Use of Information Technology in Medication Reconciliation: A Scoping Review

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OBJECTIVE: To identify studies involving information technology (IT) in medication reconciliation (MedRec) and determine how IT is used to facilitate the MedRec process.

DATA SOURCES: The search strategy included a database search of MEDLINE and Cumulative Index of Nursing and Allied Health Literature (CINAHL), hand-searching of collected material, and references from articles retrieved. The database search was limited to English-language papers. MEDLINE includes publications dating back to 1950 and CINAHL includes those dating back to 1982. The search included articles in both databases up to March 2009. Boolean queries were constructed using combinations of search terms for medication reconciliation, IT, and electronic records.

STUDY SELECTION AND DATA EXTRACTION: Three inclusion criteria were used. The study had to (1) involve the MedRec process, (2) be a primary study, and (3) involve the use of IT. Selection was performed by 2 reviewers through consensus. Data related to study characteristics, focus, and IT use were extracted.

DATA SYNTHESIS: The included studies described a range of IT used throughout the MedRec process, from basic email and databases to specialized MedRec tools. A generic MedRec workflow was created and types of IT found in the studies were mapped to the workflow activities as well as to a set of functionalities based on the Institute of Medicine's Key Capabilities of an Electronic Health Record System. In the studies reviewed, IT was mainly used to obtain medication information. Although there were only a few MedRec tools in the studies, those that did exist supported the central activities for MedRec: comparison of medications and clarification of discrepancies.

CONCLUSIONS: MedRec is an important process to ensure patient medication safety. Evidence was found that IT can and has been used to facilitate some MedRec activities and new applications are being developed to support the entire MedRec process.

KEY WORDS: information technology, medication reconciliation, scoping review.

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Medication management in health care is a complex process[1,2] requiring communication and information sharing among providers, patients, and families across different settings. This complexity can lead to medication errors[1] such as omission; incorrect dose, route, or frequency; failure to discontinue; and duplication,[3-5] which may result in adverse drug events (ADEs).[2]

Medication reconciliation (MedRec) is "a process of identifying the most accurate list of all medications a patient is taking—including name, dosage, frequency, and route—and using this list to provide correct medications for patients anywhere within the health care system."[6] The overall goal of MedRec is to improve patient safety by minimizing errors that could harm patients.[7] According to Endo and Jacobsen, MedRec "shows great promise for improving communication between healthcare providers, reducing adverse drug events and improving transitions in care."[2]

This potential to improve patient safety is well recognized. In 2005, The Joint Commission (TJC) developed a set of national patient safety goals. Goal 8 in this list was to "accurately and completely reconcile medications across the continuum of care."[8] One of the Institute for Healthcare Improvement's 6 interventions for its 100,000 Lives Campaign was to "prevent Adverse Drug Events (ADEs)…by implementing medication reconciliation."[9] In Canada, the Safer Healthcare Now! campaign also includes an intervention for medication reconciliation to prevent ADEs and potential harm.[10]

The specific steps of the MedRec process can vary among organizations and depend on when it is conducted (eg, admission, transfer, discharge). In a study by Varkey

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and Resar, the process consisted of obtaining and verifying outpatient medication history, comparing to admission medication orders, and making appropriate changes for discrepancies.[11] Although this process seems straightforward, the complexities of medication management make it challenging. In fact, a recent update on the TJC Web site recognized that many organizations are struggling to develop and implement effective and efficient processes to meet Goal 8, and TJC plans to evaluate and further refine this goal. An improved version will be crafted to be ready for implementation in January 2011.[12] What makes reconciliation so challenging? Paparella[4] explained that the first step of collecting a current medication list is important for successful reconciliation. However, ascertaining an accurate and complete history can be difficult. The list may be incomplete, patient or family members may not be able to fully describe all medications being taken, or the patient might be cared for by multiple providers.[3] Managing medications across the continuum of care requires high levels of cooperation and collaboration[7] and root causes of errors are typically related to inadequate communication, transcription, documentation, and teamwork.[4] According to Bails et al.,[13] most examples of successful MedRec implementations have reported on paper-based systems with a standardized form that also serves as a medication order document. However, Turchin et al.[14] noted that a paper-based MedRec process is not easily integrated with other parts of the care process and does not utilize computerized information already available.

Information technology (IT) refers to the software and hardware applications used for managing information. Different types of IT systems are used by health-care organizations that include email, drug databases, and electronic medical records with computerized provider order entry (CPOE). According to Anderson,[15] some hospitals are beginning to use IT for MedRec by leveraging existing CPOE systems, adding applications within existing systems, or building new specialized software. However, there does not appear to be any systematic analysis of the range of IT used for MedRec exploring how and where it has been used. In fact, Anderson asked what role IT will play in MedRec and provided examples of projects that have been undertaken, explaining that more work is needed.

According to Turchin et al.,[14] an optimal design and implementation for a computerized MedRec system is not known. However, IT has been used to some extent already within various parts of the MedRec process. Therefore, there is a need to explore such use to understand its potential in automating the MedRec process. This article describes the method and results of a scoping review that was undertaken to:

1. identify studies involving a MedRec process (ie, those that include steps/activities of the MedRec process),
2. determine the use of IT in these studies, specifically for MedRec activities, and
3. identify the different types and functionalities of IT used.

