant frequency | 2 | 2 | 0.85 |
| Subtotal | 74 | 21 | 0.27 |
| **Overall total** | **171** | **43** | **0.006** |

**Table 3. Severity of Errors**

| Severity of Error | Group; No. of Errors | | $\chi^2$ (df = 1) | *p* Value |
|---|---|---|---|---|
| | Nurses | Pharmacy Students | | |
| Class 1 | 101 | 32 | With outlier: 0.423 | 0.52 |
| | | | Without outlier: 23.464 | < 0.001 |
| Class 2 | 60 | 24 | With outlier: 0.588 | 0.44 |
| | | | Without outlier: 1.898 | 0.17 |
| Class 3 | 10 | 1 | 3.203 | 0.07 |

df = degrees of freedom.

were still a considerable number of errors, which suggests that this indicator may not necessarily be associated with high-quality medication reconciliation. There may have been differences in the interview process used by nurses and pharmacy students that resulted in differing quality of information gathered. Further research is required to test this hypothesis.

The results of this study show that pharmacy students with suitable training can capably complete the BPMH with fewer errors (and errors of similar severity) than front-line nursing staff. Pharmacy students omitted fewer medications (both prescription and nonprescription) than nurses, indicating that errors by nurses may be driven by omissions. This finding is consistent with the observational trial by Lancaster and Grgurich,[13] in which pharmacy students identified more medications being taken per patient than did either nurses or physicians. Of the medications identified by pharmacy students, 68% were over-the-counter medications,[13] which is similar to the results of this study, in which 70% of the medications omitted by nursing staff (but identified by pharmacy students) were nonprescription drugs.

Although results based on error severity were not statistically significant, they suggest a trend toward fewer clinically significant (class 2 and 3) errors for BPMHs obtained by pharmacy students, which may in turn prevent moderate to severe clinical deterioration or discomfort. Similar results were seen in a randomized controlled trial, published in 2007, in which nurse-generated medication histories were compared with pharmacist-generated medication histories for patients in a surgical preadmission clinic.[19] More medication discrepancies with the potential to cause possible or probable patient discomfort and/or clinical deterioration and affecting more patients were identified in the nurse-generated medication histories. Together, these results suggest that BPMHs generated by pharmacy students are at least no worse than those generated by nursing staff in terms of clinically significant errors. Pharmacy students may therefore represent a cost-effective alternative to other health care professionals in completing BPMHs and may also increase medication safety for patients.

This study had several limitations. Although an increase in sample size would be unlikely to affect the mean number of errors with use of more than one information source, the failure to detect a statistically significant difference in other outcomes may have occurred because of the small sample size. Furthermore, because the use of one or multiple sources of information was not blinded or randomly allocated, a risk of bias or confounding cannot be ruled out.

An additional limitation relates to the study procedure. The order in which the 2 health care professionals (nurse and pharmacy student) obtained the BPMHs for each patient was not randomized. Instead, for each patient, the BPMH was first obtained by nursing staff and then by a pharmacy student. As such, there may have been increased patient recall for the pharmacy student's interview and/or patients may have been more unwell when the BPMH was obtained by nursing staff. This approach was used to ensure that the nurse's BPMH (obtained according to usual practice at the hospitals) was available promptly for the physician to use for admission orders, thus preventing any interruption in work flow or delay in admission. Given the observational nature of this study, this limitation could not be avoided.

## CONCLUSION

The Safer Healthcare Now! indicator (using more than one source of information for the BPMH) did not affect the mean number of errors in BPMHs obtained by nurses, which suggests that an independent double-check is likely a superior method for determining BPMH quality. Trained pharmacy students were able to obtain and document a BPMH with fewer errors than nursing staff and were less likely to document errors involving allergy or prescription medications. There was no significant difference in the incidence of errors involving nonprescription medications documented by pharmacy students and nursing staff or in the severity of errors between groups. The use of trained pharmacy students would be a potential solution to improve the completion of timely, accurate BPMH at the authors' facilities.

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