

Paper to Electronic MedRec Implementation Toolkit 2nd Edition



Sponsored by:



Prepared for:

Institute for Safe Medication Practices Canada
4711 Yonge Street, Suite 501
Toronto, Ontario, Canada
M2N 6K8
www.ismp-canada.org

The Canadian Patient Safety Institute
1414 10135 103 Ave,
Edmonton, Alberta, Canada
T5J 3G1
www.patientsafetyinstitute.ca

Prepared by:

University of Victoria
Victoria, BC
Alex M.-H. Kuo, PhD
Helen Monkman, PhD

AE Informatics
Victoria, BC
Elizabeth M. Borycki, RN PhD
Andre W. Kushniruk, MSc, PhD

Institute for Safe Medication Practices Canada,
Toronto, ON
Lisa Sever, BSc Phm, ACPR, BCGP, Medication Safety Specialist
Alice Watt, BSc Pharm, Medication Safety Specialist
Brenda Carthy, BA(CompSci), National Medication Reconciliation Coordinator
Valerie Leung, Consultant

Canadian Patient Safety Institute
Edmonton, AB
Mike Cass, National Patient Safety Improvement Lead

Canada Health Infoway
Toronto, ON
Seema Nayani, BSc Phm, CDE, BCGP Pharmacist Leader

This document is in the public domain and may be used and reprinted without permission except those copyrighted materials that are clearly noted in the document. Further reproduction of those copyrighted materials is prohibited without the specific permission of copyright holders






Suggested Citation:

The Electronic Medication Reconciliation Group. (2017). Paper to Electronic MedRec Implementation Toolkit, 2nd Edition. ISMP Canada and Canadian Patient Safety Institute.

The Institute for Safe Medication Practices Canada, the Canadian Patient Safety Institute and Canada Health Infoway and other contributing organizations are not responsible, or liable, for the use of the information provided.

Acknowledgements

The authors of this document would like to acknowledge and thank staff and researchers from:

	<p>AE Informatics</p>
	<p>Canada Health Inforoute / Santé Infoway du Canada</p>
	<p>Canadian Patient Safety Institute (CPSI)</p>
	<p>Institute for Safe Medication Practices Canada (ISMP Canada)</p>
	<p>School of Health Information Science</p>

The Institute for Safe Medication Practices Canada (ISMP Canada) in partnership with the Canadian Patient Safety Institute (CPSI) along with researchers from the University of Victoria and AE Informatics supported the paper to electronic medication reconciliation initiative and development of this toolkit. This work was funded by Canada Health Inforoute.

Table of Contents

Glossary.....	5
Introduction.....	9
What is Medication Reconciliation (MedRec)?	10
What is Electronic Medication Reconciliation (eMedRec)?.....	11
What are the Benefits of e-MedRec?	11
How is Patient Safety related to eMedRec?	12
Why is eMedRec required as part of an overall Opioid Strategy?	12
What are advantages to electronically capturing health information?	12
What are specific advantages of eMedRec?	13
A how-to guide for implementing eMedRec	15
Important Considerations When Implementing eMedRec	15
Governance and Leadership	15
Assessment of Organizational Readiness	15
Workflow Standardization, Organizational Policy and Procedures.....	15
Selection and Procurement of eMedRec Solutions.....	16
System Reliability.....	17
Usability	17
Sustainability.....	18
Cost.....	19
Patient Safety.....	19
Risk Assessment.....	19
Training and Engagement.....	20
What are the Stages in Implementing eMedRec?	21
Stage 1: Understand and Assess eMedRec Components and Related Health IT in Your Organization	21
Stage 2: Analyze and Understand Your Current MedRec Approach	22
Stage 3: Understand eMedRec Models and how to Integrate eMedRec into the Organization’s Workflow	22
Ensuring Success after eMedRec Implementation	30
Compliance	30
Technological Features.....	30
Leadership.....	30
Ongoing Coaching.....	30
Performance Feedback.....	30
Evaluating eMedRec	31
How Do You Monitor and Report on eMedRec?.....	31
How do you measure eMedRec?	31
Evaluating Effectiveness: Patient Safety and Quality of Care	33
What Are the Lessons Learned in eMedRec Implementation?	34
Conclusion.....	39
Appendix A – Checklists and Tools	40
eMedRec Implementation Checklist.....	40
Ideal Features of eMedRec Solution Checklist	43
eMedRec Evaluation Checklist.....	47
Recommendations for Successful Development and Implementation of eMedRec Tools.....	48
Appendix B – What does eMedRec Look Like?	49
The Importance of External Drug Information Sources – Opioid Crisis.....	52
References.....	57

Glossary

The following terms will be used in this toolkit.

Admission Medication Orders (AMOs): Prescriber-recorded admission medication orders documented within 24 hours from the time of admission to a healthcare facility. A time frame of 24 hours is preferred for clarification of admission medication orders (i.e., permitting normal processes of care to correct problems occurring at the time of admission). These normal processes would include clinical pharmacists clarifying unclear admission medication orders (CPSI and ISMP Canada, 2017)

Adverse Drug Event (ADE): An injury from a medicine or lack of an intended medicine. It includes adverse drug reactions and harm from medication incidents. (CPSI and ISMP Canada, 2017)

Best Possible Medication History (BPMH): A history created using 1) a systematic process of interviewing the patient/family; and 2) a review of at least one other reliable source of information to obtain and verify all of a patient's medication use (prescribed and non-prescribed). Complete documentation includes drug name, dosage, route and frequency. The BPMH is more comprehensive than a routine primary medication history which may not include multiple sources of information. An electronic version of the BPMH is commonly referred to as an eBPMH. (CPSI and ISMP Canada, 2017)

Best Possible Medication Discharge Plan (BPMDP): Accounts for the medications that the patient was taking prior to admission (BPMH) to acute care, the most current medication list, and any new medications planned to start upon discharge. The best possible medication discharge plan (BPMDP) should be communicated to the patient, community physician, community pharmacy and alternative care facility or service. This may include:

- An up-to-date and accurate list of medications the patient should be taking on discharge.
- A medication information transfer letter to the next care provider which includes rationale for the medication changes.
- A structured discharge prescription to the next care provider or community pharmacist.
- A patient medication schedule and / or wallet card

An electronic version of the BPMDP is commonly referred to as an eBPMDP. (CPSI and ISMP Canada, 2017)

Blockchain: This technology is a permanent record of online transactions or exchanges that may be applied to medication information. This record can be shared among a network of computers, and users on the network can add to the record of transactions. Instead of a database that is centrally located and maintains and manages records, the database is distributed to the networks. Transactions are kept secure via cryptography, and transactions have to be approved and verified by the network in a process called mining. Each transaction can be thought of as a block, and the ledger that links them together can be thought of as the chain. (<http://www.beckershospitalreview.com/healthcare-information-technology/9-things-to-know-about-blockchain-in-healthcare.html>)

Computerized Provider Order Entry (CPOE): A Health IT that facilitates the process of electronic order entry. CPOE allows authorized healthcare providers to order medications, tests and procedures, and provide other instructions pertaining to the treatment of patients under their care. These systems generally integrate with pharmacy order entry/verification systems and Decision Support Systems (DSS). The most advanced eMedRec processes include tools that allow for direct input of reconciled medication orders into the CPOE program. However, CPOE implementations are complex and not all hospitals in Canada are currently using CPOE. Therefore, planning for moving to eMedRec should take into consideration the potential for integration with CPOE.

Decision Support Systems (DSS): Computerized systems designed to support clinician decision making. This may include provision of educational resources and guidelines, as well as automated alerts and reminders for healthcare providers. DSS are often integrated or embedded within CPOE systems.

Discharge: The discontinuation of service by the organization.

Discrepancy: A difference identified between what the patient is actually taking versus the information obtained from other sources. Bedell and colleagues (2000) defined discrepancies in an outpatient setting as, “the difference between the list of medications in the medical record (referred to as recorded medications) and what a patient actually took, based on medication bottles and on self-reports (referred to as reported medications).”

Drug Information System (DIS): An electronic repository of medication and prescription data that is held at a regional level. A region could be a regional health authority or a province [e.g., PharmaNet in British Columbia and Pharmaceutical Information Program (PIP) in Saskatchewan].

Electronic Health Record (EHR): An electronic health record (EHR) refers to the systems that make up the secure and private lifetime record of a person's health and health care history. These systems store and share such information as lab results, medication profiles, key clinical reports (e.g., hospital discharge summaries), diagnostic images (e.g., X-rays), and immunization history. The information is available electronically to authorized health care providers. (Canada Health Infoway, 2017)

Electronic Medical Record (EMR): An electronic medical record (EMR) is an office-based system that enables a health care professional, such as a family doctor, to record the information gathered during a patient's visit. This information might include a person's weight, blood pressure and clinical information, and would previously have been hand-written and stored in a file folder in a doctor's office. Eventually the EMR will also allow the doctor to access information about a patient's complete health record, including information from other health care providers that is stored in the EHR. (Canada Health Infoway, 2017)

Electronic Medication Administration Record (eMAR): An electronic record of a patient's medication administration history.

Electronic Medication Reconciliation (eMedRec): Use of electronic tools or Health IT to perform medication reconciliation.

eMedRec Tool: A computerized tool to help support the MedRec processes. eMedRec tools are used to compare BPMH to orders and identify discrepancies by displaying medication lists and providing options to select whether to hold, continue, change or discontinue medications. eMedRec tools may be linked to CPOE so that orders can be made, modified or discontinued taking into account medication reconciliation.

Hard Stop: The requirement that MedRec steps be completed and is enforced by the eMedRec system (e.g., the user cannot proceed until required actions regarding medication decision making have been made).

Health Information System (HIS): An information system that processes healthcare data.

Health Information Technology (Health IT): A broad concept that describes the use of computer hardware, software, or infrastructure to record, store, protect, and retrieve clinical, administrative, or financial information. Examples of Health IT include: electronic health records, personal health records, electronic medical records, and electronic prescribing (e-Prescribing). (<http://www.healthit.gov/providers-professionals/faqs/what-health-it>)

Intentional Discrepancies: The prescriber has made an intentional choice to add, change or discontinue a medication and this choice is clearly documented. This is considered to be a “best practice” in medication reconciliation. (CPSI and ISMP Canada, 2017)

Medication Management: is an overarching concept that describes the delivery of patient-centred care to optimize safe, effective and appropriate drug therapy. Care is provided through collaboration with patients and their healthcare teams. (CPSI and ISMP Canada, 2017)

Medication Reconciliation (MedRec): A formal process in which the healthcare provider works together with patients, families and care providers to ensure accurate and comprehensive medication information is communicated consistently across transitions of care. MedRec requires a systematic and comprehensive review of all the medications a patient is taking to ensure that medications being added, changed or discontinued are carefully evaluated. It is a component of medication management and will inform and enable prescribers to make the most appropriate prescribing decisions for the patient. (CPSI and ISMP Canada, 2017)

Non-Prescribed Medication: All medications not prescribed by a healthcare practitioner. These non-prescribed medications may include over-the counter (OTC) medications, nutritional supplements, vitamins, natural health products, or recreational drugs. (CPSI and ISMP Canada, 2017)

Personal Health Record (PHR): A complete or partial health record under the custodianship of a person(s) (e.g. a patient or family member) that holds all or a portion of the relevant health information about that person over their lifetime. This is also a person-centric health record, but unlike the EHR, the patient has control or “custodianship” over the record, rather than the health care provider. (Canada Health Infoway, 2017) This record may be maintained using electronic tools such as consumer Apps or web-based resources.

Plain Language: is a clear writing style designed to be easy to read and understood by the intended audience. It includes how information is organized and displayed within a space, such as the use of white space, fonts, ‘active’ instead of ‘passive’ voice of instructions, design elements and color. (Health Canada, 2016)


Pharmacy Practice Management System (PPMS): The information management systems used by pharmacy professionals (referred to as pharmacy practice management systems or PPMS) must support the delivery of patient care including the dispensing of drugs in accordance with Canadian regulations and standards. (NAPRA)

Prescribed Medication: Medications that are prescribed by a healthcare practitioner. These medications include all prescription drugs (as defined by each provincial pharmacy act), and may include over-the-counter drugs (e.g., ASA) and vitamins (e.g., calcium supplements). (CPSI and ISMP Canada, 2017)

Patient Medication List: Refers to a medication list kept by a person, on paper, on a computer, using a mobile application (e.g., MyMedRec App) or a mobile device (e.g., Smartphone, tablet). These lists are maintained by an individual/family and may not always be vetted by a healthcare professional. Therefore, just as with all other sources of information, they require a discussion with the patient and/or the patient’s family as they aid in the development of the BPMH.

Senior Leadership: People in leadership roles (e.g., Chief Executive Officer, Vice-President, Chief Information Officer) in an organization that can remove obstacles and allocate resources. (CPSI and ISMP Canada, 2017)

Soft Stop: Soft stops are computer-based reminders. For example, if the BPMH is expected to be complete within six hours of admission, at three hours after admission a reminder could be sent to the person responsible for completing the BPMH to complete it.



Transfer: An interface where orders need to be reviewed and rewritten according to facility policy. These may include: change of service, change in level of care, post-operatively, or transfer between units because of availability of beds (CPSI and ISMP Canada, 2017)

Introduction

Medication reconciliation (MedRec) is intended to prevent harm arising from ineffective communication of medication information as patients' transition across healthcare settings. Although reconciling medications is a critical component of providing safe care, it is complex and challenging to implement system-wide. Canadian providers have clearly indicated that technology to support the MedRec process will be essential for successful implementation across the healthcare system.

Accurate and complete medication usage patterns are essential to inform prescribing decisions, especially when high alert medications such as opioids or anticoagulants are being considered. eMedRec solutions that integrate medication dispensing data repositories and e-prescribing systems have potential to reduce harm from opioid fraud and misuse (Health Canada, 2016). The urgency of implementing eMedRec solutions has become even more critical with the opioid crisis. There is a need to know what medications are being prescribed and taken by individuals to ensure their health and safety.

A 2012 report "Identifying Practice Leaders for Medication Reconciliation in Canada" based on a Pan-Canadian survey of fifty organizations found that only 14.6 percent of healthcare organizations were using a fully electronic system for the completion of MedRec associated activities (ISMP Canada, 2012). One of the top challenges identified by responding organizations was a lack of technology to support MedRec. A subsequent 2013 Canadian survey, "Transitioning to Electronic MedRec" reported that the organizations who were using some form of electronic medication reconciliation (eMedRec), only 11 percent were fully electronic, with 80% using a hybrid approach (Kuo, Monkman, Kushiniruk & Borycki, 2013). Both reports can be found at: <https://www.ismp-canada.org/medrec/>.

This information formed the initial basis for the development of this toolkit with the goal of supporting organizations in their migration from a paper-based system to an electronic system for MedRec. The researchers from the University of Victoria, in collaboration with AE Informatics Inc., ISMP Canada and CPSI, funded by Canada Health Infoway were involved in developing the toolkit.

This 2nd edition toolkit provides updated resources to support Canadian healthcare organizations transitioning to or implementing eMedRec.

The success of developing and integrating technical solutions to support MedRec is highly dependent on attention to implementation processes, extensive usability testing and evaluation involving clinicians and other end-users. In addition, long-term periodic assessments of the use and application of eMedRec tools can ensure sustainability.

Well planned and resourced solutions that consider relevant factors outlined in this document, are much more likely to improve patient safety, increase efficiency and result in better patient and organizational outcomes. Conversely, poorly designed and inadequately resourced technical solutions to support clinical processes can result in costly reinvestment (i.e. re-implementation, re-customization and re-education of healthcare professionals) to achieve patient safety gains.

eMedRec has the potential to greatly streamline and improve patient safety and organizational efficiency. The tools and resources provided in this toolkit are designed to facilitate that journey.

What is Medication Reconciliation (MedRec)?

Medication reconciliation is a formal process in which healthcare providers work together with patients, families and care providers to ensure accurate and comprehensive medication information is communicated consistently across transitions of care.