A scoping review determines what literature exists on a topic to summarize what is known to identify gaps and does not synthesize the evidence like a standard systematic review. A wide range of sources is used, including databases and hand searching. Scoping reviews are similar to systematic reviews in terms of methodology but are not aimed at answering specific clinical questions. However, they may be helpful to plan studies or full systematic reviews.[16] For this scoping review, the aim was to determine what evidence from primary studies exists for IT use in MedRec activities.

Data Sources and Selection

SEARCH STRATEGY

A search strategy was developed to retrieve relevant studies based on articles collected and input from colleagues. MEDLINE and Cumulative Index of Nursing and Allied Health Literature (CINAHL) databases were searched using 2 queries that combined terms related to medications, reconciliation, and IT including health information systems (HIS) and records (See Appendix I for complete search queries; available at hwbooks.com/pdf/appendices/M699.pdf). The search was limited to English-language material. MEDLINE includes articles dating back to 1950 and CINAHL includes those dating back to 1982. The search included information in both databases up to March 2009. A set of studies that had been collected earlier by the review team was also hand-searched. The references from these studies were also included as part of the full list of studies to consider.

SELECTION

To be included in the review, a full study report (no abstracts) had to meet 3 inclusion criteria. First, the study had to involve the MedRec process, which consists of a comparison of at least 2 sources of medication lists, identification of discrepancies between the lists, and indication of reconciliation (resolution) of the discrepancies. Second, only primary studies were considered; pilot studies were included provided they followed an experimental, quasi-experimental, or observational design. Narratives of the MedRec process, such as an implementation or case studies without results, were excluded. Administration of user satisfaction surveys were also excluded unless combined with other design methodologies. Finally, the studies had to involve the use of IT (eg, spreadsheets, databases, computerized physician order entry systems, pharmacy sys-

tems, electronic medical records, and electronic health records). The use of IT had to be clearly stated or described in the study. For example, just the mention of "medical record" did not indicate that the record was electronic.

One reviewer (JB) compiled all results of the search into a single spreadsheet and performed an initial scan of all titles and/or abstracts, rejecting those that did not meet the criteria (n = 2322). Two independent reviewers (JB and FL) then went through the remaining material (n = 125), reviewing titles, abstracts, and full text to select studies.[a] Studies with only abstracts available were rejected. Reviewer agreement was approximately 96%. The final selection decisions were done by consensus. A methodological quality assessment was performed for studies with control groups.

DATA EXTRACTION

Once a final set of studies was determined, the general study characteristics, main focus,[b] role of MedRec, and IT use were extracted from each study. Because this was a scoping review to examine the role of IT for MedRec, outcome measures reported in the studies were not extracted. Instead, IT use was categorized in 3 dimensions: type of IT, functionality, and role within the generic MedRec process.

The types of IT were taken directly from descriptions in the study papers (eg, email, database, pharmacy information system). The IT functionality was then categorized based on the Institute of Medicine's (IOM) Key Capabilities of an Electronic Health Record System[17] (Table 1).

For example, electronic patient records generally store patient medical history including medication lists. Therefore, they would be categorized as Health Information/Data. A CPOE system, on the other hand, serves to manage and transmit orders from provider to pharmacies and therefore falls under the category of Order Entry Management.

Descriptions of how IT was used for MedRec activities in the articles, such as for obtaining source medication information or communicating the results of reconciliation, were also extracted. This formed a generic MedRec process workflow to examine where IT fit in.

Data Synthesis

SELECTED ARTICLES AND CHARACTERISTICS

Overall, the search yielded 2447 potential aticles for consideration, of which 28 were selected for the review.[18-45] Figure 1 shows the flow of selection. Many articles were rejected during the initial scan because they were systematic reviews or studies on specific drugs. Also rejected were descriptive articles on the MedRec process or studies on manual article-based processes. Articles in which the IT use was not explicitly described or mentioned were excluded. Eight studies did not meet the inclusion criteria but described promising uses of IT for MedRec[13,14,46-51] (see Discussion).

The majority of selected studies were observational and just over half had no control group. For the 13 studies with control groups, methodologic quality assessment was performed using a 10-point scale based on that developed by Johnston et al.[52] The highest score was 8 out of 10, with 9 studies scoring 5 or above, indicating acceptable quality. (The scores and scoring key are available in Appendix II; available at hwbooks.com/pdf/appendices/M699.pdf)

The clinical settings for the 28 studies included outpatient clinics, specialized units in hospitals, and a pharmacy call center. Most hospitals were affiliated with medical schools. Subjects were usually patients but, in some cases, the focus was on patient records, admission events, calls, prescriptions, or forms. See Table 2 for study characteristics.[18-45]

[a]Reviewers were a research analyst in Health Informatics and a professor in Health Informatics who has prior publications in systematic reviews. When required, a third reviewer, who has a PhD in Pharmacology and is a Cochrane Reviewer, was consulted.

[b]The main focus refers to the objective of the study such as to identify discrepancies or evaluate the impact of a MedRec process.

