Development of a tool within the electronic medical record to facilitate medication reconciliation after hospital discharge

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ABSTRACT

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Serious medication errors occur commonly in the period after hospital discharge. Medication reconciliation in the postdischarge ambulatory setting may be one way to reduce the frequency of these errors. The authors describe the design and implementation of a novel tool built into an ambulatory electronic medical record (EMR) to facilitate postdischarge medication reconciliation. The tool compares the preadmission medication list within the ambulatory EMR to the hospital discharge medication list, highlights all changes, and allows the EMR medication list to be easily updated. As might be expected for a novel tool intended for use in a minority of visits, use of the tool was low at first: 20% of applicable patient visits within 30 days of discharge. Clinician outreach, education, and a pop-up reminder succeeded in increasing use to 41% of applicable visits. Review of feedback identified several usability issues that will inform subsequent versions of the tool and provide generalizable lessons for how best to design medication reconciliation tools for this setting.

INTRODUCTION

Unintentional medication discrepancies, defined as unexplained differences in documented regimens across different sites of care,^{1 2} represent an important cause of adverse drug events (ADEs) among hospitalized and recently discharged patients.³⁻⁵ One possible way to prevent these discrepancies is medication reconciliation, 'a process of identifying the most accurate list of all medications a patient is taking... and using this list to provide correct medications for patients anywhere within the healthcare system.'6 Initially driven in part by The Joint Commission's National Patient Safety Goal,⁷ most medication reconciliation efforts to date have focused on the inpatient setting. However, medication reconciliation needs to continue after the patient is discharged, and in fact, such reconciliation may be as or more important than inpatient reconciliation efforts, for the following reasons:

- A patient's primary-care physician (PCP) may be in the best position to know precisely the patient's preadmission medication regimen and may therefore be able to correct errors in the inpatient reconciliation process.
- 2. Based on the PCP's longitudinal relationship with the patient and potentially robust knowledge of the patient's medical history, the PCP

may have strong opinions about what changes should be made to a patient's medication regimen after discharge.

3. If the postdischarge medication regimen is poorly documented or inaccurate, that is, in the ambulatory electronic medical record (EMR), any errors may be propagated to subsequent ambulatory or inpatient encounters, perpetuating the cycle of medication history errors, incorrect medication orders, and ADEs.⁸

Some new electronic inpatient medication reconciliation tools now automatically replace the ambulatory EMR medication list with hospital discharge medication orders.⁹ This may actually cause more problems than it solves because it removes the PCP from the reconciliation process and fails to address any of the above issues.

To facilitate postdischarge medication reconciliation, Partners Healthcare designed and built a new tool within the ambulatory EMR. As part of a federally funded cluster-randomized controlled trial (clinicaltrials.gov identifier NCT00740675), the tool was implemented in 10 primary-care practices affiliated with Brigham and Women's Hospital (BWH) and Massachusetts General Hospital (MGH). This manuscript describes the design and implementation of the tool, attempts to improve use, informal feedback on the tool from clinicians, and generalizable lessons learned to maximize the usability of the tool and its impact on patient safety.

METHODS

Design and description of the tool

The Partners PostDischarge Medication Reconciliation Tool was created in 2007 within the Longitudinal Medical Record (LMR), an internally developed, CCHIT-certified EMR used within Partners Healthcare.¹⁰ Efforts to design the tool began in 2004, when Partners Information Systems gathered requirements, and collected and analyzed use cases. Once the necessary features and functions were agreed upon (eg, access to the discharge summary with a single click, integration with existing EMR medication alerts, access to formulary information, separation of reconciliation from prescription writing), low-fidelity prototypes of the user interface were constructed in HTML. The graphic user interface was demonstrated to stakeholder groups and iteratively improved based on feedback.

The medication reconciliation tool relies on services provided by Partners Enterprise Medication Decision Support Services (EMEDS). The main service can compare any two medication lists, classify medications (using EMEDS mappings and the First DataBank (South San Francisco, California) classification scheme), and report differences.

