Implementing Online Medication Reconciliation at a Large Academic Medical Center

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Medication reconciliation (M.R.), as a Joint Commission National Patient Safety Goal since 2005 (and now known as NPSG.08.04.01), is an important process for ensuring patient safety. Defined most simply as “comparing a patient’s medication orders to all of the medications that a patient has been taking,” the process helps avoid mistakes at patient transition points, which are some of the situations most vulnerable to error. The prevalence of medication errors—the most frequent type of medical errors—involving incomplete medication reconciliation has been extensively described. A meta-analysis showed that approximately two thirds of patients had disparities between their home medications taken and those listed in their admission orders, that 19%–75% of those disparities were unintentional, and that 11%–59% were clinically important.

Implementing M.R. in a way that easily integrates into workflow is challenging. Pharmacists may find the process time consuming and labor intensive, and physicians and nurses may not see its relevance to patient care, especially if errors with little clinical importance are found during the process. Other potential barriers include the question of ultimate responsibility for the reconciliation process—is it a pharmacy, nursing, or physician issue? For physicians, is it the responsibility of the primary care provider, the emergency department (ED) physician who triages the patient, or the specialist who has admitted the patient? If a patient is transferred to Bellevue from another hospital, is the medical record the responsibility of the admitting nurse or the floor nurse? If a staff member documents a medication list in one area, can a different staff member in a different area trust the list? In addition, because effective M.R. is an interdisciplinary process, some organizations may not have the resources required to develop a process where physicians, nurses, and pharmacists are directly and actively involved together.

Most examples of successful M.R. programs have reported on paper-based systems, the most common of which is a standardized M.R. form that often serves as a medication order form. An interdisciplinary process was undertaken by Bellevue Hospital, New York City, to develop a full, online M.R. program.

Phase 1. Moving Beyond Paper: In 2005 Bellevue piloted a paper-based M.R. process. However, this effort was unsuccessful, so an online M.R. application that would be more accessible and easier to audit was initiated. The longitudinal outpatient medication list—the definitive, electronic medication list for patients in our system—formed the basis of the M.R. project. The list included every prescription written in the electronic health record (EHR). Historical medication could also be entered into the list, representing a useful function in the outpatient setting for patients who transfer their care to Bellevue and are already on chronic medications. In a two-month pilot in Summer 2006, compliance was achieved for only 20% of patients.

Phase 2. Auditing and Mandatory Functionality: In April 2007, M.R. was made a mandatory part of the admission process; a blocking function in the EHR prevented medication orders if the admission M.R. had not been completed. Compliance rates subsequently increased to 90% throughout the hospital. To “close the loop” in the reconciliation process, in November 2007, a discharge reconciliation was made a mandatory part of the discharge process, resulting in 95% compliance.

Lessons Learned: Successful implementation of admission and discharge M.R. suggested several lessons, including (1) mandatory functionality leads to adaptation and integration of M.R. into housestaff work flows and (2) an electronic M.R. is preferable to a paper-based process in organizations with an EHR and computerized physician order entry.

Article-at-a-Glance

Background: Most examples of successful medication reconciliation (M.R.) programs have reported on paper-based systems, the most common of which is a standardized M.R. form that often serves as a medication order form. An interdisciplinary process was undertaken by Bellevue Hospital, New York City, to develop a full, online M.R. program.

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Electronic solution, noted slower implementation times and missed opportunities to better understand the reconciliation process while waiting for the technology to be built. Although a computerized physician order entry system (CPOE) facilitates the process of reconciliation, its presence alone is not sufficient. CPOE systems are only as good as the data entered into them, and inpatient systems may not integrate with outpatient records, so the process is unlikely to be fully automated. A system must be in place, generally with human intervention, to ensure that medication records are accurate.

This article describes the interdisciplinary process undertaken by Bellevue Hospital, New York City, to develop a full, online MR program. The MR process was initially piloted on paper but quickly moved online. After an initial pilot on a medicine team and a massive educational campaign, compliance rates were relatively low. Within six months, medication reconciliation was made a mandatory part of the admission process, increasing compliance; six months later, mandatory discharge reconciliation was added to the process.