Table 1. Categories for Information Technology Functionality[a]

Category	Examples of Implementation
Health information/data	Availability of data such as medical and nursing diagnoses, medication list, allergies, demographics, clinical narratives, laboratory test results
Results management	Access to all types of results/procedures electronically
Order entry management	Computerized provider order entry
Decision support	Computer reminders and prompts, checks, computer-assisted diagnosis, disease treatment and management, compliance with established evidence-based guidelines and protocols
Electronic communication and connectivity	Email, Web-messaging to facilitate communication among providers and with patients, integrated health record, telemedicine
Administrative processes	Electronic scheduling systems, billing and claims management, tools for decision support to identify eligible pts., drug recall, research

[a]Two of Institute of Medicine's categories were not applicable: Patient Support and Reporting and Population Health.

STUDY FOCUS AND ROLE OF MedRec

All studies involved the MedRec process, either explicitly stated in the article or determined through consensus by the reviewers. However, they differed in terms of objective and design. Information on the objective of each study and the role of MedRec involved was extracted. The studies focused on identifying discrepancies, analyzing discrepancies, evaluating the role/tasks of a provider, and/or evaluating the impact of an implementation or change to a MedRec process. The role that MedRec played in the study was identified by reviewing the objectives of the studies and methods used. This helped to define 3 general categories for the role of MedRec, where they were used as (1) part of the study design or methods but not as the intervention being evaluated, (2) part of the intervention being studied but not the entire intervention, or (3) the full intervention being evaluated, as in a study looking at the effects of implementing a MedRec process.

MedRec was often (11/28 studies) used as part of the study methods to identify or analyze discrepancies. For example, 6 studies[22,24,27,32,37,41] used MedRec to assess the accuracy of a medication list. In 9 studies, MedRec was part of the intervention that evaluated the role of providers, except in 1 case where investigators evaluated the use of a tool to facilitate communication.[34] For studies with MedRec as the full intervention, 7 evaluated the impact of a MedRec process, with 1 focused on the roles of individuals in conducting MedRec.[40] See Table 3 for a summary of the study focus for each article in terms of MedRec.[18-45]

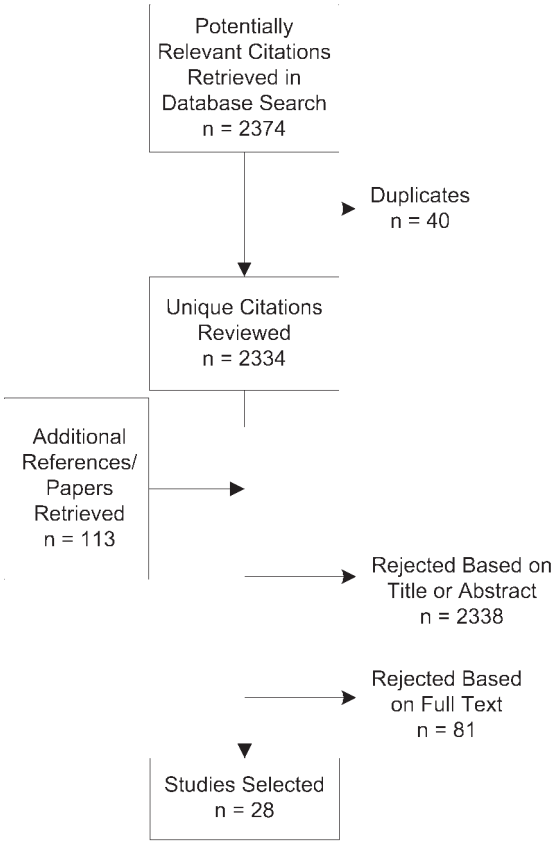

Figure 1. Article selection flow.

TYPES OF IT FUNCTIONALITY AND USE

The types of IT present in the studies for MedRec ranged from general tools like email to applications designed specifically for conducting MedRec. Overall, only 4 studies had some kind of an electronic MedRec tool,[18,34,35,38] which was classified as Decision Support functionality. Fifteen studies mentioned the existence of an organizational electronic medical record (EMR) or electronic health record (EHR).[c] Other types of IT included pharmacy systems, databases, CPOE, and medication administration record (MAR) systems. All remaining types of health information systems, such as clinical information systems and computerized record systems, were grouped into a general category of "Other HIS."

In terms of overall IT functionality, Health Information/Data was used in 26 of the 28 studies. Electronic Communication and Connectivity was accomplished through email in 4 studies,[23,36,39,40] by fax in 1 study,[27] and by other electronic means in 3 studies.[21,25,32]

IT was used in all steps of the generic MedRec process. All types of functionality except Administrative Processes (Table 1) were used to obtain medication information. In 3 studies, a medication database was used to obtain information[30,34,43] and 1 of these studies also used it to track discrepancies.[30] The MedRec tools supported various steps of the MedRec process: obtaining medication information,[18] comparing medications,[18,34,35,38] clarifying discrepancies,[18,34,38] and tracking discrepancies.[18]

Discussion

SYNTHESIS OF FINDINGS

To make sense of the study findings, we created a conceptual framework to show where IT can be used to facilitate the MedRec process (Figure 2). In particular, this framework illustrates the types of IT, their functionalities, and interrelationships involved with the various steps of the MedRec process.

