Medication errors are among the most common type of patient-safety error and therefore are a priority for organizational performance-improvement efforts. Medication reconciliation has been found to greatly reduce adverse drug and medication events. At one facility, a computer-generated Physician Discharge Medication Worksheet (PDMW) was developed to aid medication reconciliation. Use of this tool led to a reduction in discrepancies in drug frequency and dose, as well as therapeutic duplication, at the time of discharge. Through the use of the PDMW, medication reconciliation has been dramatically improved.

As the population ages, nurses are seeing an increase in the number of elderly patients they care for. This population presents many challenges for the bedside nurse, such as managing multiple comorbidities and helping patients balance over-the-counter and prescription medication use.

Multiple medication use is an important issue when identifying and addressing needs of the elderly population. Polypharmacy, and thus the potential for adverse drug events (ADEs), is increasing. Patients are frequently unsure about the dose and frequency of the medications—and even which medications—they are to take after being discharged from the hospital. Medication reconciliation is therefore a vital part of discharge planning.

**Literature Review**

Medication reconciliation can greatly reduce ADEs and medication errors. Generali (2004) defines *medication reconciliation* as communicating information about medication changes at transitions in patient care—admission to and discharge from the hospital. Positive clinical outcomes from medication reconciliation include a decrease in hospital readmissions, costs, and medication errors (Grasso, Genest, Yung, & Arnold, 2002).

Both the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the Institute for Healthcare Improvement (IHI) promote medication reconciliation as a way to prevent ADEs. Both agree that poor communication of medical information at transitional times in care is responsible for as many as 50% of all medication errors in the hospital and up to 20% of ADEs (IHI, 2005). JCAHO initiated a new standard in the
2006 National Patient Safety Goals (NPSGs) (JCAHO, 2005); the new standard calls for accurate and complete reconciliation of medications across the continuum of care.

Computer systems that help in medication reconciliation have been found to improve the safety of patients by decreasing the number of prescribing errors (Ong, 2002; Paquette-Lamontagne, McLean, Besse, & Cusson, 2001; Pronovost et al., 2003; Sands & Safran, 1994; Whittington & Cohen, 2004) and by organizing patient information from various databases to enhance communication among caregivers.

For instance, in a recent study at Johns Hopkins University, Provonost et al. (2003) evaluated a paper medication-reconciliation tool that listed all preadmission medications, medications ordered in the hospital, and medications ordered at discharge from the intensive care unit (ICU). This information was combined by the nurse into a discharge survey and reviewed by the physician. The results revealed an average of 10 errors per week within the initial 24 weeks of the study, but medication errors in discharge orders were nearly eliminated through the use of the discharge survey. The survey is now automated and is part of the electronic medical record.

Paquette-Lamontagne et al. (2003) studied medication reconciliation in a community setting. Admission, in-hospital, and discharge medications were written on a single form by the pharmacist, and the discharge physician then completed an integrated discharge prescription form, which resulted in a decrease in drug-related problems after discharge. The problems for those patients who did not have missing medications were reduced from 85% with the original prescription process to 36%.

Both studies considered the use of a tool to aid in the medication-reconciliation process. Automation can increase efficiency and reduce ADEs. Barnsteiner (2005) recommends that additional evidence is needed to support the automation of these tools.

This article describes how a not-for-profit, community-based facility introduced medication reconciliation into discharge planning. For the purposes of this article, medication reconciliation is defined as resolution of medication discrepancies (dose, frequency, therapeutic duplication) at the time of discharge.

**Challenge**

Medication reconciliation at the time of discharge is a communication challenge for nurses and physicians. Patients often are prescribed medications upon discharge at a dosage and frequency that differ from what they had been taking before their admission or during their hospital stay. Medications may also have been discontinued or changed. The admitting physician is often not the primary healthcare provider and is therefore unaware of the preadmission treatment regimen.

