National Patient Safety Goals

Medication Reconciliation in Ambulatory Oncology

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Medication history errors are common on admission to the hospital and may lead to adverse drug events.[1] Pharmacists may play a valuable role in correcting these errors.[2–5] In addition, medication reconciliation was associated with reductions in adverse drug events and medication errors in a community hospital and a tertiary care hospital intensive care unit.[6–8]

Medication reconciliation occurs when a "complete list of the patient's medications is communicated to the next provider of service when a patient is referred or transferred to another setting, service, practitioner, or level of care within or outside the organization."[9]

Massachusetts hospitals demonstrated widespread implementation of medication reconciliation in a statewide medication safety initiative.[10] On the strength of this experience and the intervention's face validity, The Joint Commission adopted medication reconciliation as a 2006 National Patient Safety Goal—effectively driving the adoption of this practice throughout health care organizations in the United States.[9,11–14]

The Institute for Healthcare Improvement's 5 Million Lives Campaign[15] has further defined medication reconciliation as a core component of the patient safety portfolio of health care organizations in the United States.

Regrettably, despite its intuitive appeal and adoption in acute care hospitals,[16–18] medication reconciliation practices are not yet widely adopted in ambulatory care settings, and few models of medication reconciliation are available in ambulatory care.[13] This may reflect the difficulty of

Article-at-a-Glance

Background: Few models for medication reconciliation in ambulatory primary or specialty care have been described, perhaps because of the special challenges posed by this environment.

Methods: Dana-Farber Cancer Institute (Boston) created a reconciliation program that was designed as a patient-clinician partnership intervention. Policies that require clinicians to review and update medication lists at regular appointments were augmented. Clinic assistants printed patients' medication lists from the electronic medical record and distributed lists to established patients for review. Patients provided updated lists to their oncology clinicians. Clinicians then entered the information or indicated changes to be entered by a pharmacist.

Results: At baseline, 81% of patients' medication lists included at least one error or omission. With medication reconciliation, 90% of incorrect medication lists were updated. In contrast, only 2% of medication lists were corrected among patients who received "usual" care ($p < .001$).

Discussion: From the program' inception in November 2005 through August 2007, patients and staff reconciled 24,148 medication lists by making 53,040 changes to 168,475 listed drugs, a rate of 31 changes per 100 medications. Implementation required broad staff engagement and ongoing attention to operational issues.

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defining care transitions for patients in longitudinal clinical relationships, the challenge of reconciling medications for patients whose care spans multiple clinicians and sites of care, and clinicians' ambiguous responsibility for updating medications prescribed by other physicians when there is a common electronic medication list. Pilot studies at Mayo Clinic suggest that medication reconciliation is both feasible and effective in primary care settings, increasing by 11%–14% the number of complete and correct medication lists.[19,20]

To share our experience with medication reconciliation in ambulatory specialty care, we describe the evolution of an initiative at our comprehensive cancer center, its architecture, and results to date.

Setting

Dana-Farber Cancer Institute (DFCI; Boston) is a comprehensive cancer center—and the site of a widely publicized 1994 chemotherapy overdose.[21–23] Clinical services at DFCI include disease-focused programs in hematologic and solid tumor malignancies for adults and children and an extensive research program. DFCI employs 3,154 staff members, including 161 physicians and 209 nurses. Physicians and nurse practitioners saw ambulatory patients in three adult clinics and one pediatric clinic for 170,000 visits in fiscal year 2006. DFCI staff members use an electronic appointment system, a laboratory ordering and result system, and an ambulatory electronic medical record with clinician order entry for chemotherapy and nonchemotherapy medications. The electronic record, shared with primary care and specialist physicians in a regional referral network, includes a single comprehensive medication and allergy list. About 20% of DFCI patients' primary care physicians share this electronic medical record with DFCI clinicians.