Medication reconciliation requires a systematic and comprehensive review of all the medications a patient is taking to ensure that medications being added, changed or discontinued are carefully evaluated. It is an essential component of medication management and will inform and enable prescribers to make the most appropriate prescribing decisions for the patient. An understanding of the patient's actual medication use is a pre-requisite to safe medication management. (CPSI and ISMP Canada, 2017)

The goal of MedRec is to prevent potential patient medication errors and adverse drug events (ADEs) due to communication gaps. MedRec is an important strategy to reduce and prevent ADEs (Poon et al., 2006).

How is MedRec Performed?

Best Possible Medication History (BPMH)

The foundation of the MedRec process is the BPMH.

The first step involves creating a BPMH. Create a BPMH by:

- Using a systematic process of interviewing the patient/family (and other caregivers) as the primary source of medication information.
- Reviewing at least one other reliable source of information to obtain and verify all of a patient's medication uses (prescribed and non-prescribed medications e.g. over-the-counter and vitamin and herbal therapies).

The MedRec Process

Medication Reconciliation in Acute Care Getting Started Kit v.4 (CPSI and ISMP Canada, 2017) outlined a three-step process for medication reconciliation in acute care:

1. **Create a complete and accurate Best Possible Medication History (BPMH)** of the patient's medications including name, dosage, route and frequency. This includes: interviewing patient and families and conducting a review of at least one other reliable source of information;
2. **Reconcile Medications:** Use the BPMH to create admission orders or compare the BPMH against admission, transfer or discharge medication orders; identify and resolve all differences or discrepancies; and
3. **Document and Communicate** any resulting changes in medication orders to the patient, family/caregiver and to the next provider of care.



TIP - For more information on Medication Reconciliation refer to:

<https://www.ismp-canada.org/medrec/>

What is Electronic Medication Reconciliation (eMedRec)?

Electronic Medication Reconciliation (eMedRec) uses information technology to access and integrate electronically stored patient medication data to support:

- the collection of the electronic Best Possible Medication History (eBPMH), the detection and resolution of discrepancies,
- the comparison of eBPMH and new orders at transfers.
- the development of an electronic Best Possible Medication Discharge Plan (eBPMDP), including discharge prescription information that can be electronically transmitted to health information repositories.

Use of a combination of paper and electronic systems is referred to as a hybrid approach to eMedRec (see Figure 1). When fully implemented, eMedRec can replace pMedRec processes.

As healthcare organizations adopt Health IT at an ever increasing rate, there is a move toward replacing all paper-based processes with computerized processes (Borycki & Kushniruk, 2008; Borycki et al., 2009).

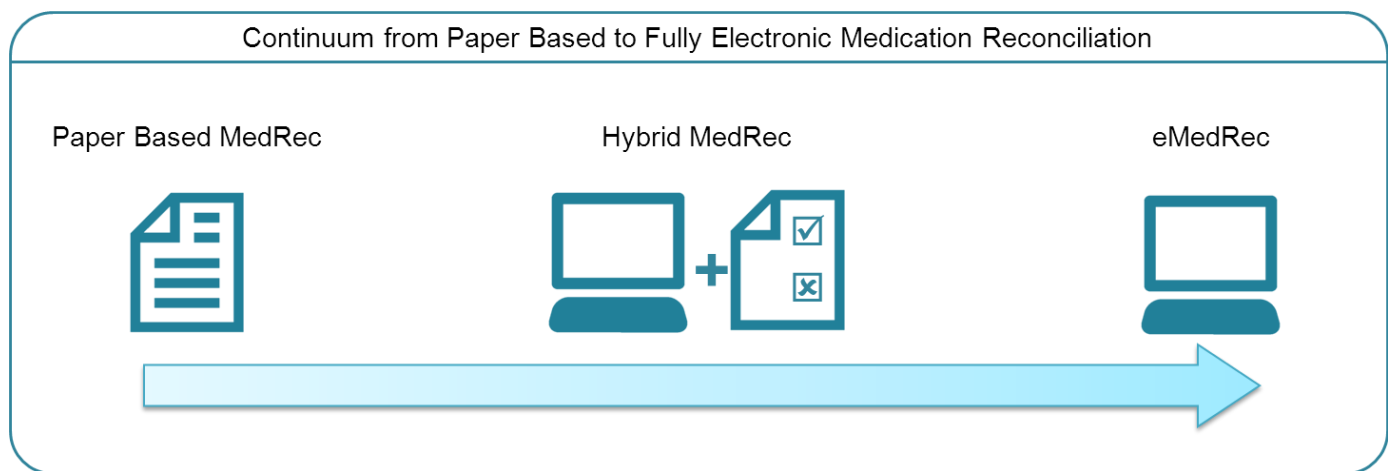


Figure 1. Continuum from pMedRec to eMedRec

What are the Benefits of e-MedRec?

Although MedRec has been an Accreditation Canada Required Organizational Practice since 2006 (Accreditation Canada, 2013), it has proven to be difficult to fully implement using paper-based forms and processes (i.e., pMedRec). eMedRec provides an enhanced ability to integrate with internal hospital systems (such as CPOE) and external systems (such as provincial databases or drug information systems). Some Canadian hospitals have shown eMedRec is more effective than pMedRec in integrating processes and facilitating discharge. eMedRec can improve the efficiency of MedRec processes by providing electronic tools to support clinical activities and enhance patient safety.

How is Patient Safety related to eMedRec?

- When a home medication history is electronically documented and readily accessible at discharge, it reduces prescribing errors, such as omissions and incomplete prescriptions at discharge (Garcia-Molina Saez C et al. 2016).
- A Canadian hospital implemented a pilot project documenting the admission BPMH in the eMedRec system. Physicians used this as a comparison list at admission, transfer and discharge. There has been a drop in the number of unexplained medication discrepancies at discharge from an average of 3 per patient to 0.7 (Accreditation Canada, 2013).
- An eMedRec interface using grouping and animations which offered cognitive support demonstrated less errors were made by clinicians performing eMedRec, which could have an impact on patient safety (Plaisant C et al. 2015).
- Hron and colleagues 2015 reported after their quality improvement project was completed, “the risk of a reported ADE related to admission MedRec in the post-intervention period was significantly lower than that in the pre-intervention period.”
- A meta-analysis showed a reduction in unintended medication discrepancies after using eMedRec (primarily omissions), with most considered minor severity. Overall, “there is a lack of high-quality studies with rigorous designs that investigate the impact of eMedRec on medication discrepancies.” (Mekonnen et al 2016).
- A multi-incident analysis revealed incidents in which the paper recorded admission BPMH was not integrated with the prescriber’s order process, led to omission errors (ISMP Canada, 2016).

Why is eMedRec required as part of an overall Opioid Strategy?

The availability of centralized medication prescribing information can lead to a dramatic reduction in inappropriate filled prescriptions for opioids and benzodiazepines (Dormuth et al, 2012). The integration of this data into eMedRec solutions has the potential to inform readily accessible, real-time clinical decision making with respect to prescribing and dispensing.

“At a time when national options are being explored to create functional electronic health records and an e-prescribing platform, the current prescription opioid crisis is a clear and present danger that should provide the impetus to move quickly in making these technological advancements a reality.”(CPhA, 2016)

What are advantages to electronically capturing health information?

General advantages of electronically capturing health information (HealthIT.gov):

- Improved standardization and accessibility of documentation; efficient care
- Improved legibility of information
- Improved communication between providers
- Enhanced tracking of process and outcome measures
- Decision support tools, clinical alerts
- Integration of electronic data from multiple sources (e.g., drug information systems, patient interviews), increases access to more information i.e., non-prescription usage, natural health products
- Improved patient safety

What are specific advantages of eMedRec?

Advantage	Evaluation	Author
Improved compliance with the process using alerts	Process measure	Agrawal A and Wu WY, 2009
Improved access to electronically available sources of preadmission medication information such as ambulatory electronic medical records	Process measure	Mueller et al, 2012
Integration with CPOE to facilitate improved medication ordering processes	Process measure	Schnipper et al., 2009
Improved efficiency of many medication-related processes in healthcare organizations. The rate of admission MedRec increased after implementation of eMedRec. Clinicians completed eMedRec more timely compared to pMedRed	Process measure	Poon et al., 2006 Sardaneh et al., 2017
Reduced unintended medication discrepancies on admission and discharge	Outcome measure	Agrawal & Wu, 2009 Mekonnen et al., 2016 Hron et al., 2015
Incorporating pharmacy claims data, or provincial drug information system with EHR increases the accuracy of the BPMH and medication discrepancies and potential adverse drug events	Outcome measure	Phansalkar et al, 2015 Fernandez et al, 2010

Testimonials for Early Adopters

“With eMed Rec, reasons for any changes to medicines are mandatory, and this information automatically goes to the GP on discharge. This information is also embedded within the discharge script for the community pharmacist and the patient medication card, which can be used to discuss medication changes with the patient at discharge”	Health Quality and Safety Commission New Zealand, 2016 Retrieved from: http://www.hqsc.govt.nz/news-and-events/news/2512
“Better communication to care providers in the community when patients are discharged. For example, discharge prescriptions are attached to the e-Discharge Summary and auto-faxed to the patient’s family physician. This same medication information can also be provided to the Community Pharmacist and patient.”	Nova Scotia Health Authority Central Zone, 2015 Retrieved from: https://accreditation.ca/sites/default/files/nova_scotia_health_authority_central_leading_practice_profile_en.pdf
Engaging patients in using an eMedRec tool is an upcoming strategy. “The physician and nurses reported the tool to be easy-to-use, easy to integrate into existing workflow, and potentially time-saving.” “Every patient found at least one error or other issues with their EMR medication lists. All of them reported that the tool was easy to use.”	Long et al., 2016 Retrieved from: https://www.ncbi.nlm.nih.gov/pubmed/27185210

To illustrate the potential of eMedRec to streamline MedRec, Figure 2 shows a reconciled medication list generated after discrepancies have been resolved by using an eMedRec tool. eMedRec tools can facilitate comparing medication lists electronically, and provide support for decision making about medication discrepancies, thereby supporting more efficient and safer medication management.

Brian Baker
 DOB: October 22, 1943 Sex: Male
 Height: 75 IN Weight: 180 LBS
 Drug Allergies: **Penicillin**

Dr. George Mitchells
 Date: June 24, 2013
 ID: 000000002

Original Lists
Reconcile Lists
Exit

Reconciled/Discharge medication List

	Medication	Dosage	Route	Frequency	Start date	End date	Continue	Discontinue	Change	Comment
1	Amlodipine	2.5 mg	Oral	Daily	Jan-15-1999	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
2	Aspirin	81 mg	Oral	Daily	Feb-05-2013	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
3	Atorvastatin	20 mg	Oral	Bedtime	Apr-18-2008	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
4	Citalopram	40 mg	Oral	Daily	Dec-17-2011	Continuous	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	
5	Digoxin	0.0625 mg	Oral	Daily	Aug-10-2004	Continuous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
6	Levothyroxine	0.1 mg	Oral	Daily	Sep-3-2010	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
7	Metformin	500 mg	Oral	Twice Daily	Jun-24-2013	Continuous	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	
8	Metoprolol	12.5 mg	Oral	Twice Daily	May-22-2012	Continuous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
9	Rabeprazole	40 mg	Oral	Daily	Aug-22-2012	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Reverse Substitution
10	Ramipril	10 mg	Oral	Daily	Dec-17-2011	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
11	Tamsulosin CR	0.4 mg	Oral	Daily	May-04-2012	Continuous	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
12	St. John's Wort	300 mg	Oral	Daily	June-09-2013	Jun-24-2013	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	

Requires Referral
In Progress
Complete

Figure 2. A final reconciled record created after using an eMedRec tool - adapted with permission from Markowitz et al. (2011)

A how-to guide for implementing eMedRec

This section of the toolkit will provide practical advice for those considering or currently implementing eMedRec.

Canada Health Infoway has tools to support the implementation of electronic solutions.

Change Management Toolkit: Leading Change in Health Care can be found:
<https://www.infoway-inforoute.ca/en/resource-centre/toolkits/change-management>

Important Considerations When Implementing eMedRec

Governance and Leadership

Senior leadership support is imperative before embarking on eMedRec implementation. The transition to eMedRec will require sustained resources, perseverance, clear accountability, preparation and dedication to achieve success. The need for strong leadership commitment and support cannot be overemphasized.

Assessment of Organizational Readiness

Understanding the current state of an organization's Health IT is critical to implementing eMedRec. For example, it is valuable to pair eMedRec with CPOE implementation because efficacy is improved when they are implemented together.

Before implementation, healthcare organizations should determine the following:

- What Health IT they currently have in their organization
- What they plan to implement in terms of eMedRec tools
- Common understanding of the components of eMedRec
- What are (and what will be in the future) the Health IT inputs (e.g. various sources of medication information) and outputs (e.g. electronic discharge prescription, patient friendly medication list) to eMedRec.

Workflow Standardization, Organizational Policy and Procedures

Implementing eMedRec requires integrating processes into clinician workflow. It is important to have a comprehensive understanding of how MedRec is currently being done. Graphical representations help to communicate before and after workflows. It is important to communicate critical aspects of the process such as:

- The overall plan for implementing and sustaining eMedRec across the organization.
- Changes in organizational policies and procedures.
- Professional roles and responsibilities and how the changes will affect their tasks. For example, if BPMH is typically collected at bedside, this may be feasible only if your organization has tablets or computers on wheels.
- Clear time expectations for tasks to be completed.



TIP - Work closely with clinicians to define best practices in workflow. For example, ideal workflow should be clearly defined for the creation of an eBPMH during patient admission and eBPMDP at discharge.

For example: A process should be in place to support updating the eBPMH when new information is discovered during the patient's admission, to prevent errors perpetuating through to discharge and beyond.

Observation of workflow and clinical simulations are increasingly being used around the world to assess the impact of new Health IT upon workflow (Borycki et al., 2005; Borycki et al., 2006; Kushniruk et al., 2006; Kushniruk et al., 2013). Clinical simulation is best undertaken in a setting similar to or in the actual setting where eMedRec takes place. Observation and clinical simulations can be used to diagram workflows, assess the impact of the technology upon care processes and identify potential sources of technology-induced errors. The eMedRec interface design, organizational policies and procedures as well as training can be refined to address cumbersome workflows and potential pitfalls of workflows prior to implementation.

Selection and Procurement of eMedRec Solutions

Organizations must carefully undertake the selection and procurement of eMedRec technology. They should consider the following:

- What Health IT is currently available in the organization? For example, if an organization has implemented a major commercially available vendor EHR, it may be most expedient to consider what type of solutions that vendor has available for eMedRec, thereby reducing issues of interoperability and interfacing of differing health IT.
- What features and functions of an eMedRec solution will be mandatory for an implementation, which are nice to have (but not required), and which features and functions will be implemented at a later date? For example, in many organizations, there may be a desire to fully integrate eMedRec with CPOE.
- What are the clinical requirements for eMedRec? Canada Health Infoway has created some clinical requirements documents that may be helpful to use during procurement. Organizations can refer to these documents that focus on the clinical requirements for technology enabled MedRec upon Admission to Acute Care and Discharge. These were created by an interdisciplinary work group with national representation – see the below links:
 - [Admission to Hospital Medication Reconciliation – Clinical Requirements](#)
 - [Discharge Medication Reconciliation – Clinical Requirements](#)
 - [E-prescribing – Clinical Requirements](#)



TIP – Evaluate the “fit” between your organization's workflow and commercial eMedRec when selecting a vendor-based system for purchase. This should involve hands-on inspection and testing of candidate systems before making the final selection.

- Ideally the features and functions of eMedRec support the following:
 - Display of current medications and eBPMH lists **side-by-side**. This display should include complete information on: current, previous, active and discontinued medications, to facilitate comparison.
 - Sorting and flagging to easily identify discrepancies that require clinical decision
 - Modification of medications (e.g., continue, discontinue, hold, or change) from the same screen.
 - Integration of eMedRec with CPOE so that new medications can be easily prescribed.
 - All outputs should communicate a clear, consistent BPMDP using plain language, using approved abbreviations and other safety strategies such as Tallman lettering and appropriate font size to increase readability (Health Canada, 2016)



Tools – Refer to Appendix A to use the Ideal Features of an eMedRec Solution Checklist and the Recommendations by Marien S and colleagues (2016) for the Successful Development and Implementation of eMedRec Tools.