Across the top of the diagram are the categories of IT functionality used for MedRec activities and within each

[c]The terms EMR and EHR generally referred to hospital or facility-based systems storing patient records. We recognize that, in the Canadian context, an EMR is usually defined to be at the provider-level, existing within private practices or clinics.

cell is the specific type of IT used within each study. The majority of studies demonstrated Health Information/Data storage or retrieval functionality using most types of IT. The most common type of IT mentioned was an EMR followed by other HIS. This is not surprising, as EMRs typically contain a patient's medical history, including current medications. As mentioned above, in many studies the focus was determining the accuracy of medication lists contained within information systems.

The activities and degree to which MedRec occurred varied depending on the study's focus. Therefore, a generic diagram for MedRec workflow activities was created based on the selected studies, which is shown on the left side of Figure 2. Most studies started the MedRec process by obtaining medication information from one source and comparing it to another source to determine discrepancies. At this point, the discrepancies were clarified and corrected if necessary by the provider and then stored to track discrepancies found or communicated to appropriate individuals. For example, in the study of Turchin et al.,[38] the physician used the PAML (Pre-Admission Medication List) Builder to compare medication lists from different sources and create a PAML by selecting medications to include. However, sometimes, if the reconciliation is done by a nurse or pharmacist, a communication of discrepancies may be sent to the physician first and then clarified and corrected in the system if approved. For example, in Orrico,[32] advice-line nurses collected medication information from patients over the phone and updated the medication list. An electronic notification was then sent to the primary care physician to review and approve all changes made. These different possibilities are represented in the diagram.

Most often, IT was used to obtain medication information. In some studies, a medication list was extracted from an EMR or information system for comparison,[24,33] while in other cases, the source list was obtained from the patient or family member and entered into the information system for use in comparison.[25,39] In either case, the IT contained a medication list that was used for comparison. In all studies, the users of the IT were nurses, pharmacists, and physicians, although electronic communication with patients was sometimes used to obtain or communicate medication information, usually by email.

Although there were only a few MedRec tools in the studies, they supported the central activities for MedRec: comparison of medications and clarification of discrepancies. The most comprehensive was the system described by Agrawal et al.,[18] which allowed the clinician to invoke the MedRec application to bring up a list of medications, document the "currently taking" status and "intended action," add additional medications, and automatically route to an electronic work queue for the pharmacy. The pharmacist could view the MedRec documentation and CPOE orders and record any discrepancies. Two other MedRec tools also supported the comparison and clarification steps. In the study by Poole et al.,[34] the Physician Discharge Medication Worksheet (PDMW) was a paper form generated by the hospital information system with medication information and posted on the paper chart for the physician to review and update prior to discharge. In the system described by Turchin et al.,[38] the PAML Builder imported medication information from source systems and displayed it on a screen for providers to create a validated list of medications at admission.

Fifteen studies included multiple types of IT, so we attempted to identify all of the functionalities present in order to determine how they were used. Databases allowed storage and retrieval of information. Two general types of databases were found in the studies: clinical databases storing medication information[30,34,43] and research databases created to track results of reconciliation.[19,32,43] It is important to note that many types of IT were nested, especially those used for MedRec tools. For example, in the study by Agrawal et al.,[18] the MedRec application was a module within the EMR and, in that of Poole et al.,[34] the pharmacist entered medications into the pharmacy order-entry system, which resulted in the online medication administration record and this information was combined with medications from a database to generate the PDMW. This can be viewed as a positive aspect of IT use, as it demonstrates the integration and interoperability capabilities of IT, facilitating communication of information. In an editorial describing challenges for MedRec, Thompson noted that "few health care settings are connected by a standardized electronic health record which would allow patient-specific information and medication lists to be shared among providers."[7] The presence of several types of IT within workflows in the studies indicates organizations are beginning to integrate IT internally.

A TAXONOMY FOR DISCREPANCIES

While many IT tools allowed users to view medication lists side by side, few articles described whether the systems categorized discrepancies according to a standardized taxonomy. Agrawal et al.[18] described a simple taxonomy, which was based on other reports in the literature. The taxonomy consisted of discrepancies that were related to the choice of drug, drug regimen (dose or frequency), therapeutic duplication, or other. Choice of drug was easily the most common reason for a discrepancy and was subclassified into medications that were to be continued but were not ordered (56% of all discrepancies) and those that were to be discontinued but were ordered (10%). The discrepancies were resolved with the prescriber, although no description was provided as to how many of these discrepancies were intentional and whether any would have the potential to cause harm to the patient. The taxonomy used by