Medication instructions can also be vague, confusing, or undefined for patients as they leave the hospital. Forster, Murff, Peterson, Gandhi, and Bates (2003) found that 76 of 400 patients had ADEs after discharge, 23 of which were preventable. The authors suggest improvements in assessment and communication among caregivers as well as improved patient education about medications.
In order to provide the patient with clear medication instructions, the nursing staff needs to have the discharging physician clearly identify the home medications. Physicians may write orders such as “discharge, continue home meds” or “discharge home,” with no specific mention of the patient’s home medications. The nurse and patient may ask, “What about the discrepancy of dosages between the hospital medication and the home prescription?” or “What about the conflicting frequencies?” To complicate matters, new medications are continually being released to the public. Neither the patient nor the nurse would be likely to recognize a therapeutic duplication in medications, with new generic and brand-name drugs being introduced to the public at such a fast pace; physician review of discharge medications is therefore of utmost importance.

It is out of the scope of practice for bedside nurses to determine the medications, dosages, and frequency of medications patients are to take at home. Without the physician’s input and explanation of home medications at discharge, nurses may have difficulty giving instructions for home medication use, leaving the patients confused, frustrated, and at a higher risk for ADEs.

Many physician- and nurse-practice issues add to the complexity of medication reconciliation. With all of these variables, the need for a tool to help with reconciliation of home medications becomes evident.

**Action**

To provide patients with an accurate list of home medications, the nursing staff sought the help of the facility’s interdisciplinary documentation expert (IDE) team. The IDE team comprises representatives from each nursing discipline, physical therapy, speech therapy, occupational therapy, clinical dieticians, pharmacy, pastoral services, medical records, radiology, and case management, along with a physician representative. During the team meeting, the nurses expressed the need for the IDE team to advocate for creating a process that would help the physician order the patient’s discharge medication and resolve discrepancies between home and hospital medications.

Using the hospital information system, the IDE team developed the Physician Discharge Medication Worksheet (PDMW) to facilitate medication reconciliation at the time of discharge from the hospital. The physician representative took the form to his medical staff colleagues for feedback and revisions: the legibility of the form and its time-saving potential were immediately recognized. The PDMW provides the physician with a list of home medications to compare with the hospital medications, allows the physician to efficiently and accurately specify medication dose and frequency, and reduces the potential for therapeutic drug duplication.

The PDMW automates patient medications from the time of admission through discharge. Upon the patient’s admission, the nursing staff enters the patient’s home medications into the historical medication database. In the database, the nurse is able to review and update the patient’s home medications from the previous hospital stay at the facility. A pharmacy staff member enters the medications ordered by the physician into the pharmacy order-entry system, which results in the online medication administration record (MAR).
At discharge, the home medications and in-hospital medications (from the MAR) are compiled by the information system into the PDMW. The PDMW is automatically printed on the patient’s anticipated discharge date, which is determined and entered into the computer documentation system by the interdisciplinary healthcare team during discharge planning. The PDMW is then posted on the chart for the physician to review before or at the time of discharge. The medications are listed in alphabetical order to help identify variations in dose and frequency. Medications are also listed together, showing which ones are home medications and in-hospital medications. The physician is then able to easily select the medications that the patient is to continue at home. The bedside nurse manually enters the specified medications into the discharge instructions provided to the patient.

The primary goal of this project was to evaluate whether the PDMW was an effective tool for communication concerning medications to be taken at home following discharge. The tool was used to resolve discrepancies in dose and frequency and reduce therapeutic drug duplication.

**Methodology**

The comparative-descriptive approach was used in this project. Three variables were compared between two study groups. The first group was discharged without using the PDMW (preimplementation), and the second group was discharged with the use of the PDMW (postimplementation). A retrospective, stratified, random review was conducted on patients over the age of 65 who were discharged home from the cardiopulmonary unit over a 6-month period. An elderly population was chosen for their polypharmacological status (see *Tables 1* and *2*). A total of 50 preimplementation and 50 postimplementation records were reviewed.

On each closed medical record, the home medications were compared with the physician discharge orders by the record-review team. The record-review team was composed of two nurses and one pharmacist. The same review team conducted both the preimplementation and postimplementation record reviews. Postimplementation data were collected 4 months after the form was implemented to allow for the learning curve and communication of the new process. Medications were reviewed for dose and frequency discrepancies.