System Reliability

System reliability is an essential aspect of implementing eMedRec. There must be a back-up plan if eMedRec fails or goes down (i.e., downtime policies and procedures that can be used when there is a power outage or scheduled downtime for system maintenance). It is imperative to have a back-up strategy available in the event that technical difficulties prevent MedRec from being done electronically.

Usability

Higher rates of compliance will be achieved with an intuitive, easy- to- use system. Users are more likely to revert to paper-based processes or find workarounds if eMedRec is difficult to use (Kushniruk & Patel, 2004).

For example, investing in and/or customizing a system to facilitate clinician cognition (e.g., side-by-side comparisons of medication lists) and efficiency (e.g., creating inpatient orders from home medications) will provide value to users. Furthermore, systems that are easier to use will require less training and be easier to use by infrequent users or users with lower levels of computer literacy (Boockvar et al., 2011).

Low-cost and rapid methods for conducting usability evaluations and assessment are now available (see Kushniruk & Borycki, 2006). Consideration of usability has been shown to be effective in leading to greater end user acceptance and fewer problems with adoption and compliance (Boockvar et al., 2011). For more information about such approaches and their application to eMedRec see Boockvar et al. (2011).

Usability testing is the most commonly used evaluation method for assessing user interactions with health IT. Usability testing involves analyzing the interactions between representative users as they perform representative tasks with IT, in a specific clinical context (Kushniruk et. al. 2006; Kushniruk & Patel, 2004). The users are asked to “think aloud” or verbalize their thoughts as they interact with the system. For eMedRec, audio recordings (of users thinking aloud) and screen recordings (of how users interact with the system) are the data that should be collected

for analysis. This data is then transcribed and coded for usability problems. Improvements to the interface can then be made based on usability problems that were identified (Kushniruk & Patel, 2004).

Usability tests ensure clinicians and other healthcare professionals have an opportunity to evaluate and provide feedback on the eMedRec systems' functionality, usability and workflows. Careful analysis of this feedback is critical to ensure that all users are comfortable with and confident in the ability of the system to align with their day-to-day activities as well as to support their MedRec processes.



TIP – Usability tests should also be carried out by health informatics professionals and a full range of health professionals (including community pharmacists and primary care for interpretation of discharge reports) as well as patients (Kushniruk & Patel, 2004).

Since differing health providers are responsible for differing tasks, it is important for them to evaluate the eMedRec tool. It is important to determine if eMedRec supports clinician workflow such as:

1. Collecting the eBPMH.
2. Revising/updating the eBPMH.
3. Ability to generate a BPMH for patients in plain language.
4. Comparing two different medication lists for discrepancies.
5. Resolving medication discrepancies.
6. Entering and activating orders
7. Generating an eBPMDP that includes:
 - a. Medication regimen for patients in plain language.
 - b. Communication template for sharing the BPMDP to the next provider (e.g., family physician, home care agency, long-term care (LTC) facility).
 - c. Prescriptions which meets legal requirements and communicates the BPDMP to the community pharmacist



TIP – Usability tests should be carried out by those who will use eMedRec. For example, if nurses and pharmacists collect eBPMHs, test with them.

Sustainability

To ensure sustainability, it is important to continually consider and communicate:

- eMedRec achievements and remaining goals
- The importance of eMedRec from a patient safety perspective
- Buy-in and support from clinicians and other end users of the system.

Cost

For any implementation to be a success it is important to identify project and long term maintenance costs. Therefore it is critical to:

- Ensure commitment and support of senior management through an executive sponsor dedicated to this project.
- Ensure that sufficient financial resources are available to implement eMedRec.
- Provide a dedicated team of healthcare professionals and Health IT staff for project implementation.
- Determine the impact on time of using new eMedRec processes by physicians, nurses and pharmacists.
- Ensure there is sufficient staff with enough time to conduct eMedRec on an ongoing basis.
- Budget for evaluation and follow-up. If eMedRec takes away resources from patient care, it may not be considered successful. Assessing resource needs during and after eMedRec implementation is key.

Patient Safety

As with other electronic tools, the introduction of eMedRec has the potential to reduce errors and/or introduce new errors into the MedRec process. To fully benefit from the potential of eMedRec to decrease errors:

- Ensure that healthcare professionals are educated in and aware of their role in all aspects of eMedRec processes.
- Encourage healthcare professionals and patients to report near misses and errors that arise, in order to refine eMedRec processes to ensure system reliability and maximize the benefits of eMedRec (Borycki et al., 2013; Kushniruk et al., 2005). For example, users may be over reliant on the accuracy of auto-populated medication lists and perform less thorough (or even forgo) patient interviews identifying how patients are actually taking prescribed medications.
- Ensure a well-defined evaluation plan is in place to track compliance with and outcomes of implementing eMedRec.

Risk Assessment

Although eMedRec has many benefits, including reducing risk and improving patient safety, implementation may introduce risks and potential for error that must be considered and mitigated. There are a number of safety heuristics (i.e., “rules of thumb”) that can be systematically applied when implementing systems such as eMedRec. For example, safety heuristics can be applied to medication ordering systems (see Carvalho et al., 2009 and Borycki et al., 2013).

Risks **potentially introduced** by eMedRec implementation include:

- Over-reliance on electronic medication lists and avoidance of, or performing lower quality, patient interviews.
- Technology-induced errors may be inadvertently introduced (Ash et al., 2011; Borycki & Kushniruk, 2008; Kushniruk et al., 2005; Institute of Medicine, 2011). For example, if computer screens are displayed in a way that visibly obscures drug lists this might lead to inadvertent error in identifying medication discrepancies. This should be discovered in advance by usability and clinical simulation testing.

- “The paper system had an effect of making the admitting physician accountable to the initial medication history. As the admitting physician signed their name at the bottom of the admission MedRec form, a discharging physician could readily discern which colleague performed the initial medication history. With an electronic format, accountability for the admission medication list became diffuse; the new EMR made the admission medication list feel like a “wiki” (responsibility diffused and accountability suffered).” (Schnipper, SHN! National Call January 2014)
- Inadvertently increasing workload by requiring electronic entry of medications.
- Changing the way users communicate.
- Healthcare professional resistance to adoption.
- Inadequate or ineffective education for clinicians and other users.

Risks **unaffected** by eMedRec implementation:

- Incomplete histories or documentation may still occur.
- Inputting of incorrect data may still occur.



TIP – Conduct clinical simulations during the procurement phase and prior to widely releasing eMedRec systems and during implementation. This can involve local testing of the eMedRec solution by a few end users as they are observed carrying out representative eMedRec tasks under realistic conditions (Borycki & Kushniruk, 2008; Kushniruk et al, 2013).

Training and Engagement

Training of users is critical and clinicians will require more than one training session or training combined with follow-up support. Indeed, in studies of eMedRec implementations, training and education of end users of eMedRec was found to be one the most important factors in facilitating adoption by physicians and pharmacists (Boockvar et al., 2011). Providers must be taught the benefits and potential consequences associated with all of the steps of eMedRec to increase buy-in and support for quality at every step in the process. Only provider support will result in the potential improvements in patient safety. For example, emphasize the importance and the impact of thorough BPMHs to downstream outputs of the eMedRec process.

A multi-pronged approach for training users of eMedRec is necessary. This may involve:

- Using more than one method for training to create widespread and repeated exposure to how the eMedRec process works.
- Making training materials available after training sessions to allow users to revisit exercises, and solve problems as they use the system.
- Providing onsite experts /champions at all service delivery hours when the system is first deployed to help guide new users through the process.
- Begin with a pilot group who can test the process and engage other users.

What are the Stages in Implementing eMedRec?

There are three stages in eMedRec implementation:

Stage 1: Understand and Assess eMedRec Components and Related Health IT in Your Organization

Stage 2: Analyze and Understand Your Current MedRec Approach

Stage 3: Understand eMedRec Approaches and How they Can be Integrated into Your Organization's Workflow

Stage 1: Understand and Assess eMedRec Components and Related Health IT in Your Organization

When implementing eMedRec, careful consideration of the components and characteristics of Health IT as it relates to and integrates with eMedRec is required.

The different types of Health IT used within the organization need to be understood and considered when moving toward eMedRec processes (see Figure 3). Even if these are not currently integrated electronically with the selected eMedRec tool, information sharing between these tools should occur as the organization and more broadly for the province (e.g. for Electronic Health Records (EHRs), Drug Information Systems (DIS)) moves toward full electronic integration. For this reason, it is essential that implementation of eMedRec be integrated into the broader system-wide information technology/information management plan for the organization (see the glossary and the Canada Health Infoway website for more information about Health IT with which eMedRec may integrate).

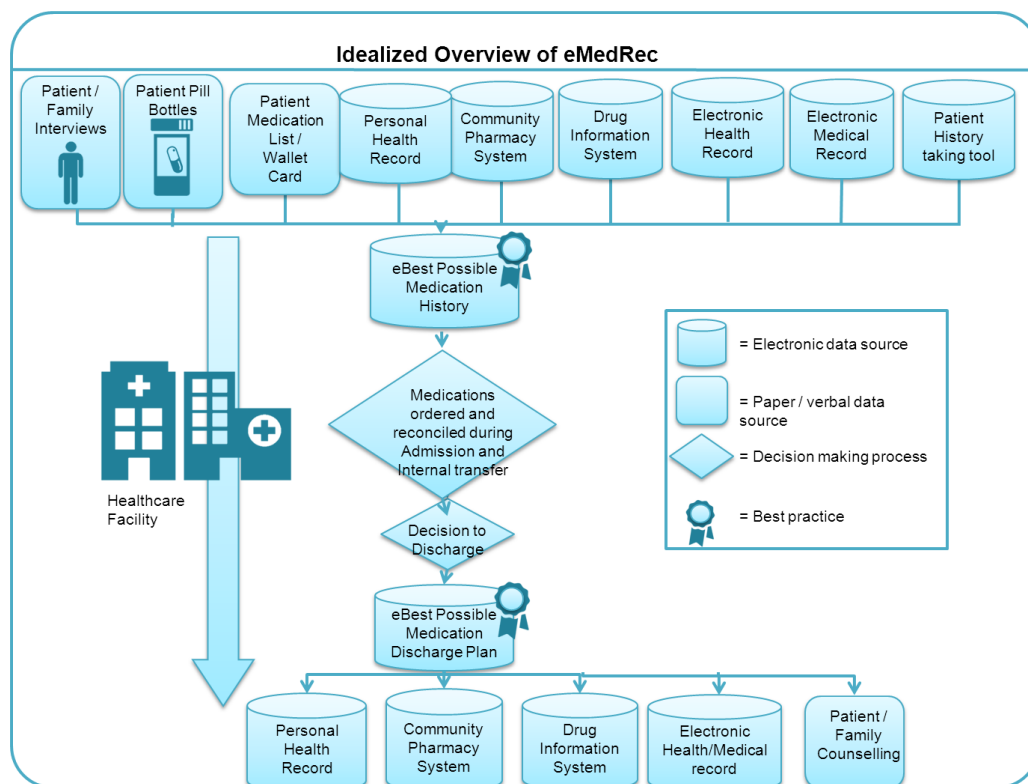


Figure 3. An idealized version of eMedRec in acute care

Figure 3 illustrates an idealized overview of eMedRec, including the number of inputs, processes and outputs that may be involved. The eMedRec process typically involves one or more components. For further information about the electronic components in Figure 3 refer to the glossary.

Stage 2: Analyze and Understand Your Current MedRec Approach

In Canada, there are several models of MedRec to consider. Identification of the particular model used by the healthcare organization is important to understanding how eMedRec processes might work (i.e., where and how eMedRec can be inserted and integrated into the healthcare organization's existing processes). The models are:

1. Proactive Model

- The BPMH is completed before medication orders are entered. The BPMH informs medication ordering. The proactive process is well suited for small hospitals with fewer admissions, for areas with planned admissions like a pre-admission clinic with highly skilled and trained clinicians dedicated to obtaining the BPMH. (CPSI and ISMP Canada, 2017)

2. Retroactive Model

- In this model the medication orders are entered before creating a BPMH. The medication orders are compared to the BPMH, discrepancies are identified and resolved, and modifications are made to the medication orders accordingly. The retroactive process is suited to sites with high admission volumes, which may lead to difficulty obtaining a BPMH before admission orders are written. Reconciliation of the admission medication orders with the BPMH is necessary to identify and resolve any discrepancies. (CPSI and ISMP Canada, 2017)

3. Mixed Model

- Some larger institutions have a proactive model when staff is available and a retroactive model when there are fewer staff. It may be necessary to have a combination of proactive and retroactive models to capture all admissions.(CPSI and ISMP Canada, 2017)

Understanding the MedRec model that an organization uses is the first step to mapping the current workflow, and identifying how the technology will align with or change the organization's workflow. The next stage in this process is to understand eMedRec approaches and how they can be integrated into an organization's workflow to make positive change.

Stage 3: Understand eMedRec Models and how to Integrate eMedRec into the Organization's Workflow

Numerous options exist for implementing eMedRec. This section will provide general information about mapping the eMedRec workflow which will be useful when consulting with IT staff and eMedRec vendors about determining what is possible in the organization, and what is provided by eMedRec software.

Figure 4 shows an idealized process flow map for eMedRec for admissions, based on a proactive model as described above. In the figure, step 2 shows where in the process eMedRec tools can be used to support MedRec.

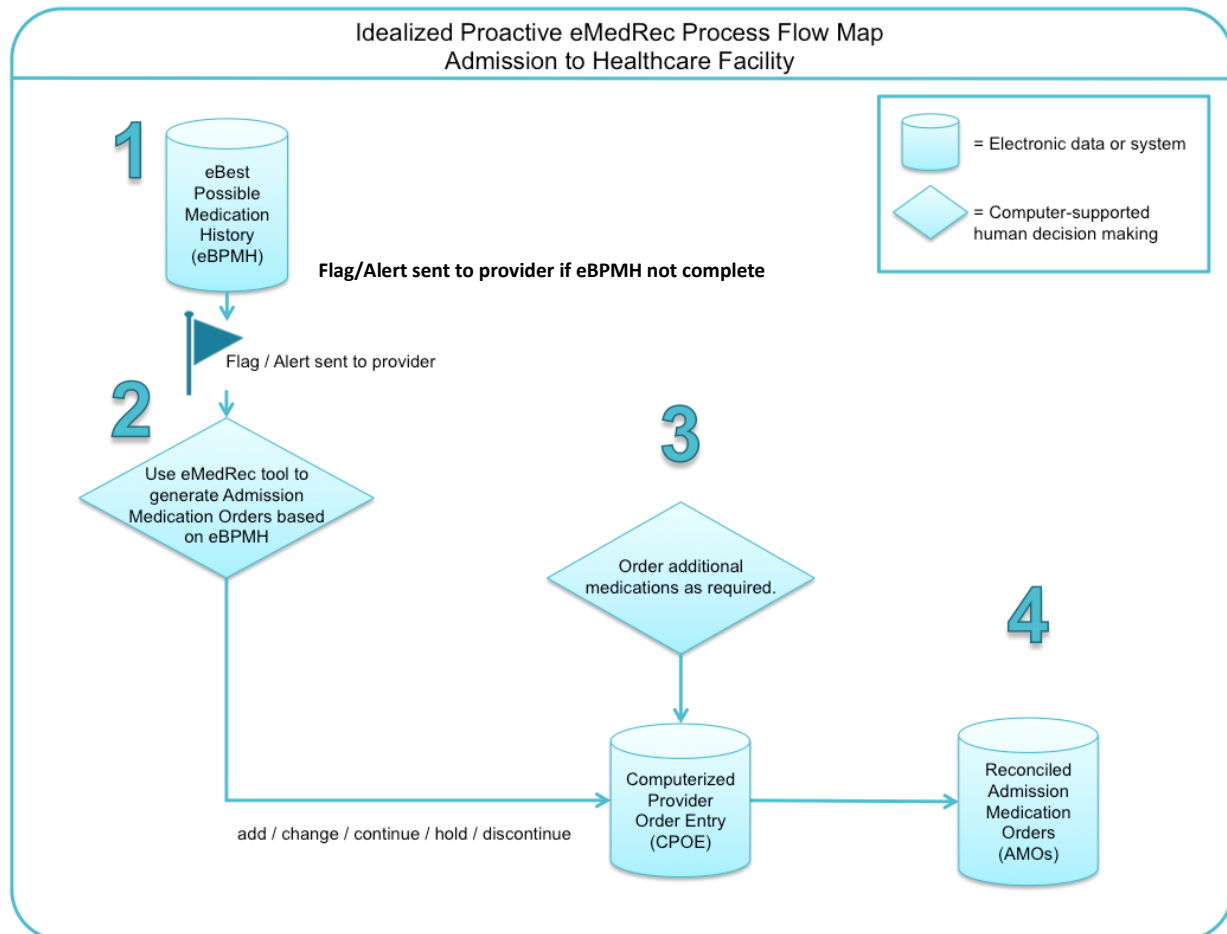


Figure 4. Idealized proactive, eMedRec process flow map for admissions to healthcare facility

Retroactive eMedRec at Admission

In a fully electronic hospital, the orders are entered into a Computerized Provider Order Entry (CPOE) system. An alert can notify the providers that medication reconciliation is required. Within a short predetermined period of time (24 to 48 hours after admission), a healthcare provider such as a nurse, pharmacist or physician, interviews the patient or caregivers to develop an eBPMH. Once the eBPMH is completed, a prescriber will review the eBPMH and use the eMedRec tool to identify, resolve or document any discrepancies with the admission orders. Then, if additional medications are required, or current medications should be changed or discontinued, this is done in CPOE by a prescriber as part of the reconciled admission medication orders. Refer to Figure 5.