Program Design

Unable to identify a suitable model for medication reconciliation in ambulatory oncology by searching the Internet, reviewing the medical literature, and calling peer organizations, patient safety and quality improvement specialists at DFCI, together with clinical leaders and frontline staff, created an ambulatory medication reconciliation initiative in 2005. The program was based on the following considerations:

- We sought to integrate the medication reconciliation program into the current care model and information system infrastructure rather than create new applications that would require significant time and resources.
- We focused reconciliation efforts on continuing patients rather than one-time "second-opinion" consultations.
- Medication reconciliation was an expectation of all clinicians as a matter of hospital policy and sound clinical care. The new program would serve as a backstop system to facilitate clinicians' efforts.
- We focused on medications other than intravenous infusion chemotherapy because this treatment modality is prescribed through a dedicated order-entry system and delivered exclusively on site.
- We relied on a strategy that would engage patients as partners with clinicians in identifying discrepancies between the electronic medication list and the patient's current regimen. This approach acknowledged that most patients were referred from outside of our physician network, that few arrived with complete medical records, and that patients were a reliable source of information about their medications.

We began by developing a medication safety brochure in English and Spanish that was sent to new patients before their initial visit and was displayed in clinic waiting areas. The brochure drew safety tips from published sources and included an insert for patients to enter their prescription medications, over-the-counter drugs, and supplements, as well as drug allergies and emergency contacts (The text is available at http://www.dfci.org/pat/patient/patient-safety/patient-information.html).

The model worked as shown in Figure 1 (page 752). At established patient follow-up visits, clinic assistants provided patients with a printed copy of the medication and allergy list in their electronic medical records. Patients received these medication lists when the clinic assistant checked and recorded the patient's vital signs in a vital signs area or when they seated the patient in the examination room. We provided a cover letter that described the program and asked patients to update their drug and allergy information by crossing out discontinued medications, writing in missing medications, and correcting doses, routes, and frequencies. We invited patients to include over-the-counter drugs, vitamins, and supplements. For

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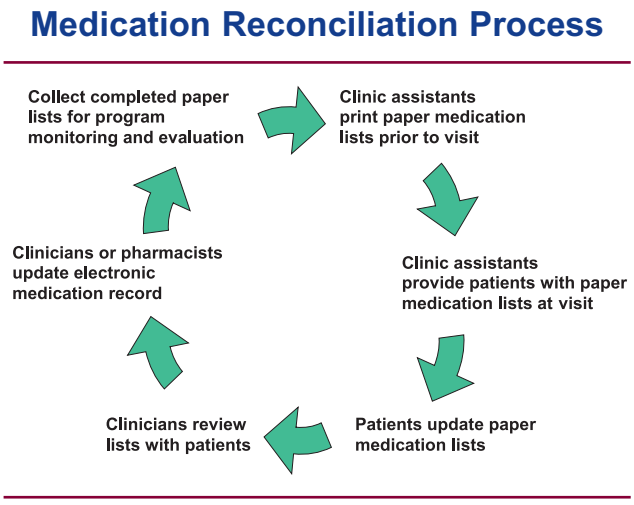

Figure 1. *The medication reconciliation process began when clinic assistants provided patients with a printed copy of the medication and allergy list from their electronic medical records.*

up-to-date medication lists, patients were instructed to write "OK" on the forms. We asked patients to give the updated form to their attending oncologist, fellow, or nurse practitioner during the cancer center office visit.

We developed the program in an iterative fashion, working with frontline staff, including clinic assistants, operations managers, and nurse managers. The intervention was similar on each unit, although small modifications were made to accommodate the unit's work flow. For example, clinic assistants distributed medication lists in exam rooms on one unit and in a vital signs measurement area on another unit. Staff printed medication lists the afternoon before the visit. We provided clinic assistants with one-on-one training. We briefed physicians and nurse practitioners in advance by electronic mail, at a faculty meeting, and in person during the project's initial phase.

We described the initiative to clinicians as a method to improve medication safety by ensuring their receipt of up-to-date medication information at the time of the clinical encounter. We encouraged clinicians to enter this data in the electronic medication list, but there was no formal requirement. We asked them to review the updated medication list and to leave completed forms in a bin in the physician work area so we could track the program's results.

Pilot Tests

Using rapid-cycle improvement techniques, we conducted 13 medication reconciliation pilots from July through October 2005 on two units. Initially, we worked with a few providers for a half-day practice session to work out methods for printing, distribution, and collection of forms. Subsequent iterations involved all clinicians on the unit for full-day sessions.