Phase 1. Moving Beyond Paper

Bellevue Hospital, established in 1736, is the nation's oldest public hospital and remains the prototype of a busy, municipal health care center. As the flagship hospital of New York City's Health and Hospitals Corporation (HHC), Bellevue has 921 inpatient beds, with more than 25,000 discharges a year. Every year, approximately 950 house staff rotate through Bellevue, the principal teaching hospital for New York University School of Medicine. Bellevue has used inpatient CPOE since 2001.

In mid-2005, HHC’s patient safety office created a corporate-wide committee [of which M.N.C. was a member] tasked with the implementation of The Joint Commission’s MR National Patient Safety Goal. Although the corporate committee was responsible for overall strategy, individual hospitals were encouraged to develop their own approaches to MR that would be the most appropriate for their specific work flows. To focus on this initiative locally, Bellevue created a local, interdisciplinary MR committee [including D.B., K.R., M.N.C.], composed of physicians, nurses, pharmacists, the hospital medical director, members of the hospital’s clinical information systems team, and the quality management department. Because all inpatient services at Bellevue Hospital use electronic medication ordering but written chart documentation, we faced a unique challenge in developing an MR program. The MR committee decided to pilot a paper-based MR process. However, this effort was unsuccessful, mainly because house staff saw the MR document as “yet another form” to complete. Therefore, the committee refocused on an online MR application. Most of the committee members agreed that the online process had a higher likelihood of success because all medication ordering was already online, any information entered on paper would be less accessible, and auditing of the online system would be much easier.

Electronic MR: Overview

In implementing a computerized system, our ultimate plan was to create a tool that could accomplish the following:

■ Be incorporated into our everyday work flow
■ Create a reliable medication list that could incorporate inpatient and outpatient medication ordering activity
■ Have measurable compliance rates so that ongoing feedback could occur
■ Be shared as an interdisciplinary activity that included physicians, nurses, and pharmacists
■ Have mandatory settings if necessary to assure full compliance

The Longitudinal Medication List

The longitudinal outpatient medication list—the definitive, electronic medication list for patients in our system—formed the basis of the MR project at Bellevue. Two of the authors [K.R., K.C.] developed it as an HTML (HyperText Markup Language) page that could be launched from within the electronic health record (EHR) to take advantage of Web-based functionality that was not available within the system. The content of the list included every prescription written in the EHR, including all outpatient prescriptions and all prescriptions written on discharge for inpatients, from the time it was deployed. The list was piloted in the adult medicine primary care clinic in the Summer and deployed in Fall 2005.

An important characteristic of the medication list is that it has only a one-way interface with the EHR system. This means that all activity within the EHR involving a prescription (for example, discontinuation, modification) is brought over to the medication list; however, any activity completed directly on the list does not translate back into the EHR.

Another, and perhaps the most useful, function of the medication list is the ability to enter historical medications. This function is useful in the outpatient setting for patients who transfer their care to Bellevue and are already on chronic medications. Since the EHR only provides for a prescription function, not a historical documentation function, previously there was no systematic way to document medications that the provider did not specifically write for. A sample longitudinal
medication list is shown in Figure 1 (above).

In addition to the basic information about each medication, each entry in the list contains the following:

1. A free-text area for instructions, indications, and last dose information
2. The date on which the medication was started
3. The date of the last activity concerning the medication (for example, renew, suspend, continue)
4. The source of the information, which is represented by three different icons:
   - Rx— an active prescription written in the EHR
   - Rx (color)— a prescription entered in the EHR but automatically deactivated/expired
   - Hx— a historical medication, entered manually onto the list

Although historical medications were initially entered on the list using free-text fields, they now are entered by searching for the medication in the vendor-provided drug database for our EHR system. If the entry is present in the database, the provider clicks on the link provided, then populates the instruction and other fields. Because of the database's breadth, including many herbal and over-the-counter (OTC) medications, most medications entered into the search field are found. However, if the provider is unable to match a medication with the search, he or she then has the ability to enter the name manually. There is also a list is complete button on the longitudinal list, allowing providers to confirm the accuracy of the list for outpatient reconciliation.

Admission Reconciliation: In August 2006, after deploying the outpatient medication list, we decided to use it—the definitive source for outpatient medications— as the core component of our inpatient admission reconciliation process. In addition, the list represented the one part of the EHR where historical medications could be easily added. Because Bellevue is a referral center and receives transfers from throughout the New York City area, we needed a function that allowed for the entry of often-complex medication lists for patients who were new to Bellevue.