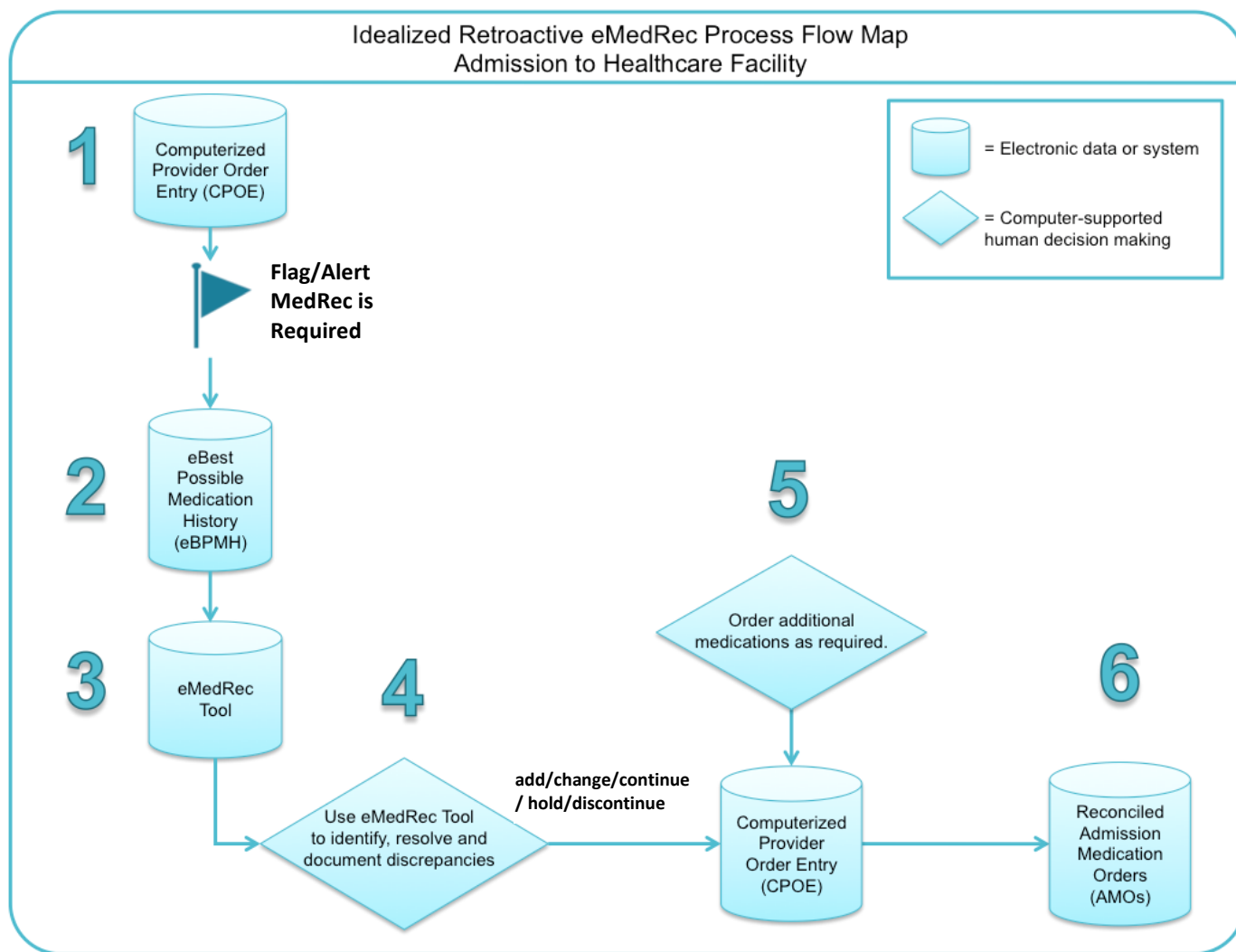


Figure 5. Idealized retroactive, eMedRec process flow map for admission to healthcare facilities

Figure 6 shows an example of an eMedRec tool that can be used to help compare medication lists in order to identify any discrepancies. This figure shows two lists displayed on the screen side-by-side (**preferred**) (the BPMH and the Admission Orders). By clicking on the “Reconcile Lists” tab we can see in Figure 7 below that discrepancies in the two lists are flagged and colour coded to support decision making about medications.

Figure 6. Two, original, unreconciled medication lists for comparison – adapted with permission from Markowitz et al. (2011)

Brian Baker
 DOB: October 22, 1943 Sex: Male
 Height: 75 IN Weight: 180 LBS
 Drug Allergies: **Penicillin**

Dr. George Mitchells
 Date: June 24, 2013
 ID: 000000002

Original Lists
Reconcile Lists
Exit

BPMH

Medication	Dosage	Route	Frequency
Amlodipine	2.5 mg	Oral	Daily
Aspirin	81 mg	Oral	Daily
Atorvastatin	20 mg	Oral	Bedtime
Citalopram	40 mg	Oral	Daily
Digoxin	0.0625 mg	Oral	Daily
Levothyroxine	0.1 mg	Oral	Daily
Metformin	500 mg	Oral	Twice Daily
Metoprolol	12.5 mg	Oral	Twice Daily
Rabeprazole	40 mg	Oral	Daily
Ramipril	10 mg	Oral	Daily
Tamsulosin	0.4 mg	Oral	Daily
St. John's Wort	300 mg	Oral	Daily

Admission Medication Orders

Medication	Dosage	Route	Frequency
Amlodipine	2.5 mg	Oral	Daily
-	-	-	-
Atorvastatin	20 mg	Oral	Bedtime
Citalopram	40 mg	Oral	Daily
Digoxin	0.0625 mg	Oral	Daily
Levothyroxine	1 mg	Oral	Daily
Metformin	500 mg	Oral	Twice Daily
Metoprolol	25 mg	Oral	Twice Daily
Rabeprazole	40 mg	Oral	Daily
Ramipril	10 mg	Oral	Daily
Tamsulosin	0.4 mg	Oral	Daily
-	-	-	-

Requires Referral
In Progress
Approve

Brian Baker
 DOB: October 22, 1943 Sex: Male
 Height: 75 IN Weight: 180 LBS
 Drug Allergies: **Penicillin**

Dr. George Mitchells
 Date: June 24, 2013
 ID: 000000002

Original Lists
Reconcile Lists
Exit

Discrepancies

	Source	Medication	Dosage	Route	Frequency	Start date	End date	Comment
1	H	Metoprolol	12.5 mg 25 mg	Oral	Twice Daily	May-22-2012 Feb-22-2013	Continuous	Patient cuts pills in half
2	H	Levothyroxine	0.1 mg 1 mg	Oral	Daily	Sep-03-2010	Continuous	
3	H	Rabeprazole Pantoprazole	40 mg	Oral	Daily	Aug-22-2012 Jun-23-2013	Continuous	Formulary Substitution
4	H	Aspirin	81 mg	Oral	Daily	Feb-05-2013	Continuous	
5	H	St. John's Wort	300 mg	Oral	Daily	Jun-09-2013	Jun-23-2013	

Complete Matches

	Source	Medication	Dosage	Route	Frequency	Start date	End date	Comment
1	H	Amlodipine	2.5 mg	Oral	Daily	Jan-15-1999	Continuous	
2	H	Atorvastatin	20 mg	Oral	Bedtime	Apr-18-2008	Continuous	
3	H	Citalopram	40 mg	Oral	Daily	Dec-17-2011	Continuous	
4	H	Digoxin	0.0625 mg	Oral	Daily	Aug-10-2004	Continuous	
5	H	Ramipril	10 mg	Oral	Daily	Dec-17-2011	Continuous	
6	H	Tamsulosin CR	0.4 mg	Oral	Daily	May-04-2012	Continuous	

Refer to Pharmacist
In Progress
Complete

Figure 7. Matching of the two medication lists and identification of discrepancies – adapted with permission from Markowitz et al. (2011)

The following (Figure 8) is an example of another eMedRec tool that can be used to help compare medication lists in order to identify any discrepancies. This figure below illustrates two lists, an intake (which could be an admission BPMH) and written hospital admission orders. They are displayed on the screen side-by-side (**preferred**).

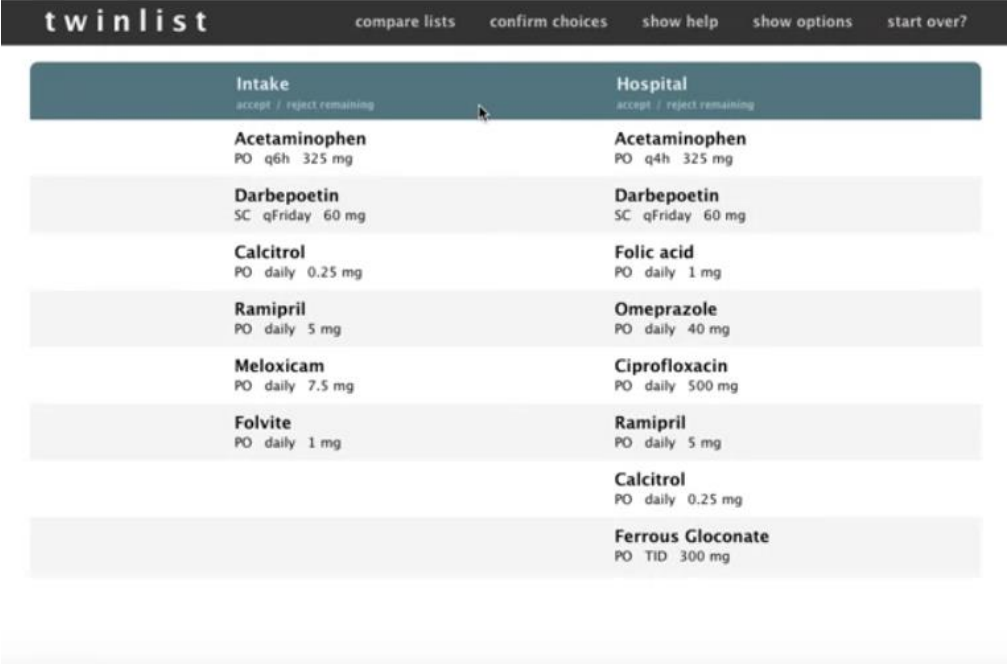


Figure 8. Two, original, unreconciled medication lists for comparison (Plaisant, 2015)

Using this application, you click on the “Compare lists” button. The lists are then sorted into 5 different categories, as seen in this screen shot below (Figure 9). The similar medications have colour coding to easily identify the differences that require clinical decisions.

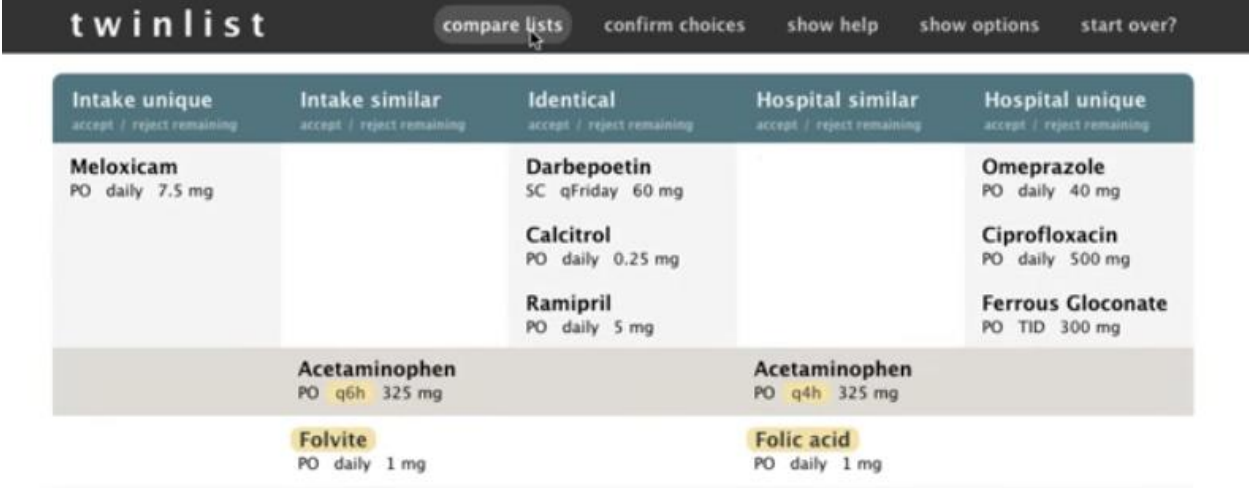


Figure 9. Example shows an application that sorts unique, similar and identical medication orders when comparing the intake medication list to the current hospital list – Twinlist (Plaisant, 2015)

Watch the [Twinlist Demo \(part 1\) Novel Interfaces for Medication Reconciliation](#)

eMedRec at Internal Transfer

The process for medication reconciliation at transfer is shown in Figure 10. The healthcare provider is presented with a list of transfer medication orders that are compared to the eBPMH. The lists are compared and discrepancies are identified and resolved. Additional medications are ordered as required.