Table 2. General Study Characteristics

Reference	Design[a]	Control Group?	Clinical Setting	Time Frame	Sample
Agrawal (2007)[18]	Observational	No	Hospital: acute tertiary care, academic	August 1–October 30, 2006	N = 3426 Consecutive inpatient admission MedRec events
Bayley (2007)[19]	Observational	No	Hospital: tertiary care	February 10–October 31, 2004	N = 105 Inpatients
Cohen (2008)[20]	Observational	No	Emergency department	June 1, 2003–May 31, 2004	N = 98
Delate (2008)[21]	Quasi-experimental	Yes	3 Skilled nursing facilities: clinical pharmacy call center	October 1, 2003–March 31, 2004	N = 521: 113 MedRec, 408 usual care
Ernst (2001)[22]	Observational	No	Clinic: family medicine, academic	January–March 1999	N = 950 Outpatients, prescription renewal requests
Grant (2003)[23]	Experimental	Yes	Community health center: academic	Interviews conducted May 2001–May 2002	N = 232: 118 intervention, 114 control
Kaboli (2004)[24]	Observational	No	Primary care clinics: hospital, academic	NR	N = 493
Kramer (2007)[25]	Quasi-experimental	Yes	Hospital: adult general medical unit	Preimplementation enrollment: September 13, 2004–February 25, 2005 Postimplementation enrollment: May 6–October 21, 2005	N = 283: 147 preimplementation, 136 postimplementation
Kwan (2007)[26]	Experimental	Yes	Hospital: tertiary care, academic	April 19–June 3, 2005	N = 416: 202 intervention arm, 214 standard care arm (464 enrolled at start of study)
Lau (2000)[27]	Observational	No	2 Hospitals: acute care, general internal medicine ward	June 1993–July 1995	N = 304
Manley (2003)[28]	Observational	No	Clinic: hemodialysis	August–December 2001	N = 63 215 Drug interviews
Nassaralla (2007)[29]	Quasi-experimental	Yes	Clinic: section of primary care internal medicine clinic	April 2005–April 2006	Electronic clinical notes of 65 pts. in preintervention, 100 pts. in postintervention, 65 in sustainability phases
Nester (2002)[30]	Quasi-experimental	Yes	Hospital: tertiary care	October 1999	N = 100: 50 control, 50 intervention
Nickerson (2005)[31]	Experimental	Yes	Hospital: tertiary care, 2 general medicine units	September 2000–June 2001, with 6-mo follow-up period	N = 253: 134 intervention, 119 control
Orrico (2008)[32]	Observational	No	Clinic: family medicine	July–December 2006	85 Calls associated with 85 unique pts.
Pippins (2008)[33]	Observational	No	2 Hospitals: academic	NR	N = 180 (taken from control group of another study)
Poole (2006)[34]	Quasi-experimental	Yes	Hospital: cardiopulmonary unit	6 mo	100 records: 50 preimplementation, 50 postimplementation
Pronovost (2004)[35]	Observational	No	Hospital: academic, surgical ICU	February 2002–February 2003	1455 Medication reconciliation forms
Schnipper(2006)[36]	Experimental	Yes	Hospital	April 1, 2002–March 20, 2003	N = 176: 92 intervention, 84 usual care (79 intervention and 73 usual care evaluated at end of study)
Tulloch (2009)[37]	Observational	No	Hospital: 2 clinical teaching units	December 1, 2006–March 31, 2007	N = 50
Turchin (2007)[38]	Observational	No	Hospital	August 1–October 30, 2006	17,335 Hospital admissions for which a PAML was created
Varkey (2007)[39]	Quasi-experimental	Yes	Clinic	May–July 2005	N = 104: 54 phase I, 50 phase II
Varkey (2007)[40]	Quasi-experimental	Yes	Hospital: family medicine, academic; inpatient care unit	NR	N = 102: 51 phase 1 and 51 phase 2
Wagner (1996)[41]	Observational	No	Clinic: academic, multidisciplinary geriatrics	3 wk in December 1994	N = 117
Weingart (2007)[42]	Quasi-experimental	Yes	Clinics: 3 adult, ambulatory oncology	November 2005–August 2007	N = 104: 54 usual care, 50 MedRec

Wemick (1996)[43]	Observational	No	Hospital: academic; adult general surgical unit	6 wk in February and March 1995	N =125 (of 246) pts. discharged during the study
Wong (2008)[44]	Observational	No	Hospital: tertiary care, academic	March 14, 2006–June 2, 2006	N = 150
Zeigler (2008)[45]	Observational	Yes	Hospital: academic	Preimplementation: September 2005 (6 mo prior to MedRec implementation) Postimplementation: September 2006 (6 mo after MedRec implementation)	N = 114: 53 pre-MedRec, 61 post-MedRec

ICU = intensive care unit; MedRec = medication reconciliation; NR = not reported; PAML = preadmission medication list.
[a]Experimental: subjects randomized to 2 or more groups with a control group; quasi-experimental: more than 1 study group being compared but subjects not randomized to groups; observational = natural variation in interventions is explored and subjects are not specifically assigned to a group.[16]

Agrawal et al.[18] represents a simple, easy-to-use system for categorizing discrepancies that is unlikely to add much to a provider's workload. However, the taxonomy lacks additional features that might further assist in improving patient safety. Providing some assessment of risk of harm to the patient would give prescribers an indication of the potential clinical impact of the discrepancy. For example, the prescriber may have added a drug that interacts with one already on the patient's drug profile, necessitating a switch in the regimen. Tracking risk can also provide policymakers with an indication of the impact of the system on patient safety. The taxonomy could be very simple: low, moderate, or high risk of harm to the patient, along with a brief description. This would not add a significant amount of workload, although it would likely necessitate an expert, such as a pharmacist, to make this assessment. An additional layer of complexity could also be added in order to not only detect errors, but also to prevent them. The IT tool could be designed to track and report on the type of drugs involved in discrepancies to determine, for instance, whether there are certain classes that are more prone to be forgotten when re-ordering medications. This information could then be fed back to prescribers, perhaps leading to fewer discrepancies. Such an IT tool would not impact the workload of the provider who is reviewing discrepancies and, in the long run, may reduce workload by reducing the number of future discrepancies requiring follow-up. Such an IT tool could be extended to include similar data about discrepancies in drug dosing and regimens, again with the goal of reducing the frequency with which unintentional discrepancies occur.