The medication reconciliation pilots included 46 physicians and nurse practitioners and about 450 patients in the hematologic, gastrointestinal, breast, and head and neck cancer groups. We received annotated forms from 338 patients with a total of 2,146 medications on their electronic medication lists. Patients identified 1,197 medication list errors or omissions, a rate of 55.8%. Errors included 102 (4.8%) drugs with the wrong dose or frequency listed, 510 (23.8%) discontinued medications, and 585 (27.3%) omissions. Overall, 274 (81%) of 338 patients had at least one error or omission on their medication list. Medication lists had incorrect doses and frequencies for high-risk drugs including oxycodone, mycophenolate mofetil, gabapentin, and warfarin. Discontinued drugs that remained on the list included antibiotics (often started for a limited course of therapy) and symptom-management medications like analgesics and anti-emetics. Medication list omissions included anticoagulants, corticosteroids, and the oral chemotherapies imatinib, erlotinib, and thalidomide.

Implementation

After reviewing the pilot data, clinical and administrative leaders endorsed the implementation of medication reconciliation across the adult ambulatory program. Despite the general receptiveness of patients and staff members, two important modifications were introduced to gain broad acceptance:

1. Staff members requested that we perform formal medication reconciliation for each patient no more than every 30 days; many patients are seen as often as twice weekly. Medication changes among patients with frequent visits are usually made by the oncology team (rather than clinicians outside the institution), and "excessive" reconciliations could impose a burden on staff members and patients. Clinicians were expected to update medication lists and to communicate these changes in the course of

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Adult Ambulatory Oncology Medication Reconciliation Process, November 2005–August 2007

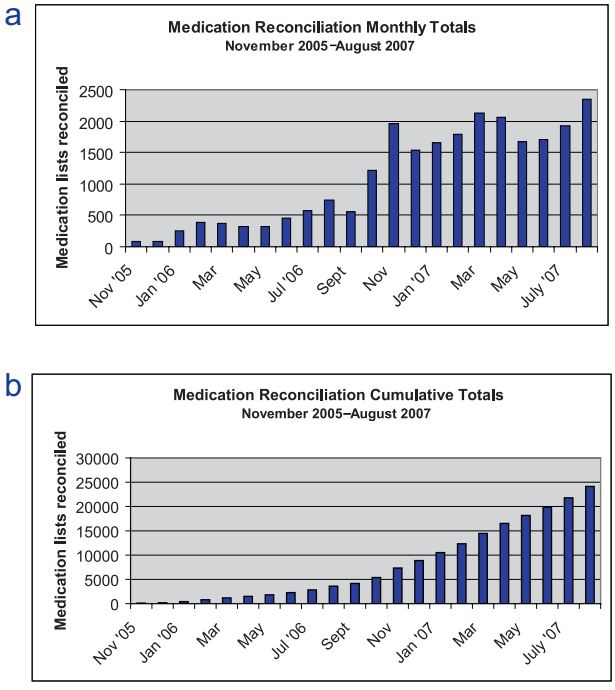

Figure 2. *The monthly (a) and cumulative (b) totals for the number of medication lists that were reconciled are shown.*

usual care, but without the routine use of printed medication lists.

2. Second, staff members requested support for creating and updating medication lists. This was a particularly important consideration for patients with extended hospitalizations (for example, patients with leukemia or bone marrow transplantation) because medication lists were often lengthy. We identified resources to support a group of pharmacists who collected medication lists from the units and updated patients' electronic lists based on physician and nurse practitioner instructions.

The program was implemented throughout the adult ambulatory service in early November 2005.