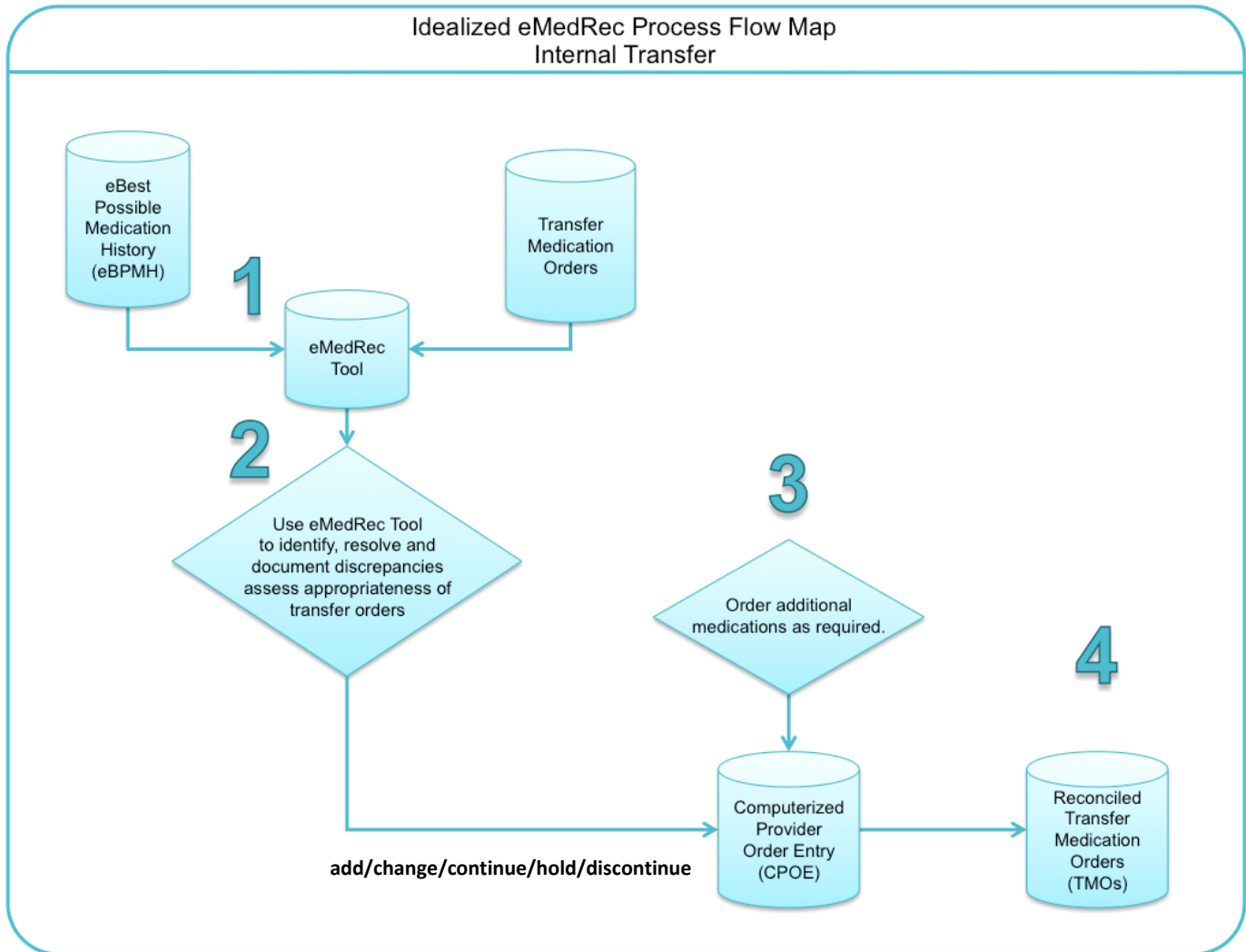


Figure 10. Idealized eMedRec process flow map for transfers within a healthcare facility

eMedRec at Discharge

The eBPMH and the current medication orders, along with any additional medications ordered at discharge, are used to inform the electronic Best Possible Medication Discharge Plan (eBPMDP). The eBPMDP is then used to generate discharge prescriptions (meeting all legal requirements), a Discharge Summary and a patient medication schedule. Some but not necessarily all of the electronic systems will be updated. Refer to Figure 11.

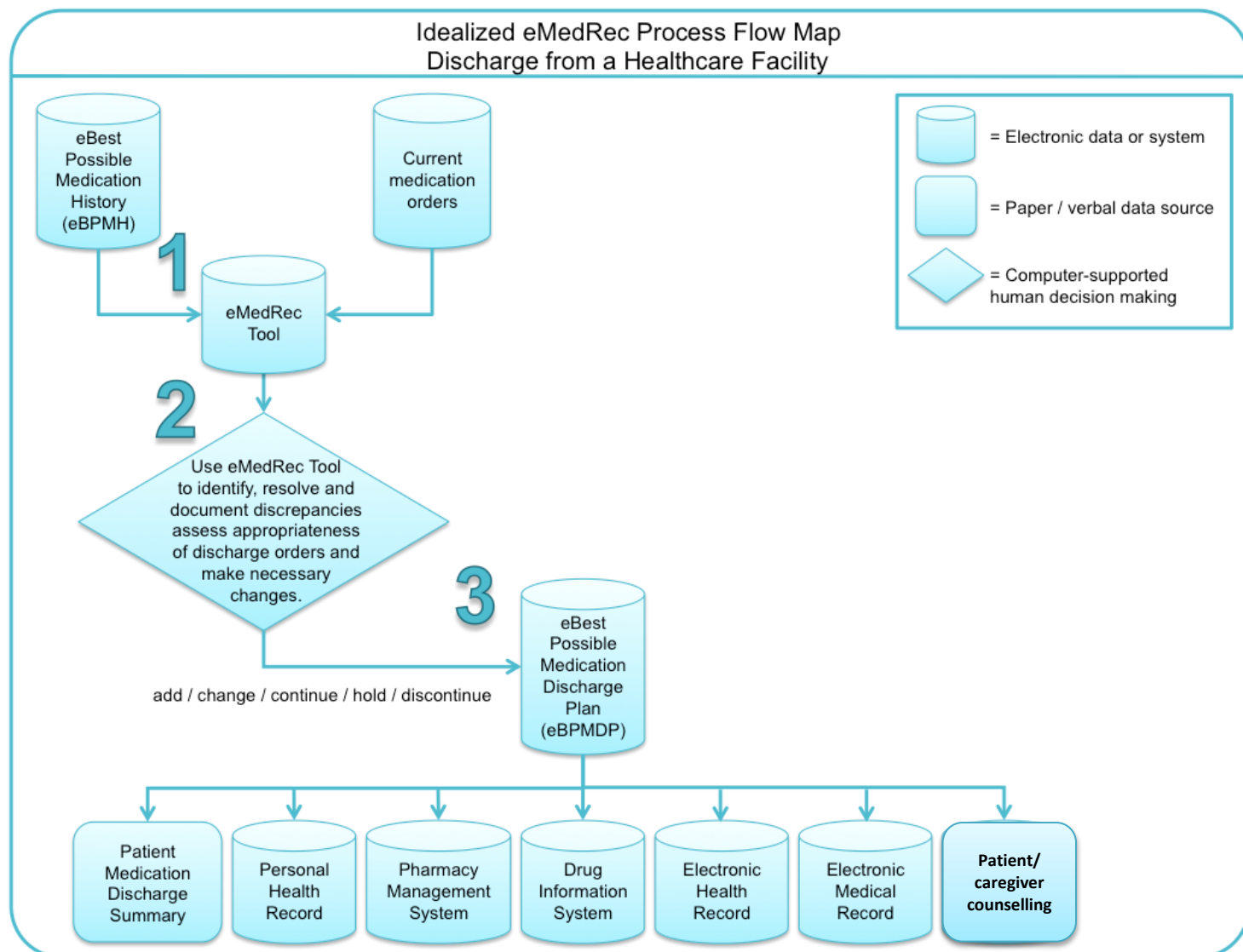


Figure 11. Idealized eMedRec process flow map for discharge from a healthcare facility

Discharge and prescribing e-MedRec module

Below (Figure 12) is an example of an eMedRec module being used to create a BPDMP at hospital discharge. The current hospital orders are sorted and aligned beside the community list (i.e., admission BPMH), to allow the clinician to decide on the medication regimen. The software, based on the choices checked off, then places the orders in the right hand column as Prescribed, Dose changes and Discontinued. There is the ability to add further prescriptions at discharge.

Discharge reconciliation and prescribing module		
In Hospital List <input checked="" type="checkbox"/> Atorvastatin 20mg PO qHS <input checked="" type="checkbox"/> Perindopril 2mg PO qAM <input checked="" type="checkbox"/> NTG spray 0.4mg S/L PRN <input checked="" type="checkbox"/> Clopidrogel 75mg PO qD <input checked="" type="checkbox"/> ECASA 81mg PO qD <input type="checkbox"/> Heparin 5000U S/C q12h <input checked="" type="checkbox"/> Cal-D 1 PO bid <input checked="" type="checkbox"/> Hydrochlorothiazide 12.5mg PO qD <input checked="" type="checkbox"/> Gliclazide 40mg PO bid <input checked="" type="checkbox"/> Levothyroxine 0.1mg PO qD <input type="checkbox"/> Salbutamol 1 neb aerosol q6h PRN <input checked="" type="checkbox"/> Ibuprofen 200mg PO tid <input type="checkbox"/> Codeine 30mg PO q4h PRN <input checked="" type="checkbox"/> Lorazepam 0.5mg PO qHS PRN <input checked="" type="checkbox"/> Salinex 2 spray qid PRN <input checked="" type="checkbox"/> Vitamin B12 100mcg IM qMonth <input checked="" type="checkbox"/> Risedronate 35mg PO qSundays	Community List <input checked="" type="checkbox"/> Atorvastatin 10mg PO qHS <input checked="" type="checkbox"/> Bisoprolol 5mg PO bid <input type="checkbox"/> Lisinopril 20mg PO qd <input checked="" type="checkbox"/> NTG spray 0.4mg S/L PRN <input checked="" type="checkbox"/> ASA 81mg PO qD <input checked="" type="checkbox"/> Calcium+Vitamin-D 1 PO bid <input checked="" type="checkbox"/> Hydrochlorothiazide 25mg PO qD <input type="checkbox"/> Glimepiride 5mg PO qD <input type="checkbox"/> Metformin 850mg PO tid with meals <input type="checkbox"/> Rosiglitazone 8mg PO qAM <input checked="" type="checkbox"/> Levothyroxine 0.1mg PO qD <input checked="" type="checkbox"/> Lorazepam 1mg PO qHS <input type="checkbox"/> Diclofenac 1.5% to Right knee bid <input type="checkbox"/> Omeprazole 20mg PO qD <input checked="" type="checkbox"/> Salt-water-desalinated <input checked="" type="checkbox"/> Mometasone 50mcg Nasal spray 2 sprays qD <input checked="" type="checkbox"/> Vitamin B12 100mcg IM qMonth	Discharge Rx Prescribed Bisoprolol 5mg PO bid Cal-D 1 PO bid Clopidrogel 75mg PO qD ECASA 81mg PO qD Gliclazide 40mg PO bid Ibuprofen 200mg PO tid Levothyroxine 0.1mg PO qD Mometasone 50mcg Nasal spray 2 sprays qD NTG spray 0.4mg S/L PRN Perindopril 2mg PO qAM Risedronate 35mg PO qSundays Salinex 2 spray qid PRN <input type="checkbox"/> Tylenol 500mg bid PRN Vitamin B12 100mcg IM qMonth <input type="button" value="Add"/> Dose changes <input checked="" type="checkbox"/> Atorvastatin 20mg PO qHS <input checked="" type="checkbox"/> Hydrochlorothiazide 12.5mg PO qD <input checked="" type="checkbox"/> Lorazepam 0.5mg PO qHS PRN Discontinued <input checked="" type="checkbox"/> Codeine 30mg PO q4h PRN <input checked="" type="checkbox"/> Diclofenac 1.5% to Right knee bid <input checked="" type="checkbox"/> Glimepiride 5mg PO qD <input checked="" type="checkbox"/> Heparin 5000U S/C q12h <input checked="" type="checkbox"/> Lisinopril 20mg PO qD <input checked="" type="checkbox"/> Metformin 850mg PO tid with meals <input checked="" type="checkbox"/> Omeprazole 20mg PO qD <input checked="" type="checkbox"/> Rosiglitazone 8mg PO qAM
<input checked="" type="button" value="Cancel"/>	<input type="button" value="Add to discharge Rx"/>	<input type="button" value="Add to discharge Rx"/> <input type="button" value="Finalize"/>

Figure 12. Discharge medication reconciliation module with hospital medications, verified community-based drug list and sorted into therapeutic classes. (Tamblyn et al, 2012)

Ensuring Success after eMedRec Implementation

Compliance

Compliance with eMedRec processes is an important issue and the incentives or requirements for clinicians doing eMedRec should be decided before implementation (Neufeld & Williams, 2012).

Technological Features

- Soft stops are reminders generated after a specific amount of time has elapsed. For example, if the BPMH is expected to be complete within six hours of admission, at three hours after admission a reminder could be sent to the person responsible for completing the BPMH (Agrawal & Wu, 2009).
- Hard stops can be implemented to prevent users from moving on before eMedRec steps are complete. An example is that patients cannot be discharged unless the discharge eMedRec is complete (Agrawal & Wu, 2009).
- The system can be set up so that tasks must be done in a specific sequence and at set times (Agrawal & Wu, 2009; Boockvar et al., 2011).

Leadership

The senior level of the organization must provide strong leadership to ensure all staff know and understand their role in, and accountability for, successful implementation of eMedRec processes (Boockvar et al., 2011).

Expectations must be clear and monitoring is required.

Ongoing Coaching

Ongoing demonstrations of how to use the system should be implemented to help overcome misconceptions and improve compliance. For resistant users it is helpful to have a champion who can mentor them on using the software with real patients, to prevent misconceptions regarding the time needed to conduct eMedRec, and to educate about the complexity of the process (Boockvar et al., 2011).

Performance Feedback

Communicating to users about what they are doing well, and what improvements are needed, is important to achieving high compliance with eMedRec. In addition to sharing quantitative data (e.g., percent of patients reconciled per month), adoption may increase through the sharing of qualitative data as well (e.g., providing vignettes about success stories and near misses or harm avoided). In a case study of frontline workers, 80% never received feedback on the quality of pre-admission medication histories (Schnipper, 2014). For example, individualized feedback to users will help improve the quality of eMedRec. Increased compliance with admission eMedRec was demonstrated by incorporating eMedRec training into newly hired physician's orientation, providing personalized feedback to physicians and sharing compliance data. (Taha et al, 2016). Training is essential for all health professions involved in the process (e.g. pharmacists, nurses).

Evaluating eMedRec

Evaluation is important before, during, and after eMedRec implementation. Measurement is an important part of assessing the success of the eMedRec implementation as it allows organizations to analyze the results and identify successful areas and those that need improvement. To be able to compare the eMedRec solution to your previous MedRec process, it is important to collect baseline data that will allow you to make comparisons pre and post implementation. Once implemented, a number of methods for evaluating the effectiveness of eMedRec can be employed.

How Do You Monitor and Report on eMedRec?

Once implemented, monitoring eMedRec should be easier and more comprehensive than monitoring paper-based MedRec. That is, criteria can be set to generate automatic reports periodically (e.g., once a month). These reports can convey data that can be used to compare performance among individual units (e.g., surgical vs. emergency), or aggregated across all units. This facilitates knowing when eMedRec goals are met, as well as what specific areas are having more challenges meeting the goals.

Given that the data is collected and stored electronically, performance measure data entry error is limited, and the amount of time to collect the data is reduced. Often as a consequence of the time required to parse the charts and collect the data, only a sample of charts were used to provide an estimate of measures when MedRec was a paper process. However, with eMedRec all of the charts can be used to determine the actual values (as opposed to estimates) of the descriptive statistics.

How do you measure eMedRec?

Clinician satisfaction surveys, interviews and/or focus groups - can provide valuable feedback about the success or identified concerns surrounding the implementation of the eMedRec system. Canada Health Infoway has a sample of a [System and Use Survey](#).

Patient satisfaction surveys, interviews and/or focus groups - can provide valuable feedback on their level of engagement, or the usability of the outputs (e.g., Was the medication plan complete? Could it be interpreted? Was it useful?)



TIP – Refer to the [Canada Health Infoway Benefits Evaluation Indicators Technical Report](#), Version 2.0 April 2012 for indicators to evaluate an ICT for health systems.

Baseline data is important to determine successful outcomes and to identify new opportunities for improvement, by allowing for comparison of performance before and after eMedRec implementation. Before implementing eMedRec, baseline data should be collected for the existing MedRec process (i.e., paper moving to hybrid, or hybrid moving to fully electronic, or paper to fully electronic).

Outcome measures - answers whether the team is achieving what it is trying to accomplish and articulates the picture of success.

eMedrec outcome measures. For example if the goal is to reduce the number of readmissions due to medications discrepancies / issues, measure:

- The % of patients having a medication related emergency room visit or readmission within 30 days of discharge

Process measures- Processes which directly affect the outcome are measured to ensure that all key changes are being implemented to impact the outcome. These metrics are usually able to be captured by the data elements within the system.

eMedrec process measures

1. The % of completed admission BPMH within 24 hours
2. The % of patients whereby the BPMH collected utilized 2 or more sources of information
3. The % of BPMHs that were validated by involving the patient and/or caregiver
4. The % of patients that had discharge medication reconciliation completed

Balancing measures - answer the question whether improvements in one part of the system were made at the expense of other processes in other parts of the system.

eMedRec balancing measure. If resources are pulled from one area to support eMedRec activities, are there consequences or a change in outcomes. If pharmacists are now completing 100% of admission eMedRec activities, they have reduced time to spend on other clinical activities, a balancing measure could include:

1. The # and % of clinical interventions performed within pre-defined timeframe such as therapeutic drug monitoring, patient counselling, warfarin dosing etc.
2. Turnaround time on other pharmacist consultations or % of other pharmacist consultations completed within 24 hours.
3. Perceptions of unintended outcomes of eMedRec (qualitative feedback through interviews or focus groups).