CONSIDERATIONS FOR PROMISING IT-SUPPORTED MedRec

Beyond the review of 28 MedRec studies, 8 additional articles[13,14,46-51] were found that described promising IT tools for MedRec including newly designed MedRec applications (Table 4). All of these studies offer some important insights for applying IT to the MedRec process.

The PAML Builder tool used by Turchin et al.[38] was described in 2 additional articles.[14,50] Poon et al.[50] explained that the application leverages existing electronic information sources, but that this requires aggregating information from non-interoperable resources that may use different medication terminologies. To do this, they developed heuristics to group and display medications. Another source of medication information in MedRec applications is data entered manually into the system. This can be a combination of free-text or coded entry and adds to the mix of data for MedRec. Cimino et al.[46] described an approach using controlled terminology to automatically analyze the mixture of terminology coming from coded and narrative sources.

The user of the MedRec system also plays an important role in data entry. In all of the studies reviewed, MedRec

Figure 2. Information technology use in key activities for the MedRec process. CPOE = computerized provider order entry; EHR = electronic health record; EMR = electronic medical record; HIS = health information systems; MAR = medication administration record; MedRec = medication reconciliation.

Table 3. MedRec Study Goals

Reference	Main Focus	Goals	General Role of MedRec
Agrawal (2007)[18]	Evaluate impact	Evaluate impact of an electronic MedRec system on discrepancies	Full intervention
Bayley (2007)[19]	Evaluate role	Look at impact of new TCP services; describe interventions done by TCP at all phases of care and MedRec is part of TCP tasks	Part of the intervention
Cohen (2008)[20]	Identify discrepancies	Determine discrepancies in medication names obtained during ED care and medication history profiles; use MedRec process for comparison	Part of the methods
Delate (2008)[21]	Evaluate impact of process	Assess impact of a MedRec program	Full intervention
Ernst (2001)[22]	Identify and analyze discrepancies	Assess accuracy of medications in an EMR	Part of the methods
Grant (2003)[23]	Evaluate role	Determine medication adherence barriers and evaluate impact of pharmacist intervention on adherence and discrepancies; use MedRec process for comparison	Part of the intervention
Kaboli (2004)[24]	Identify discrepancies	Assess accuracy of an electronic medication list; use MedRec process for comparison	Part of the methods
Kramer (2007)[25]	Evaluate role	Evaluate effect of pharmacist and nurse collaboration to electronically complete MedRec	Part of the intervention
Kwan (2007)[26]	Evaluate role	Evaluate impact of pharmacist as part of the MedRec process and use of a postoperative medication order form	Part of the intervention
Lau (2000)[27]	Identify discrepancies	Assess completeness of medication histories in the hospital medical record; use MedRec process for comparison	Part of the methods
Manley (2003)[28]	Identify discrepancies, analyze discrepancies	Determine drug record discrepancies and look at correlations of discrepancies to predictor variables; use MedRec process to identify discrepancies	Part of the methods
Nassaralla (2007)[29]	Evaluate impact	Evaluate the impact of implementing a standardized MedRec process	Full intervention
Nester (2002)[30]	Evaluate role	Compare impact of pharmacist obtaining medication history and doing MedRec versus nurse	Part of the intervention
Nickerson (2005)[31]	Evaluate role	Look at effect of implementing a seamless care pharmacist to do MedRec process at discharge	Part of the intervention
Orrico (2008)[32]	Identify discrepancies	Assess accuracy of medication list by comparing EMR medication lists with information obtained by pt. interview to identify discrepancies; use MedRec process for comparison	Part of the methods
Pippins (2008)[33]	Identify and analyze discrepancies	Classify types of PADEs and uncover reasons for them; use MedRec process to determine discrepancies	Part of the methods
Poole (2006)[34]	Evaluate impact	Assess impact of a computer-generated discharge medication worksheet to help with MedRec	Part of the intervention
Pronovost (2004)[35]	Evaluate impact	Assess use and impact of an electronic MedRec tool	Full intervention
Schnipper (2006)[36]	Evaluate role	Evaluate effect of pharmacist intervention (including MedRec) on discrepancies and ADEs	Part of the intervention
Tulloch (2009)[37]	Identify discrepancies	Assess accuracy of the PIP by comparing to a BPMH and identify discrepancies; use MedRec process for comparison	Part of the methods
Turchin (2007)[38]	Analyze discrepancies	Analyze relationship between characteristics of medication records and probability of record validation; use outcomes of MedRec process for analysis	Part of the methods
Varkey (2007)[39]	Evaluate impact of MedRec process	Evaluate effect of MedRec process interventions on discrepancies	Full intervention
Varkey (2007)[40]	Evaluate role	Evaluate effectiveness of a multidisciplinary MedRec process	Full intervention
Wagner (1996)[41]	Identify discrepancies	Assess accuracy (completeness and correctness) of medication lists in an EMR; use MedRec process for comparison	Part of the methods
Weingart (2007)[42]	Evaluate impact	Evaluate effect of MedRec process involving pts.and clinicians	Full intervention
Wernick (1996)[43]	Evaluate role	Evaluate impact of pharmacist performing MedRec	Part of the intervention
Wong (2008)[44]	Identify discrepancies	Perform MedRec at discharge to determine discrepancies and potential impact	Part of the methods
Zeigler (2008)[45]	Evaluate impact	Evaluate effect of MedRec on incidence of prolonged (or inappropriate) use of a prescription	Full intervention