Discrepancies were recorded only if the medications were being taken at home and were also prescribed in the hospital. The discharge orders were then reviewed to determine whether the discrepancies had been resolved. For example, a patient taking Pepcid 20 mg at home was prescribed Pepcid 10 mg twice daily during the hospital stay. Did the physician state in the discharge orders which frequency and dose the patient was to continue after discharge? If the physician wrote a discharge order that resolved these discrepancies, it was scored as *clarified*. If the discrepancies were not resolved, it was scored as *unclarified*. This comparison was made for charts without the PDMW and charts with the PDMW for the variables *frequency* and *dose*.

In addition, if the reviewing pharmacist found a medication on admission and a therapeutically duplicated medication on the MAR, and the physician did not direct the patient in the discharge order to continue or discontinue the medication, it was scored
as unclarified. It was scored as clarified if the physician crossed out either medication in the discharge orders (preimplementation) or selected the medication on the PDMW (postimplementation). Table 3 displays the results of the chart reviews.

**Statistical Analysis and Results**
The goal of the PDMW was to decrease discrepancies in drug dosage and frequency and reduce therapeutic duplication. Statistical analysis was conducted to evaluate whether the tool would have a significant impact on medication reconciliation. The null hypothesis for the data analysis was that the use of the PDMW would have no effect on discrepancies in drug dosage and frequency and therapeutic duplication. The chi-square analysis in Table 3 clearly illustrates ($p < .001$) a significant difference in clarification of drug frequency and dose and elimination of therapeutic duplication with the use of the PDMW. The null hypothesis was rejected.

**Limitations**
Although the results of the project were significant—the PDMW reduced the number of drug dosage and frequency discrepancies as well as therapeutic duplication—they apply only to the study population. The sample population was restricted to patients age 65 and over who were admitted to the cardiopulmonary unit within a 6-month period. The records of patients younger than 65 or admitted under another specialty were not reviewed, nor were herbal or over-the-counter medications considered in the review. Future studies with a broader sample population from various nursing units are needed to further evaluate the effectiveness and significance of the PDMW.

**Discussion**
The PDMW was found to be effective in reducing discrepancies in frequency and dose and reducing therapeutic drug duplication at the time of discharge. Resolution of discrepancies in frequency improved by 65% with the tool. Resolution of discrepancies in dosages improved by 60%, and therapeutic drug duplication was addressed in 58% more cases.

The PDMW offered several advantages. The medication history and current medications could be easily viewed together by the physician. The time required for searching records by hand was reduced. In addition, use of the worksheets resulted in a reduction in medication errors in dosage, frequency, and therapeutic duplications, as well as in ADEs. However, the PDMW could be simplified to make comparison of medications easier. Furthermore, the necessity of manually entering in-hospital medications ordered on paper as well as the medications selected by the physician for the discharge instructions is labor-intensive and detracts from the efficiency of the whole process.

It is interesting to note that an increase in the number of medications ordered at discharge occurred with the use of the PDMW—434 medications compared to 112 without the PDMW. One conclusion is that the PDMW prompts the physician to clarify and specify all discharge medications instead of giving the common order to “discharge home, and continue home meds.”
Although review of the literature clearly shows an increase in ADEs related to the lack of medication reconciliation, much resistance was met during the initial implementation phase of this project. Poor physician compliance was evident in the use of the PDMW, with only 50 completed worksheets out of the 238 discharged records reviewed. A further study is needed to determine whether sharing these data with the physicians will increase compliance in the use of the PDMW.

**Future Application**

Computerization of the medication history and hospital medications has been shown to save healthcare-provider time, decrease errors, and expose discrepancies in medication dose and frequency and in therapeutic duplications. The process described in this project explores the benefits of a computer-generated form. *Figure 2* is a representation of the current state of medication reconciliation and a future vision with the use of the computerized medication reconciliation tool.

Imagine the benefits of a complete online medication reconciliation process. As the patient enters the hospital, the home medications prescribed at discharge from the previous hospital stay populate the admission medication history for review by the admitting nurse or pharmacist with the patient. The review includes updating the medication list to include any additions or deletions since the last hospital stay. This list of medications could be presented to the physician for review as admission medication orders are written and then sent to pharmacy for computer entry. Online order entry at this point could allow physicians to enter medications directly into the database. This would potentially eliminate errors that may occur when pharmacy staff members interpret orders and enter medications into the database. The pharmacist’s role would then be to confirm rather than enter medications, because the prescription would be transmitted directly to the online MAR.