Alternatively, if pharmacy technicians are trained to complete admission eBPMH a balancing measure could include:

1. The % of pharmacist time completing clinical activities to increase the number of clinical interventions made by pharmacists

Technology-induced Error measures - Incident reports, usability and workflow analyses as well as evaluations of health professionals' satisfaction with health information technology training needs to be conducted to ensure that the technology does not inadvertently introduce new forms of errors (i.e. technology-induced errors arising from usability problems and changes to workflow and lack of end user training on the new system).

Information measures – Measures that collect general details relative to the intervention, such as compliance (e.g., the number of medication reconciliations that take place each month).

Electronic processes facilitate the measuring of compliance. For every patient, the following information measures should be readily determined:

- Was a BPMH collected? Was the patient/caregiver interviewed? Was more than one medication source used?
- How much time elapsed between when the patient was admitted and when the BPMH was collected?

- Average time taken to complete admission eMedRec or discharge eMedRec?
- What percentage of medication reconciliations were completed using electronic tools?
- What electronic data sources were accessed and how frequently?
- Were the patient’s medications reconciled at admission? Transfer? Discharge?
- Did the patient receive a BPMDP?
 - Were changes in the medication regimen communicated to the next provider (e.g., primary care)?
 - Were changes in the medication regimen and new prescriptions communicated to the community pharmacy?



Tool – refer to the Medication Reconciliation Getting Started Kits for more information on measuring MedRec. Found at: <https://www.ismp-canada.org/medrec/>

Evaluating Effectiveness: Patient Safety and Quality of Care

Effectiveness of eMedRec hinges on the quality of task performance. That is, whether eMedRec is able to achieve the goal of improving patient safety and quality of care depends to a large extent on the quality of the BPMH and compliance with using the system. **Interviewing the patient / caregiver, in addition to using more than one source of written medication information for the BPMH collection is considered the gold standard to ensuring the accuracy of the information.** It is ideal to have the eMedRec tool identify the sources of information used and a prompt to ensure the eBPMH was validated with the patient / caregiver. Having mandatory data fields facilitates measurement of whether multiple information sources were used in collecting the BPMH.

Case Example:

The hospital emergency department contacted the patient’s community pharmacy to get a copy of the medication profile. The list was faxed, but contained medications that had been filled a long time ago and had been discontinued, but the hospital staff did not know this. They did not verify the actual medication use with the patient. The medication was administered to the patient during hospitalization, and was included on the discharge prescription. The patient followed up with his primary care prescriber 3 days later. It was identified that a previously discontinued medication had been restarted in error.

Recent evaluations of eMedRec have indicated that different types of users may approach the process of using eMedRec quite differently, with important impact on the quality of the medication reconciliation.

For example, Boockvar and colleagues (2011) found that some users (particularly those who were not properly instructed on the role, importance and impact of using eMedRec) very quickly used electronic templates and expected the process to be more accurate as it now involves technology. In contrast, other users recognized that the eMedRec templates and screens were only there to support their own decision making and used eMedRec to lead to improved safety outcomes.



Pharmacist user:

“Have somebody really look at the quality of the reconciliation and speak to whoever did it, whether it’s done correctly or not correctly. Because I’ve seen too many people just use the template, click, click, and then sign. You can finish the note [in] two minutes, but it’s not going to be accurate and it’s not going to do the patient any good.”

Having an eMedRec solution may give a false impression that the quality of the BPMH is good because it is in the system. That may not necessarily be the case and quality audits are an integral part of checking that the process used to obtain the BPMH is sound. Therefore, measuring the quality of MedRec using eMedRec audit tools in conjunction with observational and cognitive studies is recommended (Boockvar et al., 2011).

Electronic sources of information should be used in conjunction with information obtained from patient interviews to identify actual medication usage, validate information from electronic databases, and gather medication information that may not be recorded in databases. Electronic sources should complement (and not replace) obtaining information from the patient interview to develop an eBPMH.

What Are the Lessons Learned in eMedRec Implementation?

Practitioners and researchers have identified multiple lessons learned. These lessons learned can be grouped into the following categories: Human Factors and Usability Engineering, Workflow and Sociotechnical Perspectives, Health Informatics and Organizational. The following chart provides a list of these lessons learned and tips for implementing eMedRec.

Lessons Learned	
Lessons Learned from the Human Factors and Usability Engineering	
Usability testing involving all user groups and clinicians is an essential component of developing and implementing eMedRec processes.	Kushniruk and Patel (2004)
A standard set of steps and processes to be performed by clinicians should be developed, documented and shared.	Agrawal and Wu (2009)
When IT solutions are developed that do not support current practice, clinicians may not readily adopt the technology and may use workarounds, creating a greater chance for error. This new type of error has been termed “technology-induced error”. According to Palojoki (2016), based on a study in a fully automated health system in Finland, 1 in 10 reported incidents involved health information technology.	Borycki and Kushniruk (2008); Palojoki et al. (2016)
Involve end users early and iteratively in the design process using prototypes.	Poon et al. (2006)
The user interface should be as simple and standardized as possible.	Poon et al. (2006); White et al. (2011)
The user interface should be prototyped and piloted.	Poon et al. (2006)
Let user feedback and usage data guide incremental enhancement and do not over anticipate user needs.	Poon et al. (2006)
Make the active/expired/discontinued status of medications clear on the computer display.	Boockvar et al. (2011)

The MedRec tool should clearly show where to insert revisions to the medication history, changes to the outpatient/inpatient orders and medication discrepancies that have been resolved.	Boockvar et al. (2011)
Annotation of medication lists may have an important role in MedRec; it is not always included in eMedRec systems, but should be.	Owen et al. (2011)
The user interface should allow physicians to enter rationale for prescribing changes.	Boockvar et al. (2011)
Ensure the system anticipates and meets users' relevant information needs.	Agrawal and Wu (2009)
Linking medications to patient problems/diagnoses should also be included in eMedRec functionality.	Stock, Scott, and Gurtel (2009)
Relevant information should be presented so that minimum effort or clicks are needed.	Agrawal and Wu (2009)
Users should be provided with visible and transparent feedback regarding their performance.	Agrawal and Wu (2009)
The system should have redundancies so that critical process steps are not missed. (Caution should be exercised so as to not to add work for clinicians).	Agrawal and Wu (2009)
Compliance is a challenge for novel workflows and may be improved through user feedback and/or "hard stops."	Agrawal and Wu (2009)
Education programs must be designed around the capability of the end users, and should be available to clinicians when and where they provide care.	Boockvar et al. (2011)
Grouping and animation, along with other interface design strategies which reduce cognitive load, was shown to be faster and more accurate for clinicians. Less errors were made. Use Human Factors Principles when designing.	Plaisant et al (2015) Belden et al (2014)
Lessons Learned from the Workflow and Sociotechnical Perspectives	
All stakeholders should be involved, including clinicians as well as personnel who perform other tasks such as chart reviews or quality evaluations.	Agrawal and Wu (2009)
Workflow challenges that have been reported have included the timing of report printing, deciding who would print the report, and delays in pharmacy staff receiving a copy of the report. (Murphy 2009, p. 2129-2130). These challenges were addressed by: <ul style="list-style-type: none"> • Setting a minimum turnaround time of two hours' advance notice to provide pharmacists with enough time to review the discharge orders and print the discharge take-home-medication report before patient discharge from hospital. (p. 2130) • Nurses providing a copy of the report to pharmacists instead of waiting for the unit clerk to disassemble the chart and then provide a copy of the discharge orders to the pharmacist. (Murphy, 2009, p. 2130). The form was subsequently shortened and the duplicate check boxes were removed. 	Murphy (2009, p. 2129-2130)
Lessons Learned from Health Informatics	
Make sure differing medication terminologies are taken into account in the system (e.g., brand versus generic).	Poon et al. 2006.

Clinical workflow should be analyzed and documented before developing the system because a robust understanding of the workflow and users' roles is crucial to successful implementation of a new system.	Agrawal and Wu (2009)
Representative end users should be involved in developing implementation strategies.	Agrawal and Wu (2009)
eMedRec should be integrated within the workflow of the clinical workplace.	Agrawal and Wu (2009)
The eMedRec intervention-provider fit should reflect the mission, objectives and routines of the host.	O'Laughlin, Renaud, Richard, Sanchez Gomez, and Paradis (1998)
Over-automation of workflow should be avoided because it may introduce new types of errors.	Agrawal and Wu (2009)
A highly reliable and visible system should be created.	White et al. (2011)
Lessons Learned from an Organizational Perspective	
Leadership commitment and support is essential to ensure that eMedRec is and remains an organizational strategic priority with adequate human and fiscal resources allocated to the work.	Boockvar et al., 2011
This work needs to be integrated into the overall IM/IT plan for the broader organization.	Boockvar et al., 2011
Implementation of eMedRec should support and align with other technologies related to medication management, such as CPOE.	Borycki and Kushniruk, 2008
A comprehensive education and re-education plan for all practitioners, clinicians and end users needs to be developed with adequate resources attached.	Boockvar et al., 2011
An evaluation strategy with relevant and meaningful measures needs to be developed at the outset of the project and, integrated into the organization-wide quality improvement/patient safety program.	Boockvar et al., 2011
Clinician scepticism about the benefits of eMedRec on clinical outcomes should be addressed.	Lorenzi and Riley (2010)
Seek effective communication among members of the team involved in implementing eMedRec, as well as with the organization.	Joint Commission (2010)
There should be leadership and support that promotes a culture of safety.	White et al. (2011)
All clinicians, practitioners and end users roles and responsibilities in implementing and deploying eMedRec should be clarified.	White et al. (2011)
Clearly defined and actionable policies and procedures should be developed because as a multistep longitudinal process involving multiple clinician groups, it is inherently complex and vulnerable to breakdown.	Agrawal and Wu (2009)
Consider the impact upon patient care and clinician concerns about potential negative consequences.	Joint Commission (2010); Lorenzi and Riley (2010); Institute of Medicine, (2011)
User efficiency and adoption could benefit from more training/practice.	Boockvar et al. (2011)
Ensure a backup plan is in place and communicated to all staff for times when eMedRec is not available due to system failure or scheduled downtime for system maintenance.	Boockvar et al. (2011)

Resistance from medical staff during hybrid implementation of eMedRec can be addressed by: <ul style="list-style-type: none"> including check boxes for duplicate orders, flagging hospital therapeutic interchanges, and reducing confusion upgrading the EMR such that brand and generic names were displayed on the report pharmacy representatives attending weekly physician meetings on the medical unit to allow for a continual dialogue regarding the new report form and process 	Murphy et al. (2009, p. 2129)
Efforts must be made to ensure the sustainability of eMedRec.	White et al. (2011)
Form a multidisciplinary working group, share baseline metrics, educate physicians and address concerns, provide daily user reports, incorporate e-MedRec into mandatory EMR training, provide e-mail reminders, disseminate successes and lessons learned	Taha et al. (2016)

Tips, Advice, and Lessons Learned from Canadian Users

Participants from the online survey conducted in 2013, who indicated they had implemented eMedRec to some extent, were invited to participate in a subsequent phone interview to collect more detailed data about their experiences. Fourteen (n = 14) participants, each representing different organizations in Canada, were interviewed. Here is some of the advice they would give to others who are thinking about transitioning to eMedRec.

eMedRec Process

- Do not overestimate the capabilities of eMedRec.
- Interoperability is ideal for improving efficiency and patient safety where eMedRec is concerned.
 - If implementation of CPOE is planned, it may be prudent to wait until its implementation before implementing eMedRec fully. eMedRec is much more efficient than paper. When paper MedRec was implemented it may have given providers a false impression of the workload and this should be discussed when creating buy-in for adoption of the electronic process.
- Mixed systems may create gaps in communication that should be noted and addressed.
- After a pharmacist reconciles a patient's discharge medications, there is **no assurance** that his or her advice has been considered.
- Gaps may occur at times of reduced staffing (e.g., weekends and evenings) which could result in printed forms and lists with missing medication information.
- Rural facilities may be more challenging to transition to eMedRec because of infrastructure (e.g., unreliable internet access, limited implementation of other health IT).
- Standardization of MedRec processes through eMedRec implementation can improve quality of care.

Compliance

- Compliance improved when patients could not be admitted until their BPMH were entered; however, reconciliation was not mandatory.
- An understanding of the importance of MedRec is needed to motivate compliance.
 - Nurses did not always see the value of doing a quality BPMH because the value is demonstrated upstream in the patient care process and the quality of the BPMH suffered as a result.
- System notifications facilitated compliance.
 - Flags next to patient name to indicate readiness for admission, transfer and discharge MedRec.
 - Pharmacists were provided with lists of patients requiring BPMHs.
 - The most responsible provider is notified when the BPMH is available for MedRec. This reminder can be discarded, but will pop up again the next time the chart is opened.
- Continuous evaluation is required to ensure the process is successful.
 - Adjustments in policy and re-education may help improve compliance.
- Consider implementing one or more hard stops for eMedRec to ensure compliance.
 - Patients cannot be discharged without having discharge medications reconciled with provincial drug databases/drug information databases/drug information systems.
- Provincial drug databases are a helpful starting point but **cannot** replace patient interviews.
 - Many medications are not available on provincial drug databases (e.g., HIV medications, chemotherapy medications).
 - Providers may overly rely on provincial drug databases being correct instead of interviewing patient.
- Patients may be taking medications differently than prescribed (e.g., decreased dose of warfarin after prescription has been filled, cutting pills in half) and these medications may not be included in the typical 90- day refill display.
 - Adjusting so that the provincial drug database displays 120 days of medications was one strategy used to get a more comprehensive list.
- Provincial drug databases may be read-only which impedes communication among providers and seamless care.

Challenges with Ordering

- There may be challenges with physicians “re-ordering” some medications. Strategies need to be developed to address this issue prior to implementation and may include:
 - If a physician can put a medication on hold, then they can re-prescribe it.
 - Add a mechanism for a MedRec referral.

Formulary Substitutions

- It is helpful for providers if specifications include automatic substitutions for acceptance at admission and automatic defaulting back to home medications to increase the efficiency at discharge.

Conclusion

MedRec is complex and challenging to implement reliably across all interfaces of care without the support of technology. eMedRec will facilitate MedRec from admission through discharge if the systems are intuitive, easy-to-use and support the clinicians' workflow. In order to reduce the potential for unintended consequences such as: technology-induced errors, resistance to use and inefficient workarounds, extensive planning is required to ensure:

- Sufficient overall resourcing of the system, staff and training costs.
- Identification, mapping and documenting of current MedRec practices, issues and gaps before proceeding to eMedRec
- The characteristics of an eMedRec solution are aligned with patient safety principles, effective MedRec processes, and the organizations requirements prior to the purchase of the system.
- Careful consideration of the integration of eMedRec with existing Health IT and infrastructure.
- Evaluation before, during and after implementation.

While the focus of this toolkit is on the acute care environment, MedRec is a challenge at all interfaces of our health system. On the horizon are eMedRec solutions that will engage patients using mobile technology (Long et al, 2016, Heyworth 2014); integration into primary care (Cadwallader et al, 2013); interfaces with primary care and pharmacy claims (Comer D, 2015); and home care to primary care integration (Kramer H, 2016). A prototype using blockchain technology has already been developed and has tremendous potential for providing secure access, confidentiality, authentication and data exchange and management while retaining the evolving medication list in one place (Ekblaw A et al, 2016).

When implemented appropriately, eMedRec has the potential to create a safer more efficient system contributing to improved quality of care and patient safety.