ADEs = adverse drug events; BPMH = best possible medication history; ED = emergency department; EMR = electronic medical record; MedRec = medication reconciliation; PADEs = potential adverse drug events; PIP = Pharmaceutical Information Program; TCP = transitional care pharmacist.

was typically done individually or through a collaboration of pharmacists, nurses, or physicians. However, patients or family members are usually interviewed to collect information on current medications. Two additional articles went further, to actually have the patient use a system to view and update their own medications. In the article by Lesselroth et al.,[48] patients used a kiosk in the clinic lobby upon arrival to view photos of medications and enter information. Schnipper et al.[51] described a program in which patients accessed a medications module as part of a patient portal and could create a journal with medication information for providers to view. These approaches may reduce time and transcription effort spent by providers in collecting and entering medication information from patients.

These user considerations lead to an important aspect of designing MedRec applications: impact on clinical workflows and design. In the article by Lessleroth et al.,[48] staff reported that the kiosk helped with history collection, but the staff felt overwhelmed with the volume and formatting of medication lists and the new responsibility of MedRec. Bails et al.[13] also recognized that workflow changes due to a new MedRec process can lead to a steep learning curve. In the implementation described by Levanda,[49] the new medication-ordering procedures were incorporated into the existing workflow and the new MedRec form replaced other forms to ensure that the process would not be viewed as a new task. Because the introduction of a MedRec process, regardless of whether it uses IT, is going to have an impact on a variety of individuals involved in the care process, their input is necessary. Of the 8 additional articles that described MedRec system implementations, about half explicitly stated that multidisciplinary teams were formed to help develop the system. For example, to create the PAML Builder, a team of clinicians and IT professionals developed an IT-supported process for MedRec.

These additional studies that gathered preliminary feedback from users provided interesting results regarding the MedRec systems. For example, both Poon et al.[50] and Turchin et al.[14] found that clinicians using the PAML Builder wanted integration with medication order entry to be able to easily turn the PAML into medication orders. However, Poon et al. explained the team's reluctance to do this, as it may introduce errors if users could bypass safety checks. As well, Lesselroth et al.[48] and Levanda[49] reported that some clinicians were concerned with making decisions regarding discrepancies for medications outside their area of expertise. This shows that, while a system can be information-rich, it needs to display the appropriate information for the user.

The database search was limited to articles indexed by MEDLINE and CINAHL. Few studies specifically looking at the use of IT for MedRec were found and we had to rely on the information presented in the articles, which was often limited. Studies with very minimal descriptions of IT were excluded and therefore some in which IT was utilized may have been missed. It was also often difficult to determine whether a given study involved MedRec activities and whether reconciliation was actually performed. To determine this, we relied on the methods presented and assumed that discrepancies found in prospective studies were resolved, as it would be unethical not to do so. It was also sometimes challenging to categorize some types of IT presented, as they were not usually described in detail and we had to rely on consensus for the categorizations. The actual functionalities offered by a system depend on the individual

Table 4. Additional Articles

Reference	Title	IT Application for MedRec
Bails (2008)[13]	Implementing Online Medication Reconciliation at a Large Academic Medical Center	Online MedRec program
Cimino (2007)[46]	Medication Reconciliation Using Natural Language Processing and Controlled Terminologies	MedLEE
Groeschen (2007)[47]	Electronic System Improves Medication Reconciliation Rates	EMR
Lesselroth (2009)[48]	Design and Implementation of a Medication Reconciliation Kiosk: the Automated Patient History Intake Device (APHID)	APHID
Levanda (2007)[49]	Implementing a Medication Reconciliation Process in a Community Hospital	Computer-generated pt. medication/ reconciliation order form
Poon (2006)[50]	Design and Implementation of an Application and Associated Services to Support Interdisciplinary Medication Reconciliation Efforts at an Integrated Healthcare Delivery Network	PAML builder
Schnipper (2008)[51]	Design and Implementation of a Web-Based Patient Portal Linked to an Electronic Health Record Designed to Improve Medication Safety: The Patient Gateway Medications Module	Patient gateway medications module
Turchin (2008)[14]	Evaluation of an Inpatient Computerized Medication Reconciliation System	PAML builder

EMR = electronic medical record; IT = information technology; MedLEE = Medical Language Extraction and Encoding; MedRec = medication reconciliation; PAML = preadmission medication list.

system setting, design, and implementation and so may be more comprehensive than indicated in the article. However, an attempt was made to minimize differences in individual IT by generalizing use according to an established set of functionality categories by the IOM. Lastly, the articles included in the review may be subject to publication bias.