We decided to split the reconciliation process into two steps. After accessing the link in the EHR, the provider (generally the physician) is presented with the longitudinal medication list. At this point, he or she can “clean” the list (that is, remove old medications), add new medications to the list, or just review the list. Nurses also can edit the longitudinal list but, per hos-
hospita... may only add medications to it. Once the list is correct, the provider can then proceed to step 2 of the process—the actual reconciliation.

At this second step, the system display is split, with the patient's longitudinal medication list on top and current active inpatient orders below. For each medication, the provider has one of three options: continue on admission; suspend for admission; or change dose/formulation. Initially, the row for each unreconciled medication is green. The provider then reconciles the list by indicating his or her choice of action for each medication. Once reconciliation is complete, the row turns blue, so once the entire list is blue, the provider has finished and can click on “OK” to close out the application. Because of limitations in the EHR system, the inpatient reconciliation tool can only be used for documentation; indications on the online form do not directly translate into orders within the CPOE system. A sample inpatient reconciliation screen is displayed in Figure 2 (above).

The MR application also has a color-coded status bar across the page to indicate the “status” of the reconciliation process. The bar indicates the last activity related to the list as well as to the associated provider. The bar has three colors for the three different states of reconciliation: red for none; yellow for partial, and green for complete. A drop-down menu (Figure 1) allows providers to document instances when the patient is on no medications or when the provider is unable to assess the patient's medications.

**Discharge Reconciliation.** Discharge reconciliation is based on the same functionality as the admission process and takes advantage of the information entered by the provider throughout the patient's visit. The discharge reconciliation form has only two columns—discontinue and resume/continue. There is no need for the “change” column for obvious patient safety reasons: to a patient, changing the formulation of a medication is the same as prescribing a new one. Like for admission reconciliation, the status bar is displayed, unreconciled medications are colored green, and reconciled medications are colored blue. Because there is only a one-way interface between the hospital CPOE system and the reconciliation form, house staff complete their discharge prescriptions before the discharge reconciliation process. These prescriptions then autopopulate the discharge reconciliation form. The discharge reconciliation process is depicted in Figure 3 (page 503).

One of the most important aspects of discharge reconciliation is that it allows the provider to provide a complete, current medication list for the patient. Once the process is complete, the provider can click on the print version for patient link and produce a formatted medication list. Completing the discharge reconciliation process also ensures that the information on the hospital's medication list is the same as the one given to the

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**Figure 2.** At this step of inpatient reconciliation, the system display is split, with the patient's longitudinal medication list on top and current active inpatient orders below. Po, orally; bid, twice a day; q6h, every 6 hours; prn, as needed; tid, three times a day.
Discharge Reconciliation Form

Because there is only a one-way interface between the hospital computerized provider order entry system and the reconciliation form, house staff complete their discharge prescriptions before the discharge reconciliation process. Po, orally; bid, twice a day; tid, three times a day.

Sample Discharge Medication List

Because there is a single, definitive medication list for each patient, all changes to the list related to an admission are recorded in one place. The final discharge medication list becomes the new outpatient longitudinal medication list. OTC, over-the-counter; po, orally; tid, three times a day.

patient. Currently, information on the list is displayed in “medicarese” (for example, “BID” instead of “twice a day”), but we plan to change the frequency instructions to display in lay language for the next version of the application. Because there is a single, definitive medication list for each patient, all changes to the list related to an admission are recorded in one place. The
A 78-year-old woman with poorly controlled diabetes, hypothyroidism, hypertension, and poor compliance with medications was admitted to the medicine service for unstable angina. A longstanding Bellevue patient, her hypertension has been managed on fosinopril, 10 mg daily, for many years. The hospital formulary angiotensin-converting enzyme inhibitor has recently changed, so the patient is placed on lisinopril, 10 mg daily, during her stay. On discharge, she is instructed to continue her inpatient medications, and she receives a prescription for fosinopril 10 mg daily. Routine blood work the day before her next clinic visit shows a postassium level that is elevated from her baseline. At her next clinic visit, she brings all her medication bottles, and her physician notes that she is taking both lisinopril and fosinopril because she was instructed to continue her inpatient prescriptions. Her physician informs her to stop taking the fosinopril, and a follow-up potassium level is normal.