Results

Adherence to the Medication Reconciliation Process

We monitored adherence to the medication reconciliation

Evaluation Design for Medication Reconciliation Program

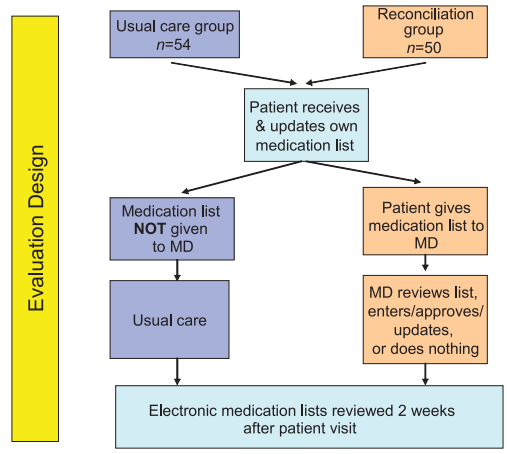

Figure 3. *The evaluation design for the medication reconciliation program is shown.* MD, physician.

process by counting the number of returned medication lists. We estimated the number of lists printed and distributed, assuming that clinic assistants had printed all the lists for a particular clinician on a given day if any of the lists were returned. Lists that were returned but not completed by patient or provider were assumed to have been printed but not distributed.

As shown in Figure 2 (left), the use of medication reconciliation expanded rapidly throughout the adult clinical practice. To accommodate the request to avoid overwhelming patients and staff, we scheduled each oncologist for one to two reconciliation sessions per month initially, gradually increasing the frequency of these sessions to a weekly and then daily schedule. The increased number of medication reconciliation sessions resulted in a > 400% increase in the number of medication lists reconciled each month (from 300–400 per month in early 2006, to 1500–2000 per month by 2007). From program inception in November 2005 to the end of August 2007, patients and clinicians together reconciled 24,148 medication lists.

Patient participation depended on several factors: printing and delivery of medication lists to eligible patients on hectic clinic days and when the unit was short staffed; patients' familiarity with their own medications and their willingness to participate; and providers' ability

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Table 1. Medication and Drug Allergy Reconciliations, November 2005–August 2007

	*n**	95% Confidence Interval	
Medications			
Initial	168,475	152,444	184,505
Changes			
–Discontinued	31,541	25,208	37,873
–Corrected	4,857	2,877	6,836
–Added	17,013	12,899	21,126
All changes	53,040	44,382	61,698
Final	153,946	139,133	168,760
Drug Allergies			
Initial	19,200	14,717	23,684
Changes			
–Discontinued	0	0	0
–Corrected	180	-86	447
–Added	448	23	874
All changes	629	129	1,128
Final	19,649	15,162	24,135

* Weighted total based on sampling weights, using 1% sample; totals may not add because of rounding.

to review the information during a busy clinic session, to update the list, and to submit it. Patients and providers completed the reconciliation process by returning 45% of marked-up, signed-off medication lists (monthly range, 36%–69%). This figure may underestimate participation because it does not include cases when completed forms were misplaced or inadvertently discarded.

Errors and Omissions

We sampled completed medication reconciliation forms at random each month and calculated the rate of medication list errors and omissions per patient and per prescription. We weighted the error and omission rates by the number of completed reconciliations each month, to calculate the total number of errors and omissions identified and corrected via medication reconciliation. As shown in Table 1 (above), we deleted 31,541 medications that were no longer used, corrected 4,857 medications with dose or frequency errors, and added 17,013 drugs that were incorrectly omitted from the list. Overall, we made 53,040 changes to 168,475 listed drugs, a rate of 31 changes per 100 medications. We also corrected 180 drug allergy errors and added 448 drug allergies to the initial list of 19,200 drug allergies, a rate of 3 changes per 100 drug allergies. Table 2 (page 755) lists selected drugs, including some over-the-counter drugs, that patients and clinicians deleted, amended, or added to the medication list.

Pharmacy Time

Pharmacists collected paper medication lists from clinician work areas and then corrected the electronic medication lists to reflect changes approved by the physician or nurse practitioner, verify correct medications, and query clinicians about ambiguous notations or potential drug interactions. The first full year of the program required 257 hours of pharmacist time at $40 per hour, for a total cost of $10,280. The fully implemented program currently requires 0.6 full-time equivalents of a pharmacist's time.