Summary

MedRec is an important process to ensure patient medication safety, especially during transitions in care. Through this scoping review, evidence was found that IT can and has been used to facilitate MedRec activities, from basic email and databases to specialized MedRec tools. In the selected studies, IT was mainly used to obtain medication information. However, promising applications are being developed to support the entire MedRec process, including comparison of medications and clarification of discrepancies.

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Uso de la Tecnología de Información en la Conciliación de Medicamentos: Una Revisión de Oportunidades

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EXTRACTO

OBJETIVO: Identificar estudios del uso de la tecnología de información (IT) en la conciliación de medicamentos (CM) y determinar cómo la IT se usa para facilitar el proceso de CM.

FUENTES: La estrategia de búsqueda incluyó el uso de MEDLINE y CINAHL, búsqueda manual de manuscritos y referencias de manuscritos identificados en la búsqueda. La búsqueda estuvo limitada a manuscritos en inglés y a artículos publicados desde el 1950 en MEDLINE y desde 1982 en CINAHL hasta marzo de 2009. Búsquedas Booleanas se construyeron usando combinaciones de términos de búsquedas para conciliación de medicamentos, IT, y récords electrónicos.

SELECCIÓN DE ESTUDIOS Y EXTRACCIÓN DE RESULTADOS: Se usaron 3 criterios de inclusión para los estudios. Los estudios tenían que (1) involucrar el proceso de CM, (2) ser de datos primarios, e (3) involucrar el uso de IT. La selección fue llevada a cabo por 2 revisores mediante consenso. Los datos relacionados a características del estudio, enfoque, y la IT fueron extraídos.

SÍNTESIS: Los estudios que se incluyeron describieron el alcance de las IT usadas mediante el proceso de CM desde los más básicos (e-mail y bancos de datos) a herramientas especializadas de CM. Un diagrama de flujo genérico de CM fue creado y los tipos de IT encontrados en los estudios fueron trazados de acuerdo a los diagramas de flujo y a las funcionalidades basadas en las capacidades básicas de un sistema electrónico de expedientes de salud del Instituto de Medicina (IOM). En los estudios revisados, la IT fue usada mayormente para obtener información de medicamentos. Aunque hubo pocas herramientas de CM en los estudios, las que existían apoyaban las actividades centrales para CM: la comparación de medicamentos y aclaración de discrepancias.

CONCLUSIONES: La conciliación de medicamentos en un proceso importante para asegurar la seguridad del paciente en cuanto al uso de medicamentos. Se encontró evidencia de que la IT puede y se ha usado para facilitar algunas actividades de CM y que se están desarrollando nuevas aplicaciones para apoyar el proceso de CM.

Traducido por Homero A Monsanto

Revue d'Utilisation des Technologies d'Information pour Effectuer un Bilan des Médicaments

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RÉSUMÉ

OBJECTIFS: Identifier les études impliquant les technologies de l'information (TI) dans un processus de bilan de médicaments (BM) et déterminer comment celles-ci sont utilisées pour faciliter la tâche.

SOURCES DE DONNÉES: La stratégie de recherche incluait une recherche dans MEDLINE (1950–mars 2009) et CINAHL (1982–mars 2009), une recherche manuelle dans des références accumulées ainsi que dans les références croisées. La recherche dans les banques de données a été limitée à la langue anglaise. Les requêtes booléennes d'informations ont été construites en combinant les mots-clés medication reconciliation, IT, et electronic records.

SÉLECTION DES ÉTUDES ET EXTRACTION DES DONNÉES: Trois critères d'inclusion ont été utilisés: 1) processus de bilan de médicaments, 2) étude primaire et, 3) utilisation des TI. La sélection a été effectuée avec le consensus de 2 réviseurs. Les données reliées aux caractéristiques de l'étude et à l'utilisation des TI ont été extraites.

SYNTHESE DES DONNÉES: Les études choisies décrivaient une utilisation des TI pour effectuer le bilan des médicaments allant d'un simple courriel à des banques de données et outils spécialisés. Un plan de gestion d'un processus générique a été développé et les différents types de technologie y ont été intégrés selon les capacités définies par l'Institute of Medicine Key Capabilities of an Electronic Health Record System. Dans les études revues, les TI étaient principalement utilisées pour obtenir l'information médicale. Bien qu'un faible nombre d'outils de BM ait été utilisé dans les études, ceux-ci ont démontré un support pour la centralisation des BM en comparant les médicaments et en mettant en évidence les différences.

CONCLUSIONS: Le bilan des médicaments est un processus important pour assurer l'usage sécuritaire des médicaments. Il y a des données qui prouvent que les TI peuvent faciliter ce processus et de nouveaux outils sont présentement en développement afin de supporter l'ensemble du processus.

Traduit par Nicolas Paquette-Lamontagne