As the patient changes levels of care during the hospital stay, medications are discontinued, reconciled, and reordered upon admission to and discharge from each level of care (e.g., ICU, surgery). At these points of transition, the physician could conduct reconciliation with either a computer-generated order sheet or an online order entry process. On the anticipated discharge date, the physician could select discharge-home medications online. This eliminates errors that may arise during transcription of medications into the patient’s home-discharge instructions, because the selected medications could automatically populate the discharge-home instructions. Automation of the physician’s medication orders at discharge could also provide automatic printing of prescriptions and faxing capabilities to the community pharmacy.

**Conclusion**

For purposes of this project, the point of discharge is exclusively addressed using the PDMW. However, this same type of tool could be used at other points of transition, such as admission and patient transfers during the hospital stay. The PDMW depends on the nurse’s entry of the medication history, as well as medication orders entered by the pharmacist, into the computer database. This provides the “computer-generated paper” for the physician to review at the time of the patient’s discharge.
When used to its fullest potential, the PDMW would provide medication reconciliation throughout the hospital stay. Through use of the PDMW, patient safety was greatly increased through resolution of discrepancies in medication dose and frequency and elimination of therapeutic duplication. It is crucial, however, that the medication reconciliation process selected be a fit for the facility’s culture and nursing framework. The PDMW has become an integral part of our facility’s nursing framework. An interdisciplinary effort with physician, nursing, pharmacy, and informatics is vital to the success of the medication-reconciliation process.
Figure 1. Physician Discharge Medication Worksheet

Recent Medications (Hospital & Home) (Check if ‘Yes’)

<table>
<thead>
<tr>
<th>Medication</th>
<th>HospHome Med</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>Continue at Home?</th>
<th>Script Given?</th>
<th>Optional Reason for Med</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMBIEZ (CLONIDINE)</td>
<td>X</td>
<td>10MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATAPRES (CLONIDINE)</td>
<td>X</td>
<td>0.1MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATAPRES (CLONIDINE)</td>
<td>X</td>
<td>0.1MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CITRACAL</td>
<td>X</td>
<td>95MG</td>
<td>BID</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COUNADIN (WARFARIN)</td>
<td>X</td>
<td>2MG</td>
<td>PO</td>
<td>1X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COUNADIN (WARFARIN)</td>
<td>X</td>
<td>5MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DARVOCET N-160</td>
<td>X</td>
<td>1TAB</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIOVAN (VALSARTAN)</td>
<td>X</td>
<td>160MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KEFLUX (CEREALEXIN)</td>
<td>X</td>
<td>250MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LASIX (FURSEMMIDE)</td>
<td>X</td>
<td>20MG</td>
<td>PO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVAQUIN</td>
<td>X</td>
<td>250MG</td>
<td>QC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Prescriptions given to Patient (Check if ‘Yes’)

<table>
<thead>
<tr>
<th>Medication</th>
<th>HospHome Med</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>Continue at Home?</th>
<th>Script Given?</th>
<th>Optional Reason for Med</th>
</tr>
</thead>
</table>

Med Allergies: ASA
Weight: 128 lbs 58.1 kg
Date Weight Taken: 03/09/04

THIS FORM IS FOR THE MEDICAL RECORD ONLY, DO NOT SEND HOME WITH PATIENT. THIS FORM IS NOT A PHYSICIAN ORDER, NO SIGNATURE REQUIRED.
**Figure 2.** Medication Reconciliation: Current State and Future Vision

- **Current state:** Physician discharge medication worksheet (PDMW)
- **Future state:** Computer-generated medication order sheet (CGMOS)
  On-line physician order entry (OLPOE)
### Table 1. Characteristics of Study Groups