Appendix A – Checklists and Tools

eMedRec Implementation Checklist

Adapted with permission from the MARQUIS Manual (2014, p. 92) and Acute Care GSK (2017, Appendix A)

eMedRec Implementation Checklist	
1. Gain and secure senior leadership commitment <input type="checkbox"/>	
<input type="checkbox"/>	Secure senior leadership commitment
<input type="checkbox"/>	Develop a communication plan to inform senior leadership and staff about eMedRec implementation progress
<input type="checkbox"/>	Identify resources that may help facilitate eMedRec implementation within your organization
<input type="checkbox"/>	Identify organizational support challenges that may impede eMedRec implementation
<input type="checkbox"/>	Project is linked to the hospital's quality / safety reporting structure
2. Form a team <input type="checkbox"/>	
<input type="checkbox"/> Physician <input type="checkbox"/> Nurse <input type="checkbox"/> Pharmacist <input type="checkbox"/> Pharmacy Technician <input type="checkbox"/> Educator	<input type="checkbox"/> Affiliated Staff <input type="checkbox"/> Patient or Family Representative <input type="checkbox"/> Senior Administrator <input type="checkbox"/> Quality Improvement Expert <input type="checkbox"/> Medication Reconciliation Expert
Technical Expertise (of those that apply)	
<input type="checkbox"/> Team Leader <input type="checkbox"/> Content Expert <input type="checkbox"/> Data Analyst	<input type="checkbox"/> Opinion Leader / Clinical Expert <input type="checkbox"/> Project Manager <input type="checkbox"/> Informatics

eMedRec Implementation Checklist

3. Define the project

Set aims (goals and objectives)

Make sure the goals and objectives for your eMedRec implementation are S.M.A.R.T.E.R. (Doran, 1981)

- | | |
|---|---|
| <input type="checkbox"/> Specific
<input type="checkbox"/> Attainable
<input type="checkbox"/> Time-bound
<input type="checkbox"/> Re-evaluate | <input type="checkbox"/> Measurable
<input type="checkbox"/> Relevant
<input type="checkbox"/> Evaluate |
|---|---|

Identify project scope

- Determine what is within and beyond the realm of the eMedRec implementation.

Identify existing and needed resources

- Outline what you have that will support the eMedRec implementation and what you need to acquire to support the implementation.

Collect baseline data

- On current level of automation and access to electronic resources needed before proceeding
- Map current processes (paper-based / electronic) and ideal process with interdisciplinary team

Risk Assessment

- Have you selected a risk assessment model (a protocol or algorithm for identifying patients at increased risk for post-discharge adverse drug events?)
- If yes, have you developed recommendations for different levels of risk?

4. Establish policies and procedures for eMedRec

- Establish your hospital's definition of eMedRec
- Establish the management infrastructure for oversight of eMedRec

Establish how the management infrastructure plans to measure and evaluate eMedRec

- What data will be reviewed
- The person responsible for reviewing data
- The frequency of data review

If applicable, develop organizational policies for the following:

- An individual (or role) with overall responsibility for eMedRec
- Individuals (or roles) with responsibility for each component of medication reconciliation

eMedRec Implementation Checklist

Communicate the process of what needs to be performed during each episode of eMedRec

5. Conduct your selection/procurement of needed electronic components to carry out eMedRec

See Ideal Features of eMedRec Tool Checklist.

See eMedRec Evaluation Checklist

6. Design the change management and educational program.

7. Start with a small pilot project (e.g. on admission to one hospital unit) and build expertise in reconciling medications.

8. Evaluate improvements being made – Collect data and identify ways the process can be improved.

9. Spread eMedRec across the organization.

Ideal Features of eMedRec Solution Checklist

(Adapted with permission from the MARQUIS Manual 2014 p. 77-80)

Ideal Features of eMedRec Solution Checklist

1. Describe the current IT landscape within your organization:

- Use of Computerized Provider Order Entry (CPOE).
- Use of an inpatient electronic Medical Record (EMR).
- Use of an electronic Medication Administration Record (eMAR).
- Use of an eMedRec tool.
- Investigate plans to change the current health information systems in the next 1-2 years.
- Investigate organizational willingness to invest in any new systems.

2. Ideal features of an eMedRec tool

- Displays current medications and eBPMH lists side by side to facilitate comparison.
- Allows filters for sorting medications for example, by therapeutic class, most recent date prescribed, ordering physician, discontinued medications, etc.
- Displays medication history (current and previous, active and discontinued medications), ideally medications are displayed on a timeline.
- Allows modification of medications: continue, discontinue, hold (optional), or change from the same screen. Ideally, the system is integrated with CPOE (if applicable) so that new medications can be prescribed as well.
- Clearly identifies automatic formulary substitutions and automatically reverts these to original medications during discharge eMedRec.
- For pre-admission accounts, allows eMedRec to occur any time before schedule re-visit (e.g., surgery).

3. Access to electronic source of preadmission medication information

- Community pharmacy prescription data.
- Medication lists from ambulatory EMRs.
- Discharge medication orders from recent hospitalizations at participating hospitals and/or hospitals in the region.
- Medication lists from patient personal health records (ideally linked to the ambulatory EMR) and electronic provincial medication record.

Ideal Features of eMedRec Solution Checklist

4. Facilitates the comparison of various sources of preadmission medication information		<input type="checkbox"/>
<input type="checkbox"/>	Identifies the source(s) of information for each medication.	
<input type="checkbox"/>	Displays dates prescribed/ordered as appropriate for each source.	
<input type="checkbox"/>	Highlights differences in doses frequencies, routes, and formulations for each medication.	
<input type="checkbox"/>	Allows sorting of medication by name, class, date and source.	
5. Ability to show patient adherence to medications		<input type="checkbox"/>
<input type="checkbox"/>	Calculation of medication possession ratio and/or graphs of medication possession time based on pharmacy fill and refill data.	
<input type="checkbox"/>	Access to any documented information from EMRs and PHRs regarding medication adherence includes rational , side effects, intolerances etc.	
6. Documentation of the electronic Best Possible Medication History (eBPMH)		<input type="checkbox"/>
<input type="checkbox"/>	Ability to create a eBPMH separate from the sources on which it is based	
<input type="checkbox"/>	Ability to pull medications from electronic sources into an eBPMH (with or without changes).	
<input type="checkbox"/>	Ability to add new medications into the eBPMH based on other (non-electronic) sources of information.	
<input type="checkbox"/>	Ability to update the eBPMH at any time during the hospitalization.	
<input type="checkbox"/>	Ability to document the quality of the eBPMH (from a list of choices) in the opinion of the history-taker and for that information to be clearly visible to any other provider who pulls up the medication list.	
<input type="checkbox"/>	Ability to document the sources of information used to create the eBPMH from a list of coded choices and for that information to be clearly visible to any other provider who pulls up the list.	
<input type="checkbox"/>	Ability to update the eBPMH at any time during the hospitalization.	
<input type="checkbox"/>	Audit trail to document changes to the eBPMH made during the course of hospitalization, including when and by whom (person and role).	
7. Facilitation of eBPMH Sign-off		<input type="checkbox"/>
<input type="checkbox"/>	Sign-off that the eBPMH is ready for comparison to the admission orders (reconciliation).	
<input type="checkbox"/>	Ability to document verification of BPMH by a second clinician	

Ideal Features of eMedRec Solution Checklist

8. Facilitation of admission orders based on the eBPMH		<input type="checkbox"/>
<input type="checkbox"/>	Document the planned action on admission for each eBPMH medication: continue without changes, continue with changes, substituted for a different medication, temporarily hold, discontinue.	
<input type="checkbox"/>	Ability for continued medications to link to the admission order entry process.	
9. Facilitation of reconciliation at admission		<input type="checkbox"/>
<input type="checkbox"/>	Ability to compare and flag differences between eBPMH and admission orders.	
<input type="checkbox"/>	Document intentional reasons for changes from the eBPMH to admission orders.	
<input type="checkbox"/>	Modify admission orders as needed to resolve unintentional discrepancies.	
<input type="checkbox"/>	Ability to document verification of admission orders by a second clinician.	
10. Facilitation of medication ordering at intra-hospital transfer		<input type="checkbox"/>
<input type="checkbox"/>	Compare eBPMH to current (pre-transfer) inpatient medications (e.g., differences in medications, dose route frequency of formulation highlighted).	
<input type="checkbox"/>	The ability to order medications from eBPMH or the current pre-transfer medication list as transfer orders (with or without further modification).	
<input type="checkbox"/>	Ability to add new medications to transfer orders (i.e., not on either list)	
11. Facilitation of medication reconciliation at intra-hospital transfer		<input type="checkbox"/>
<input type="checkbox"/>	Compare and flag differences among eBPMH, pre-transfer medications and transfer orders.	
<input type="checkbox"/>	Document intentional reasons for changes made to transfer orders.	
<input type="checkbox"/>	Modify transfer orders as needed to resolve unintentional discrepancies.	
<input type="checkbox"/>	Ability to document verification of orders by a second clinician.	
12. Facilitation of medication ordering at hospital discharge		<input type="checkbox"/>
<input type="checkbox"/>	Compare eBPMH to current (pre-discharge) inpatient medications (e.g., differences in medications, dose, route, frequency of formulation highlighted).	
<input type="checkbox"/>	The ability to order medications from eBPMH or the current pre-discharge medication list as discharge orders (with or without further modification).	
<input type="checkbox"/>	Ability to add new medications to discharge orders.(i.e., not on either list)	
<input type="checkbox"/>	Ability to run decision support on entire discharge medication regimen (e.g., for duplicate therapy)	
<input type="checkbox"/>	Ability to transmit electronic prescription or print and sign prescriptions at discharge (from final verified medication orders)	

Ideal Features of eMedRec Solution Checklist

13. Tools to facilitate patient/caregiver education

- Ability to print a final discharge medication list in patient-friendly language that clearly indicates (with pictures if possible) the indications of each medication, time(s) of day to take it, number of pills/sprays, etc. with each administration, and common side effects to watch for.
- Ability to clearly display the differences between pre-admission and discharge medication regimens, including which medications are new, which have had changes in dose/frequency/route/formulation, which are to be continued without changes and which preadmission medications should be stopped.
- Ability to add standardized medication educational materials (e.g. 5 Questions to Ask About Your medications) and for high-alert medications (e.g. anticoagulants, insulin etc.)

14. Tools to facilitate communication with post-discharge providers

- Clear documentation in the discharge paperwork of the discharge medication regimen, including a clear explanation of changes compared with the preadmission medication regimen and reasons for all changes.
- Ability to transmit this information electronically to post-discharge providers (e.g., to their community pharmacy, ambulatory EMR, sub-acute facility/Long-term care facility EMR, via online portal to hospital's information systems, or through health information exchange program).

15. Tools to facilitate compliance with medication reconciliation process

- Ability to track timing of BPMH documentation relative to time of admission
- Provide alerts, reminders and/or hard stops if eBPMH or reconciliation has not been completed in a timely manner.
- Ability to stop the discharge process unless eBPMH has been verified and every medication in the BPMH and current inpatient regimen have been reconciled with the discharge medication regimen.
- Ability to generate real-time reports of all patients with discharge orders completed and in need of reconciliation.

16. Tools to identify high-risk patients

- Automatically identify and generate a report of patients at high-risk for medication problems (e.g., based on the number and/or classes of medication in the eBPMH in admission or discharge orders, and/or based on the number of changes from pre-admission to discharge medications) so that further action can be taken.

17. Facilitation of reconciliation at hospital discharge

- Compare and flag differences among eBPMH, pre-discharge medication list and discharge orders.
- Document reasons for intentional changes made to discharge orders (e.g., compared with the eBPMH).
- Modify discharge orders as needed to resolve unintentional discrepancies.
- Ability to document verification of discharge orders by a second clinician.

eMedRec Evaluation Checklist

eMedRec Evaluation Checklist

1. Evaluate usability of the eMedRec tool

Prepare

- Test the equipment to collect the audio and screen recordings.
- Select the representative tasks and users for testing the tool.
- Obtain ethical approval through your organization's ethical review board.

Test

Record representative users performing the following tasks:

- Collecting the electronic Best Possible Medication History (eBPMH).
- Revising / Updating the eBPMH.
- Comparing two different medication lists for discrepancies.
- Resolving unintentional and undocumented intentional discrepancies.
- Generating an electronic Best Possible Medication Discharge Plan eBPMDP that includes:
 - Medication regimen for patients in consumer friendly language.
 - Communicating the medication regimen to the next provider (e.g., family physician).
 - Communicating the medication regimen and new prescriptions to the community pharmacy.
- Other tasks?

Analyze The Data

- Transcribe the audio recordings and annotate the video records.
- Identify where users encountered usability issues.

Revise the eMedRec System

- Work with IT staff and/or vendor to customize the solution to ameliorate the usability issues identified.

2. Evaluate the influence of eMedRec on workflow

3. Estimate the impact of eMedRec on organizational costs

- Use Meisel's formula (p. 85, MARQUIS Manual) to estimate the net cost of eMedRec Implementation.
- Use Rough's (p. 87, MARQUIS Manual) formula to justify the use of pharmacy staff in eMedRec.

Recommendations for Successful Development and Implementation of eMedRec Tools

Box 1: Recommendations Made by Authors for the Successful Development and Implementation of eMedRec Tools

Recommendations concerning the context of development

Adapt the tool workflow to the habits of frontline users^{1,7,24,25,27,28,30}
 Offer the possibility of invoking the application from multiple points in the workflow,¹ regardless of the EMR medication list status³²
 Define the roles of each frontline user in the eMedRec process^{11,24,27,30}
 Ensure support from clinical/hospital leaders^{1,30} and a suitable organizational climate^{24,25,30}
 Persuade frontline users, especially clinicians, of the importance of MedRec³⁰
 Engage patients in the MedRec process^{2,24}

Recommendations concerning functionalities and development of the tool

Concerning the tool in general

Develop tool features and design interfaces in an iterative manner, driven by the clinical processes^{9,12,27}
 Use design guidelines for designing health IT; identify and use individual design components (eg, animation, groupings)
 Choose a design that matches the overall design philosophy of the EHR user interface⁹
 Use prototypes and pilots²⁷
 Involve patients as collaborative partners in developing the tool¹
 Do not anticipate users' needs¹
 Medication information needs to be entered in coded format²⁷

Gathering the best possible medication history

Use information from different sources^{1,2} and gather this information electronically by linking the eMedRec tool to medication lists of other systems (EMR, CPOE, EHR, pharmacy claims, etc.)^{25,29,30}
 Aim for interoperability between different medication lists, with the possibility of automatically charting the reconciled list in the EHR/CPOE^{25,30}
 Develop easy-to-use technology (drug pictures, prescribers' information next to each medication)^{11,25,29}
 Do not overautomate the tool¹

Identification of discrepancies

Develop robust detection of discrepancies¹¹
 Develop technology that is easy to use and reduces cognitive burden: use animations and offer different filters for classification; help providers to recognize, contextualize, and manage medication discrepancies^{2,9,12,25,29}

Resolving discrepancies

Explore and develop decision support algorithms to help providers identify clinically meaningful discrepancies^{2,11}
 Develop easy-to-use technology: allow manual verification of all medication,³² allow partial reconciliation,²⁴ document reasons for all reconciliation actions taken,³² enable inter-facility provider communication of discrepancies,¹¹ foresee tight integration with the CPOE system^{27,29,30}

Recommendations concerning the implementation of the tool

Provide education and support: regularly train users and local leaders, provide on-site support^{1,7,25,27,32}
 To improve compliance: introduce reminders or hard stop,^{27-30,32} reduce the time needed to reconcile medication,²⁹ have measurable compliance rates to enable ongoing feedback,^{28,30} collect users' suggestions^{1,25,27,30}
 Compare electronic lists to a gold standard structured medication history^{10,24}
 Conduct usability testing^{2,12,29} and test the software (reliability + interoperability) in selected and disparate settings^{10,24}
 Focus on efficiency in addition to clinical improvements¹²
 Establish a process for referring recurrent errors and discrepancies for failure analysis and potential system-based intervention¹¹
 Assess the generalizability of your findings using comparable data from other hospitals using eMedRec tools²⁹

Reproduced with permission. Marien S and colleagues, 2016. Electronic tools to support medication reconciliation – a systematic review.

Appendix B – What does eMedRec Look Like?

In this section we will illustrate some examples of eMedRec tools and processes. These examples are from existing eMedRec systems and user interfaces in Canada and internationally.