The tool is accessible for 6 months after a patient is discharged from BWH or MGH, or until the reconciliation process is complete and is accessed by clicking on a pink 'Discharge Reconciliation' button within the EMR main Medications screen. The tool presents the EMR medication list (ie, as it existed prior to hospital admission) and the discharge medication regimen side by side, with all medications sorted by class, identical medications displayed next to each other, and all differences in dose or frequency highlighted (figure 1).

A change to the ambulatory EMR medication list can be made with a single click using one of three action buttons (figure 1):

- 1. Add: If a medication ordered at hospital discharge is not on the EMR medication list, the 'Add' Action button is displayed. Clicking on the button copies the medication to the EMR medication list.
- 2. Modify: If the same medication is on both lists, but the dose or frequency is different, then the 'Modify' Action button is displayed. Clicking on this button updates the medication in the EMR with the dose and frequency ordered at discharge.
- 3. Verify: If a medication is identical in the two lists (including name, route, dose, and frequency), or the medication is only

on the EMR list, then the 'Verify' Action button is displayed. Clicking on this button updates the date last verified in the EMR (as a way for other clinicians to judge the accuracy of medication information) but otherwise makes no changes to the EMR medication list. Conversely, if the user wants to delete the medication from the EMR list, that is done by clicking on a trash-can icon.

Note that different medications in the same therapeutic class are near each other (although not directly across from each other); making such a change to the EMR requires both adding the discharge medication and deleting the preadmission EMR medication.

One conscious design decision was to not require that every medication be acted upon (eg, accepted, rejected, or modified) by the user. Rather, if a medication is already accurate in the EMR list, nothing need be done. This approach minimizes the amount of work required by the user to reconcile medications. However, as noted below, this decision did cause some confusion among users.

Once a user is done, s/he may select 'Reconcile in Full' or 'Reconcile in Part.' Partial reconciliation was designed primarily for specialists who may prescribe only a subset of a patient's medication regimen (eg, a rheumatologist who prescribes methotrexate but none of the other medications a patient takes). Partial reconciliation does not turn off the 'Discharge Reconciliation' button on the main Medication Reconciliation screen and allows the patient's PCP to complete reconciliation at

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Figure 1 Screenshot of the postdischarge-medication reconciliation tool. The preadmission electronic medical record (EMR) medication list is on the left, the discharge medication regimen on the right. Selecting 'Add' or 'Modify' buttons between the two lists updates the ambulatory EMR medication list. The trash-can icon can be used to delete medications from the EMR list. EMR medications can also be verified. Once the user is done, the buttons at the bottom reconcile the EMR medication list in part or in full. Note at the top the links to the most recent discharge summary and 'Quick Look,' a read-only view of the EMR.

a future date. PCPs were expected to reconcile medications in full under most circumstances. Users then sign the changes they made to the EMR medication list and continue their other tasks.

IMPLEMENTATION AND TRAINING

To evaluate this new tool, we implemented it at 10 primary care practices, five each affiliated with BWH and MGH, involving 103 PCPs. Each intervention practice was visited by one of the study authors, who demonstrated use of the tool. In addition, each PCP in these practices received periodic emails reminding them to use it, reviewing instructions for use, and providing tips. In the tool itself, users could also access an animated demonstration of the application, created using RoboDemo software (Macromedia, San Francisco, California).

OBSERVATIONS

Use of the tool

In the first 6 months of the trial, use of the tool was low (table 1). Of 1114 patients hospitalized at BWH and MGH with a PCP appointment in any of the intervention practices within 30 days of discharge, the tool was used in only 198 patients (18%), despite an average of 1.7 visits to PCPs during that period, and during the first 10 days after discharge, the tool was used in only 12% of patients.

We hypothesized several possible reasons for the low rate of use:

- 1. Despite our efforts to publicize the new tool, some users may not have been aware of its existence (ie, they missed the meeting at their site, ignored the emails, etc).
- 2. The 'pink button' invoking the tool in the main medication screen was not sufficiently obvious to remind users from a human-factors perspective.¹¹
- 3. The tool had other usability issues beyond visibility, and users may not have perceived it as valuable.
- 4. Users may have been too busy to want to use it during a given visit.
- 5. It was a completely new feature and unlike other tasks built into the EMR.
- 6. Because it was designed to be used in only a minority of outpatients (ie, those with a recent hospitalization), users may never have gotten in the habit of using it.