<table>
<thead>
<tr>
<th></th>
<th>Preimplementation</th>
<th>Postimplementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 50</td>
<td>n = 50</td>
</tr>
<tr>
<td>Age</td>
<td>71.64</td>
<td>70.36</td>
</tr>
<tr>
<td>Male</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>29</td>
</tr>
<tr>
<td>Married</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Widowed</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Single</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Number of medications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ordered at discharge</td>
<td>112</td>
<td>434</td>
</tr>
</tbody>
</table>

### Table 2. Primary Diagnoses of Study Groups (Percentage)

#### Preimplementation (n = 50)

- Respiratory: 26
- CVA: 10
- Multitrauma: 10
- UTI: 8
- Other: 46

#### Postimplementation (n = 50)

- Respiratory: 32
- CHF: 10
- CVA: 8
- UTI: 6
- Other: 54

*Note. CVA = cerebrovascular accident; CHF = congestive heart failure; UTI = urinary tract infection.*
<table>
<thead>
<tr>
<th></th>
<th>PDMW Not Used</th>
<th>PDMW Not Used</th>
<th>Clarification Increased by</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Discrepancies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarified</td>
<td>9</td>
<td>38</td>
<td>65%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unclarified</td>
<td>23</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose Discrepancies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarified</td>
<td>14</td>
<td>41</td>
<td>60%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unclarified</td>
<td>23</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Therapeutic Drug Duplication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarified</td>
<td>0</td>
<td>15</td>
<td>58%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unclarified</td>
<td>15</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
By participating in this independent study offering, the reader will be able to

1. define medication reconciliation and its implications for patient safety
2. describe the advantages and disadvantages of the Physician Discharge Medication Worksheet (PDMW)
3. examine the future application of medication reconciliation.

1. **Medication reconciliation** in this article is defined as
   
   a. the reconciliation of duplicated dosage, frequency, and discrepancies.
   b. the resolution of medication discrepancies in dose, frequency, and therapeutic duplication at the time of discharge.
   c. the reconciliation of medications throughout the patient’s hospital stay.
   d. the clarification of the patient’s medication at the time of discharge.

2. Clinical outcomes of medication reconciliation include decreased
   
   a. hospital readmissions, costs, and medication errors.
   b. hospital readmissions, costs, and discharge medication orders.
   c. costs, confusion over medications, and hospital staff satisfaction.
   d. patient satisfaction, confusion over medications, and costs.

3. A review of the literature reveals that
   
   a. utilizing a paper system for medication reconciliation can improve patient safety.
   b. more evidence is needed to support the use of computerized medication reconciliation tools.
   c. medication reconciliation has not been shown to decrease hospital costs.
   d. the 2006 Safety Standards of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) recommend that hospitals reconcile medication at admission and discharge only.

4. JCAHO’s 2006 National Patient Safety Goals call for medication reconciliation
   
   a. upon admission.
   b. within 48 hours of admission.
   c. during all transitions in level of care.
   d. at discharge.
5. The PDMW reduces discrepancies concerning medications in all of the following except

a. dosage.

b. frequency.

c. route of administration.

d. therapeutic duplication.

6. The PDMW described in this article

a. lists both generic and trade names of all medications.

b. is not a computer-generated tool.

c. was established in order to decrease the number of medications ordered at discharge.

d. was found to decrease dosage discrepancies by 60%.

7. Determining what medications are to be taken at home is the responsibility of the

a. patient.

b. physician.

c. patient’s family.

d. bedside nurse.

8. Use of the PDMW results in all the following except

a. a reduction in clinicians’ time spent on medication reconciliation.

b. the generation of a list of historical medications and current medications.

c. a paper form on which medications have been manually entered.

d. a reduction in adverse drug events.

9. Implementation of the medication reconciliation process requires the interdisciplinary effort of

a. nurses, physicians, laboratory technicians, and informatics.

b. nurses, physicians, pharmacists, and informatics.

c. nurses, physicians, chaplains, and informatics.

d. nurses, physicians, pharmacists, and physical therapists.
10. According to the authors, medication reconciliation in the future
   a. will include online physician order entry.
   b. will not include an automated medication history.
   c. will continue to require the pharmacist to enter medications into a database.
   d. will continue to be a computer-generated paper process.

**Author's Biography**
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**References**