Electronic Medication Lists

We formally evaluated the impact of the medication reconciliation program on the electronic medication list as compared with usual care by examining 104 patients selected at random from each of the three clinical practice units (Figure 3, page 753). We described the evaluation to each patient and requested their participation; none declined. We provided all patients with a copy of their current medication lists and the one-page cover letter. Half the patients, those in the medication-reconciliation group, took the updated list into their clinician appointment. We collected the medication list from the remaining patients, the usual-care group, before their appointments. A physician reviewed the updated medication lists of usual-care patients within one day and notified the patient's oncologist of changes that might affect clinical care; this occurred in one case. We reviewed all patients' electronic medication lists 14 days after the visit and identified medication list changes by providers in the usual-care group and by the providers or pharmacists in the medication-reconciliation group.

Medication-reconciliation and usual-care patients had a similar number of drugs on their medication lists at baseline (6.7) and follow-up (6.5 versus 6.9). However, as

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Table 2. Selected Medication List Errors Identified on Medication Reconciliation*

Discontinued Medications

Antibiotics, antivirals, and antifungals: acyclovir, amoxicillin, ampicillin, azithromycin, dicloxacillin, doxycycline, fluconazole, cephalexin, levofloxacin, trimethoprim, valacyclovir, voriconazole
Narcotic and non-narcotic analgesics: acetaminophen, fentanyl transdermal, hydromorphone, methadone, morphine, naproxen sodium, oxycodone, rofecoxib, sulindac, tramadol
Chemotherapies: bevacizumab, fluorouracil, temozolomide
Anticoagulants: enoxaparin, warfarin
Hormonal therapies: letrozole, nilutamide
Antidepressants and anxiolytics: citalopram, eszopiclone, lorazepam, olanzapine, sertraline, venlafaxine, zolpidem
GI: esomeprazole, famotidine, glycol, granisetron, maleate, polyethylene ondansetron, prochlorperazine omeprazole
Cardiovascular: atenolol, furosemide diltiazem, lisinopril, losartan
Corticosteroids: dexamethasone, prednisone
Other: conjugated estrogen, erythropoetin alfa, gabapentin, hydroxyurea, pegfilgrastim, rizatriptan

Wrong Dose or Frequency

Antibiotics, antivirals, and antifungals: cephalexin
Narcotic and non-narcotic analgesics: acetaminophen/oxycodone, fentanyl transdermal, methadone
Chemotherapies: imatinib
Antidepressants and anxiolytics: clonazepam, escitalopram, fluoxetine, lorazepam, methylphenidate, nortriptyline, venlafaxine
Other: decadron, insulin, furosemide, prednisone

Omitted Medications

Antibiotics, antivirals, and antifungals: amoxicillin
Narcotic and non-narcotic analgesics: celecoxib, hydromorphone, ibuprofen
Anticoagulants: warfarin
Hormonal therapies: exemestane, leuprolide, octreotide
Antidepressants and anxiolytics: citalopram, clonazepam, diazepam, fluoxetine, paroxetine, venlafaxine
GI: docusate sodium, esomeprazole, granisetron, pantoprazole, ranitidine, tegaserod
Cardiovascular: amiodarone, amlodipine, aspirin, atenolol, atorvastatin, ezetimibe, fluvastatin, hydrochlorthiazide, irbesartan, lisinopril, lovastatin, metoprolol, potassium chloride, valsartan, verapamil
Endocrine/metabolic: alendronate, estradiol, insulin, levothyroxine, rosiglitazone, zoledronic acid
Antihistamine: diphenhydramine, fexofenadine, loratadine
Pulmonary: albuterol, montelukast
Other: allopurinol, darbepoetin alfa, doxazosin, tamsulosin

* Generic names are used for medications, including over-the-counter drugs (for example, acetaminophen (Tylenol®), ranitidine (Zantac®), and naproxen sodium (Aleve®). GI, gastrointestinal.

shown in Table 3 (page 756), 38 (90%) of 42 medication-reconciliation patients had at least one patient-identified correction completed, versus only 1 (2%) of 47 usual-care patients ($p < .001$). Overall, clinicians of medication-reconciliation patients made 4.3 medication list changes, compared with 0.1 changes per patient in the usual-care group ($p < .001$).