The house staff saw MR as yet another “regulatory requirement” offered by house staff was that, in effect, they were already documenting MR did not automatically trigger medication reconciliation portion more reliably. Nurses also were then able to refer to the outpatient medication list in the “medications” section of their (paper) assessment, thus avoiding double documentation.

■ **Inaccurate Medication Lists.** House staff were overwhelmed initially by long and cumbersome medication lists. Technical revisions were required to eliminate repetitive entries on the list. In the initial version, prescriptions and their renewals populated the list as separate entries. After catching this error, we realized that prescriptions that were not exactly the same, such as those with different numbers of refills, were also populating as separate entries. For example, when the prescription order “Lisinopril 10mg tabs 1 po daily disp 30 5 refills” was renewed on hospital discharge, but with 0 refills, both entries would populate the list, even though they were for the same medication. We also reeducated outpatient staff, this time concentrating on subspecialty clinics not as familiar with the MR concept.

■ **New Patients.** Because the medication list populates by outpatient medication activity, no such lists were found for patients new to the inpatient setting. Entering each medication one by one proved to be an onerous task for the house staff; a full list typically took several minutes. We worked with our nurses to assist in this area in attempts to bring together the admitting processes of doctors and nurses as they performed their initial assessment. In this newly developed admission process, our admitting nurses entered new entries onto the medication lists of patients new to Bellevue. As the project has progressed from the pilot phase, floor nurses have also started referring to and adding to the medication list as well. Nursing involvement has enabled our admitting physicians to complete the reconciliation portion more reliably. Nurses also were then able to refer to the outpatient medication list in the “medications” section of their (paper) assessment, thus avoiding double documentation.

■ **Lack of Performance Reports.** Our pilot demonstrated the importance of feedback to motivate staff; without performance data, it was clear that we would have difficulty knowing where to concentrate our implementation efforts. After “flags” were created on our electronic patient summaries, our ability to track patients with unreconciled medications improved dramatically, ultimately increasing compliance.

The project team learned the following lessons from this phase:
Although it was possible to integrate online MR into work flows without much disruption, house staff were not yet persuaded of its value.

Because the hospital admission process is so complex, and house staff are extremely busy, it was easy to bypass MR or just forget to do it.

There was some ambiguity regarding maintenance of the outpatient medication list (for example, permanently removing inactive medications from the list), which presented a major obstacle for the admitting team because lists for long-term Bellevue patients could be extremely dense and confusing.

The speed with which one could complete the process was a major issue. Populating the medication list for a patient new to Bellevue and on multiple medications could take up to 1 minute per medication, which added up over a call period where 8 or more patients were admitted.

Auditing compliance with MR was difficult and tedious.

**Phase 2. Auditing and Mandatory Functionality**

The next phase of MR implementation, which began in October 2006, featured the development of the MR compliance audit report. This report permitted hospitalwide auditing, with the level of detail chosen by the user (for example, hospital, service, team). Reconciliation is shown to be complete (reconciliation completed within 24 hours), delinquent (not completed), or in overall compliance (completed at some point during the admission). In addition, the report can be displayed at the “detail” level, which shows a list of patients along with hyperlinks to their actual medication reconciliation pages. This report, which eliminated the need for manual reviews, allowed for direct feedback to service chiefs and enabled the project team to benchmark performance. A sample report is shown in Figure 5 (right). Medication reconciliation status of patients is now included in management reports for attendings on the wards, so that they can see if admission reconciliation has been completed for patients on their team. These reports also indicates status of screening for deep venous thrombosis (DVT) and tobacco use. A sample report may be found in Figure 6 (right).

**Making MR Mandatory**

By November 2006, on completion of education and auditing, the vast majority of physicians were familiar with MR and its importance. In addition, the outpatient clinics became more involved in keeping the outpatient medication lists up to date. Yet, compliance remained low—an average of 10% to 65%
ing produced by the EHR’s blocking function is shown in Figure 8 (page 507).

To our surprise, the house staff generally embraced MR’s mandatory functionality, which was implemented in April 2007. They recognized the value in reconciling medications but were so immersed in their work that they welcomed the reminder. We followed a model similar to that used in our EHR system, which does not allow medication ordering until allergies have been documented.