To determine which of these factors were most important, we sent three different email surveys to study PCPs, one each to three different types of users (never users, those who used it once or twice, and more frequent users). For example, for never users, using partially open-ended questions, we asked whether any of the following issues were applicable: the PCP had not seen a patient in the office within 30 days of discharge, training in use of the tool was inadequate, the PCP forgot to use the module when seeing recently discharged patients in the office, or other reasons. The surveys revealed the following:

- 1. Most PCPs were in theory supportive of the postdischarge medication reconciliation tool.
- 2. The vast majority of users stated they forgot to use it because it was a new feature and was intended for a minority of patient visits, and the pink button was a weak reminder. Several PCPs spontaneously asked for an interruptive reminder to use the tool.
- 3. A significant minority voiced concerns about usability. Specifically, as noted above, several clinicians were confused about whether they needed to act upon every medication discrepancy. For example, they wanted a way to indicate that they did not want to make a change to a medication on the existing EMR medication list. This confusion was exacerbated by a pop-up reminder that appeared at the time of signing if there were still any discrepancies between the two lists (an expected and in fact desired occurrence in most patients) and by the fact that the tool did not let the user indicate that reconciliation was complete if no changes had been made to the EMR medication list.

Additional usability issues

Several other usability issues surfaced as a result of our surveys:

- 1. When selecting the 'modify' button to change the dose or frequency of a medication, the system functionally discontinued the old medication order and started a new one. This meant that any prescription refill or patient instruction information in the old order was removed.
- 2. Because inpatient medication orders do not typically include dose/strength information, only dose information (eg, atenolol 100 mg daily, not 100 mg tablet, take 1 tablet daily), any newly ordered medication added from the inpatient setting was lacking dose/strength information. Because the electronic prescribing application requires this information in the outpatient setting, the user needed to add this information manually when writing a prescription for these new medications.
- 3. Because the EMR allows users to verify each medication on the list, some users suggested that verifying all medications on the list should be the same functionally as selecting the Reconcile in Full button (ie, removing the pink button to invoke the tool).

Table 1	Use of the postdischarge	medication reconciliation	n tool among patient	s with a visit to a l	PCP in an intervention	practice within 30 days of
hospital of	discharge					

	Percentage							
	July—August 2008	September— October 2008	November— December 2008	January— February 2009	March—April 2009	May—June 2009	July—August 2009	Total
All intervention practices	47/351 (13%)	87/388 (22%)	58/347 (17%)	89/398 (22%)	89/394 (23%)	146/421 (35%)	155/376 (41%)	671/2675 (25.1%)
Site A	12%	13%	23%	28%	30%	41%	41%	62/223 (28%)
Site B	7%	17%	8%	11%	12%	35%	46%	137/701 (20%)
Site C	26%	39%	48%	27%	22%	41%	48%	53/149 (36%)
Site D	30%	50%	60%	30%	30%	30%	80%	26/62 (40%)
Site E	10%	10%	13%	10%	9%	19%	38%	32/208 (15%)
Site F	5%	18%	7%	19%	34%	34%	36%	84/369 (23%)
Site G	24%	37%	24%	35%	33%	44%	44%	194/550 (35%)
Site H	18%	28%	19%	67%	25%	46%	38%	37/117 (32%)
Site I	10%	20%	20%	50%	10%	30%	10%	18/88 (20%)
Site J	6%	10%	0%	4%	18%	14%	31%	27/208 (13%)