In the medication-reconciliation group, the clinician updated the electronic medication list him- or herself in 9 (21%) of 42 cases when the patient identified a change. However, clinicians were more likely to update the list when patients made fewer than 4 changes (8 [32%] of 25 patients); clinicians usually asked the pharmacist to input lists with more than 4 changes (16 [94%] of 17).

Discussion

The described approach to medication reconciliation offers a compelling model for ambulatory care. As reported, DFCI patients and staff together have reconciled more than 24,000 medication lists and corrected more than 53,000 errors and omissions since the program's inception. Compared with usual care, the intervention reduced medication list errors by 90%.

Patients' willingness and ability to update medication lists is a critical component of the program. Engaging patients as partners in medication reconciliation is a prom-

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Table 3. Corrected Medication Lists in Medication-Reconciliation Versus Usual-Care Evaluation*

	Medication Reconciliation *n* = 42	Usual Care *n* = 47	*p* value†
Any correction	38 (90%)	1 (2%)	< .001
Mean no. of corrections (S.D.)	4.3 (4.1)	0.1 (0.4)	< .001

* Excludes 8 reconciliation patients and 7 usual care patients with correct lists. S.D., standard deviation.

† Wilcoxon rank-sum test.

ising approach, particularly in highly motivated and literate patient populations. Without bringing in their medication bottles or reading the prescription labels aloud, some patients may not recall their own medication information accurately.[24–29] However, many are able to do so. Oncology patients may make particularly capable partners, given their high-stakes illnesses and treatments, longitudinal care, use of interdisciplinary care teams, and involvement of family and friends. A patient partnership approach may also be useful in settings such as ambulatory surgery, obstetrics-gynecology, pediatrics, and adult primary care.

We believe that the model is applicable to organizations with electronic or paper medication lists. Clinicians in most acute care hospitals use electronic or paper tools to elicit medication histories, compare medication lists, investigate and reconcile discrepancies, and communicate this information among practitioners and across care settings. Although electronic systems offer many benefits, electronic medication lists are quickly outdated if providers do not manage them actively.[30–33] Inaccuracies occur when outdated medications are retained, when verbal instructions are not entered, and when orders are called in to a pharmacy without concurrent changes in the medication list. Missing drugs are more common when patients receive care at multiple sites, especially if clinicians do not share a common record. DFCI's ambulatory pediatric unit implemented a paper-based version of the initiative in July 2006, providing a medication list template to each family at each visit. The completed form is reviewed by the clinician and retained in the medical record.

Despite its promise and apparent efficacy, medication reconciliation in ambulatory oncology offered a variety of operational challenges. Printing and distributing medication lists was difficult on busy clinic days. Lists were sometimes misplaced. Regular education and monitoring was necessary to ensure that staff and clinicians were familiar with their responsibilities. Although we have committed to the goal of asking every patient every day to formally reconcile their medications, and although clinicians do so routinely during office visits and when they prescribe new medications, the volume and acuity of patients and a variety of operational constraints sometime conspire to frustrate this effort. To improve our performance, we are developing the capacity to allow patients to reconcile medications at their convenience from home using an electronic Internet portal. Electronic medication reconciliation applications are promising tools for ensuring medication safety at the transition between hospital and outpatient care.[34,35]

In addition, some clinicians were uncomfortable updating medications that they did not prescribe, arguing that the discrepancy should be noted in a consultation or progress note and communicated to the prescribing physician directly or via the patient. Others resisted the use of a standard reconciliation template, instead using their own custom forms or preferring to review the medication list as part of usual care during appointments. We received several calls from primary care clinicians who were concerned about medications that appeared to be prescribed by our pharmacists but that were in fact only annotations on the medication list. We were also obliged to contact and inform the primary care physician when a medication list update triggered a drug dose or interaction alert.

Conclusion

Medication reconciliation in ambulatory oncology is a feasible and effective mechanism for reducing medication list errors. This approach requires broad staff engagement and ongoing attention to operational issues but offers a potentially replicable model for improving medication safety in a variety of ambulatory settings. Moreover, it demonstrates how patients and clinicians may work together to support safe care.

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