After creating mandatory functionality, compliance rates increased to 90% throughout the hospital on a consistent basis but never reached 100% (Figure 7). Yet, in most cases, reconciliation relied on the mandatory function; few reconciliation efforts occurred at admission. In addition, the burden of the reconciliation process often fell to the night-coverage staff, who did not know the patients as well but were required to complete reconciliation before placing orders overnight. Given our desire to direct the reconciliation efforts to the admitting team at a time close to the admission process, we recently decreased the window to 12 hours. There have been calls from clinical leadership to reduce the time frame to zero to improve compliance and ensure that the admitting house staff (rather than coverage) are the ones actually completing the MR process. Because the ED uses paper orders, this remains a potential intervention.

MANDATORY DISCHARGE RECONCILIATION

With the success of the admission MR process, we realized that we needed to “close the loop” on the reconciliation process. We made the discharge reconciliation tool available in early November 2007 and, several weeks later, made it a mandatory part of the discharge process—a discharge summary could not be completed before discharge reconciliation was complete (Figure 9, page 507). Discharge reconciliation allowed for accurate communication with outside providers; provided the patient an accurate list to take home; emphasized the importance of the admission reconciliation process; and helped identify common errors, such as duplicate prescriptions for medications or substitutions of hospital formulary medications for patients’ home medications. Discharge reconciliation enforces the review of held medications, as well as focus on inpatient/outpatient discrepancies that may be due to the hospital formulary rather than clinical indications. Since the inception of mandatory discharge reconciliation, compliance has been stable at approximately 95% across the hospital. We believe that the remaining 5% of noncompliance reflects the fact that some discharge summaries are completed beyond the 24-hour window after a patient is officially discharged.

PENDING ISSUES

Despite the success of the MR project, MR remains a difficult issue for many house staff, many of whom still see it as a burden. We realized, for example, that the last 5%–10% of compliance generally comes from patients who are admitted, have admission orders written within the 12-hour window, and then do not have any changes to their medications during admission, so the mandatory trigger is never activated. On a more positive note, we have not seen an increase in delinquent discharge summaries since discharge reconciliation was made mandatory.

When MR was first implemented, house staff’s major demand was that the system link their documentation to order entry. Although the technical limitations of our system prevented us from meeting this demand, we found that the house staff were still able to comply with the reconciliation requirements. Having automatic order generation would likely have reduced the need for the order-blocking function that made admission MR mandatory.
**Figure 8.** A blocking function, shown as the warning, in the electronic health record prevents medication orders if the admission MR has not been completed. Po, orally; DC, discontinue; ASO, automatic stop order.

**Discharge Medication Reconciliation Warning**

**Figure 9.** The discharge reconciliation tool is a mandatory part of the discharge process. Disch, discharge.
Pharmacy staff have recently begun to audit the accuracy (as opposed to compliance) of reconciliations performed in the hospital. On one medical unit, for example, 80% of patients had at least one reconciliation error in their charts. Education has helped reduce the rate of error to under 40%, but it remains significant.

Another major challenge has been to work with primary care physicians to ensure that longitudinal lists are up to date. Because a list contains every prescription written since July 2005, it can become very cluttered for patients on multiple medications or who see multiple providers. Admitting a patient with a long list makes it difficult for the admitting team to obtain an accurate list, so the MR committee has been working with the ambulatory clinics to emphasize the importance of verifying patient medication lists at every visit. The major burden is the upfront time it takes to clean the list; however, after this initial effort, subsequent verification becomes much easier.

Lessons Learned

The successful implementation of admission and discharge MR taught us several important lessons, as follows:

- Hospital leadership, both administrative and clinical, must take a visible and active role in supporting and emphasizing the importance of MR initiatives.
- Work-flow changes involved in implementing MR can lead to a steep learning curve, so initially frequent education and reinforcement may be required.
- Because of increased demands on house staff, MR must be emphasized and prioritized.
- House staff want to comply with safety initiatives, and actually prefer mandatory functions, rather than reminders, so that they do not have to remember to complete certain functions.
- Mandatory functionality leads to adaptation and integration of MR into house staff work flows.
- In institutions with CPOE and an EHR, an electronic MR function is vastly preferred to a paper process because of better monitoring, auditing, and compliance.

MR is an interdisciplinary process, and involvement from all parties brings different perspectives on dealing with challenges involved in changes to work flows.

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