Table 2	Usability	issues	and	actions	taken	or	proposed
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Issue	Proposed change(s)	When action taken	
Users forgot to use the module	1. Email reminders to primary-care physician on day of visit	1. March 2009	
	2. Active pop-up reminder in Medications screen	2. June 2009	
	3. Passive reminder in Summary Page	3. June 2009	
Confusion about whether user needed to act on each	1. Remove reminder that warns users if discrepancies remain at signing	1. June 2009	
medication discrepancy	2. Let users complete reconciliation, even if no changes made to EMR list	2. Proposed	
	3. Provider education	3. Throughout study period	
Addition of inpatient medications led to omission of strength/ form information	1. Derive default strength/form information for added inpatient medications	1. Proposed	
Modifying medication dose/frequency led to loss of patient instructions and refill information	 Improve tool such that modifications retain old patient instructions and refill information 	1. Proposed	
Module could not be invoked if EMR medication list blank	1. Allow module to be invoked regardless of EMR medication list status	1. Proposed	
Lack of alternate ways to complete reconciliation process	 Allow manual verification of all medications in EMR to be functional equivalent of reconciling in full 	1. Proposed	
Lack of ways to document reasons for actions taken	1. Provide field to document reasons for all reconciliation actions taken	1. Proposed	

EMR, electronic medical record.

Response to survey results

We took several actions in response to these results. First, we returned to each of the intervention practices to review use of the tool, emphasizing that not every medication needed to be acted upon. This educational outreach was accompanied by new emails to providers explaining how the tool worked and providing examples. We also removed the pop-up reminder alerting users to remaining discrepancies at the time of signing. As of the conclusion of the study, in June 2009, users still could not indicate that reconciliation was complete if no changes were made to the EMR medication list.

To deal with the issue of users forgetting to use the tool, in March 2009, we automated email reminders about using the tool to PCPs of intervention practices on the morning they were scheduled to see a recently discharged patient. More importantly, starting in June 2009, we modified the EMR to provide two different reminders regarding postdischarge medication reconciliation:

- 1. a passive reminder on the EMR Summary page, where other health-monitoring reminders reside, stating that this patient had been recently discharged and had medications to be reconciled, and explaining how to invoke the tool;
- 2. an active reminder that popped up whenever the Medications screen was selected for patients discharged within the previous 6 months in whom medications had not already been reconciled in full.

Table 2 lists all usability issues discovered during the study and proposed or enacted changes to manage them.

Impact on use

As a result of these efforts, use of the tool in eligible patients increased steadily during the last 6 months of the study (table 1). During the last 2 months of the study, July–August 2009, the tool was used in 41% of eligible patients.

DISCUSSION

This paper describes a novel approach to facilitate medication reconciliation by ambulatory providers in recently discharged patients. Many PCPs likely do this process manually; our postdischarge medication reconciliation tool, built into the EMR, compares and contrasts preadmission and postdischarge regimens in a way that should make the process easier and safer. In contrast to many other automated approaches, our postdischarge medication reconciliation tool still actively involves the PCP in the medication reconciliation process, involvement that we believe is critical for patient safety.

We noted several barriers to use, some unique to the way our EMR and the tool were designed, but most generalizable. Because this is a new process for most EMRs and is meant to be used in a minority of patients visiting on a given day, it is likely that an active reminder system is needed for applicable patient visits. A high degree of clarity and transparency is essential, regarding whether or not explicit decisions are required for every medication discrepancy. A requirement to document every decision would likely take more time to use but may in fact be less confusing to users and could result in fewer downstream errors. Lastly, differences in e-prescribing formats in inpatient versus outpatient pharmacies also need to be considered.

As a result of our study, several additional changes to our tool have already been undertaken or are planned:

- 1. ability to complete the reconciliation process even if no changes are made to the EMR medication list;
- 2. creation of default dose/strength information for medications added to the EMR medication list from the inpatient setting;
- 3. changes to the Modify button so it updates dose and frequency without removing previously entered refill and patient instruction information;
- 4. treating the manual verification of all medications on the list as the functional equivalent of completing the reconciliation process.

This study had several limitations. It was carried out at 10 practices within an integrated delivery system affiliated with two academic medical centers, and the results therefore may not be generalizable to other centers or practice types.

We developed a tool to enable postdischarge medication reconciliation. This reconciliation—though required by the Joint Commission—can be challenging to accomplish, especially for patients taking large numbers of medications. Development and evaluation of our tool identified a number of important issues and lessons learned that we hope will be valuable to others in their efforts to improve patient safety during the transition from the inpatient to the ambulatory setting.

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