The following figure shows an eMedRec tool developed for use in Veterans Affairs hospitals. The tool provides a template for showing active and expired medications for in-patient medications, out-patient medications and non-VA medications. The provider who interacts with this tool indicates (by selecting medications and typing) in the template if there are discrepancies in medication lists. Tabs that are linked to a range of reports and electronic notes relevant to the patient's condition are at the bottom left side of the screen in Figure B1. This shows the capability of integrating eMedRec with other types of HIS, including patient and hospital records and reports to support provider decision-making. This particular eMedRec tool is integrated with one of the most comprehensive and integrated EHR systems in the world.

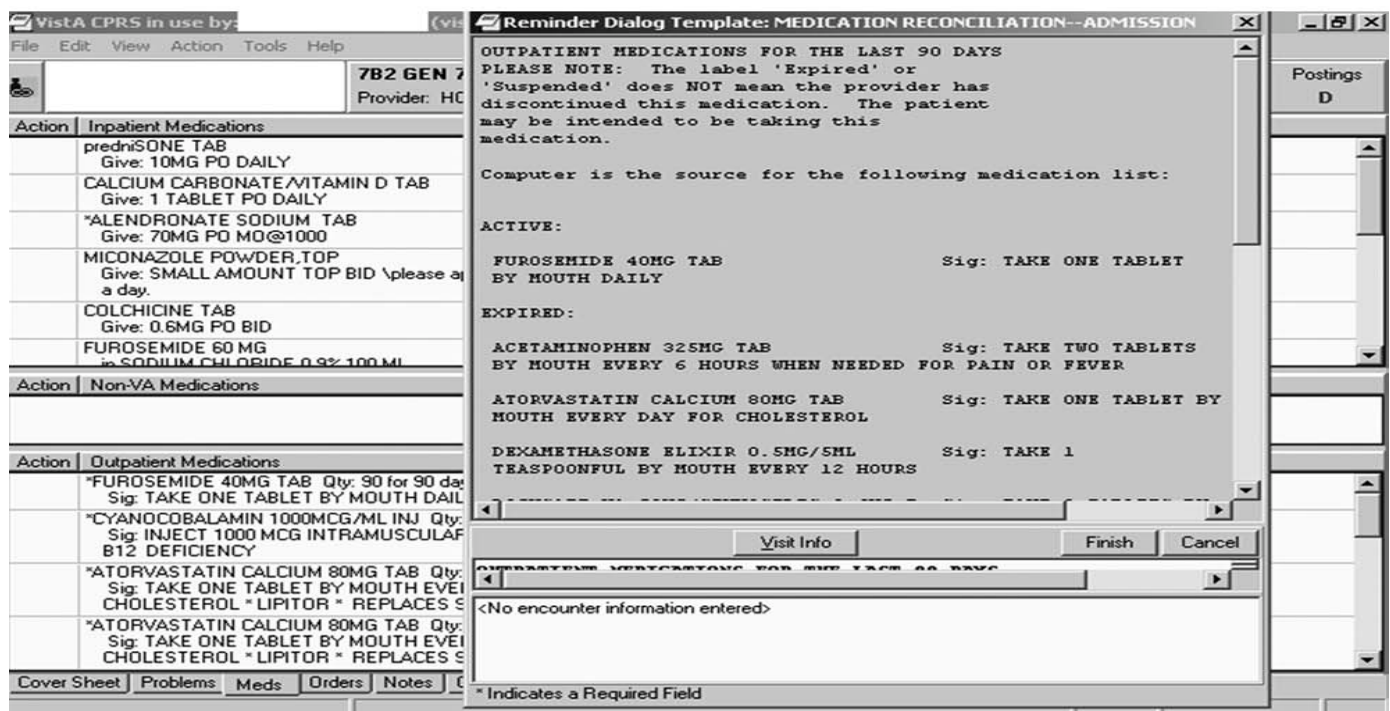


Figure B1. Computer screen shot of a medication reconciliation tool showing template for reconciling admission medication list – used with permission from Boockvar et al. (2011)

Figure B2. shows how an e-MedRec system (on admission), allows the clinician to enter information about the community medication usage. Adherence can be documented in addition to the source of information, who prescribed it and what pharmacy it was dispensed from.

Community - Medication Validation

fenofibrate
TABLET 160 MG

Trade Name
SANDOZ FENOFIBRATE S, APO FENO MICRO, APO FENOFIBRATE, FENOMAX, LIPIDIL EZ, MYLAN FENOFIBRATE MICRO, TEVA FENOFIBRATE S

Medication Validation

Taking? Reason
-select-

Prescribed Posology [Switch to a free text posology](#)

#/intake	Unit	Frequency	Directive	Switch to free text	PRN
1	tablet	daily	-select-		<input type="checkbox"/>

Source of validation Apply to all meds

<input type="checkbox"/> Patient	<input type="checkbox"/> Institution	<input type="checkbox"/> Nursing Home
<input type="checkbox"/> Pharmacy	<input type="checkbox"/> Family/Friend	<input type="checkbox"/> Vial/Dosette/Dispill
<input type="checkbox"/> Other		

Adherence status Apply to all meds

<input type="radio"/> Good adherence
<input type="radio"/> Non-adherence - Intentional
<input type="radio"/> Non-adherence - Not intentional

Prescribing Physician
Dr. Xiaosi Zhang
Phone : (514) 932-2122

Dispensing Pharmacy
PHARMACIE STEPHANE GRANGER, MARTIN HALLEY, MATTHEU LEDUC, MARC-ANDRE PINEL INC.
509 BOUL ARTHUR-SAUVE Phone: 450-473-4169
SAINT-EUSTACHE, QC J7P4X4 Fax: 450-473-4186

Manage Notes Copyright@ 2014, McGill University. All rights reserved Cancel Save

Figure B2. (Reproduced with permission from McGill University)

Figure B3. In this retroactive MedRec model, the hospital admission orders (In-Hospital Meds) are listed beside the admission BPMH (Community Meds Validation). The clinician decides to continue (✓), change (Δ) or discontinue (x). A summary of the choices made appears on the right hand side of the screen and forms the basis of the hospital treatment going forward.

Prior to Admission		Admission/Transfer/Med Review		Discharge		Options: Admission	
Community Meds Validation		In-Hospital Meds		Action		Recommended Order Summary	
Status: Completed						Status: In Progress	
2014-11-08 14:45:13						2014-11-08 15:05:17	
						Add New Medication	
						<input type="text"/>	
Medication		Medication				Medication	
amlodipine 5 MG tablet 1 TAB oral daily	<input type="checkbox"/> <input type="checkbox"/>	amlodipine tab 5 MG - 1 TAB po daily	✓	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Continued
atorvastatin 10 MG tablet 1 TAB oral daily	<input type="checkbox"/> <input type="checkbox"/>	atorvastatin tab 20 MG - 1 TAB po qhs	✓	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Continue amlodipine tab 5 MG - 1 TAB po daily
No (not taking at all): Does not like taking meds	<input type="checkbox"/> <input type="checkbox"/>						Continue atorvastatin tab 20 MG - 1 TAB po qhs
enalapril 10 MG tablet 1 TAB oral bid	<input checked="" type="checkbox"/> <input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Continue magnesium tab 250 MG - 1 TAB po tid
hydrochlorothiazide 12.5 MG tablet 1 TAB oral qam	<input checked="" type="checkbox"/> <input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Continue metformin tab 500 MG - 1 TAB po bid
		magnesium tab 250 MG - 1 TAB po tid	✓	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Continue gliclazide tab 80 MG - 0.5 TAB po daily 40 mg = 0.5 tab po daily with breakfast for diamicon
metformin 500 MG tablet 1 TAB oral daily	<input type="checkbox"/> <input type="checkbox"/>	metformin tab 500 MG - 1 TAB po bid	✓	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Continue asa chw tab 80 MG/TAB - 1 TAB po daily 80 mg = 1 tab po daily with breakfast
Yes, but not as prescribed: Takes just 0.5 tab ds	<input type="checkbox"/> <input type="checkbox"/>						Continue acetaminophen tab 325 MG - 2 TAB po q6h
		gliclazide tab 80 MG - 0.5 TAB po daily	✓	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Stopped
tamsulosin 0.4 MG la-tablet 1 TAB oral daily	<input type="checkbox"/> <input type="checkbox"/>	tamsulosin sr cap 0.4 MG po daily	✓	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Stop tamsulosin sr cap 0.4 MG po daily
asa 325 MG enteric tab. 1 TAB oral daily	<input type="checkbox"/> <input type="checkbox"/>						Stop hydromorphone tab 2 MG - 1 TAB po q6h prn
							Modified
							New
							Start enalapril 10 MG tablet 1 TAB oral bid
							Start hydrochlorothiazide 12.5 MG tablet 1 TAB oral qam

Copyright © 2014, McGill University. All rights reserved

Figure B3. Admission Module (Reproduced with permission from McGill University)

In another eMedRec system, the following figure shows a screen that displays medications from a variety of electronic external sources that are used to create a pre-admission medication lists (a pre-admission list builder). This example illustrates good usability principles by allowing users to simply click a button to move medications from other lists to the pre-admission medication list.

Meds from Electronic Sources			Pre-Admission Medication List (PAML) Reviewed				
Source	Medication	Date	Medication	Date	Need to Clarify	Medication Details	Planned action on admission
LMR	Atorvastatin → Atorvastatin (Lipitor) PO 10 MG QHS	03/15/06	Atorvastatin (Lipitor) PO Alternate QHS dose last taken 05/26/2000 17:00	11/08/06 12:58	<input type="checkbox"/>		Discontinue
LMR	Capecitabine Capecitabine (Xeloda) PO 2000 MG BID	04/06/06	Cyproheptadine Hcl (Periactin) PO 4 MG QPM	11/08/06 12:58	<input type="checkbox"/>		Hold on Adm
OrCall	Clonazepam Clonazepam (Klonopin) po 0.5mg bid	11/22/04	Insulin Lispro (Lispro) SC Sliding Scale QID	11/08/06 12:58	<input type="checkbox"/>		Uncertain
LMR	Cyproheptadine Hcl → Cyproheptadine Hcl (Periactin) PO 4 MG QPM	06/15/04					
LMR	Diazepam Diazepam PO QD unit strength: 5MG form: TABLET	12/05/05					

Figure B4. Pre-Admission Medication List (PAML) Builder (Reprinted from Studies in health technology and informatics, Vol 129 (Pt 2), Turchin, A., Gandhi, T. K., Coley, C. M., Shubina, M., & Broverman, C., The use of electronic medication reconciliation to establish the predictors of validity of computerized medication records, Page 1022, Copyright (2007), with permission from IOS Press.

The Importance of External Drug Information Sources – Opioid Crisis

The ability to integrate external drug information sources (e.g., provincial drug information or pharmacy dispensing records) increases the accessibility of this data to the prescriber. With the opioid crisis, Provincial Colleges of Physician and Surgeons are recommending or mandating that **a patient’s medication history from a reliable source be consulted prior to issuing new prescriptions for opioids or other high risk medications.**

Electronic medication reconciliation software platforms that incorporate this data source automatically enable timely access to this medication information while causing minimal disruption to clinical workflow.

This screen shot (Figure B5) shows how an e-MedRec system (at internal transfer), allows the clinician to discontinue a medication and document the reason for discontinuing.

Transfer - Discontinue Medication

HYDROCHLOROTHIAZIDE
TABLET 12.5 MG

Trade Name
APO HYDRO, PMS HYDROCHLOROTHIAZIDE

Prescribed Posology

#/intake	Unit	Total Dose per administration	Frequency	Directive	PRN
1	tablet	12.50 mg	daily	-select-	

Reason For Discontinuing

- Adverse drug event
- Drug interaction
- Duplicate therapy
- Ineffective treatment
- No longer needed
- Improve adherence
- Nonformulary**
- Prescribing error
- Other

Cancel Save

Copyright@ 2014, McGill University. All rights reserved

Figure B5. Transfer module. (Reproduced with permission from McGill University)

Figure B6 shows the discharge module in an eMedRec system with the community medication list and the in-hospital medications side by side for comparison and matched. Under the Action column, the clinician decides to continue (V), change (Δ) or discontinue (x). A summary of the choices made appears on the right hand side of the screen and forms the basis for the Best Possible Medication Discharge Plan (BPMDDP).

Community Meds Validation		In-Hospital Meds		Action		Recommended Order Summary	
Status: Completed						Status: In Progress	
2014-11-06 15:04:47						2014-11-06 15:34:08	
Add New Medication						Add New Medication	
Medication		Medication				Medication	
amlodipine 5 MG tablet 1 TAB oral daily	✓ D M	amlodipine tab 5 MG - 1 TAB po daily	✓	✓	▲	✕	Continued
atorvastatin 10 MG tablet 1 TAB oral daily	✓ D M	atorvastatin tab 20 MG - 1 TAB po qhs	✓	✓	▲	✕	Continue amlodipine 5 MG tablet 1 TAB oral daily x30 day(s)
No (not taking at all): Does not like taking meds:							Continue atorvastatin 10 MG tablet 1 TAB oral daily x30 day(s)
enalapril 10 MG tablet 1 TAB oral bid	✓ D M			✓	▲	✕	Continue hydrochlorothiazide 12.5 MG tablet 1 TAB oral qam x30 day(s)
hydrochlorothiazide 12.5 MG tablet 1 TAB oral qam	✓ D M			✓	▲	✕	Continue metformin 500 MG tablet 1 TAB oral daily x30 day(s)
		magnesium tab 250 MG - 1 TAB po tid	✓	✓	▲	✕	Continue asa 325 MG enteric tab. 1 TAB oral daily x30 day(s)
metformin 500 MG tablet 1 TAB oral daily	✓ D M	metformin tab 500 MG - 1 TAB po bid	✓	✓	▲	✕	Stopped
Yes, but not as prescribed: Takes just 0.5 tab ds:							Stop enalapril 10 MG tablet 1 TAB oral bid
		gliclazide tab 80 MG - 0.5 TAB po daily	✓	✓	▲	✕	Stop tamsulosin 0.4 MG Ia-tablet 1 TAB oral daily
tamsulosin 0.4 MG Ia-tablet 1 TAB oral daily	✓ D M	tamsulosin sr cap 0.4 MG po daily	✓	✓	▲	✕	Modified
asa 325 MG enteric tab. 1 TAB oral daily	✓ D M	asa chw tab 80 MG/TAB - 1 TAB po daily	✓	✓	▲	✕	New
							Start magnesium tab 250 MG - 1 TAB po tid x30 day(s)
							Start gliclazide tab 80 MG - 0.5 TAB po daily 40 mg = 0.5 tab po daily with breakfast for diamicron x30 day(s)
							Start acetaminophen tab 325 MG - 2 TAB po q6h x30 day(s)

Copyright © 2014, McGill University. All rights reserved

Figure B6. A Discharge module (reproduced with permission from McGill University)

Figures B7 and B8 are examples of print-outs that could be automatically generated electronically and given to patients. The reports provide a clear summary of changes (stop, change and new) to a patient's medications as well as a complete medication plan going forward after discharge.





Brian Baker		Summary of Changes to My Medications		University Heights Hospital Dr. George Mitchells June 24, 2013	
Action	Medication	Reason			
	Citalopram (40 mg)	This medication has been replaced with a different medication to helping your depression.			
	St. John's Wort (300 mg)	This medication may have caused a drug interaction and an adverse drug reaction. Please do not take this medication anymore.			
	Metformin Before 500 mg Now 1000 mg	You will take more of this medication to help control your blood sugar. Now please take 2 pills with breakfast and 2 pills with dinner.			
	Bupropion SR (150 mg)	This medication is to help your depression. Take this one instead of your old depression medication.			
SAME	Amlodipine (2.5 mg)	<p align="center">Questions About My Medications?</p> <p>If you have any questions about your new medications or about the changes made to your old medications please contact:</p> <p align="center">Alison McCoy (Pharmacist) (555) 555 - 9876</p>			
SAME	Aspirin (81 mg)				
SAME	Digoxin (0.0625 mg)				
SAME	Levothyroxine (0.1 mg)				
SAME	Metoprolol (12.5 mg)				
SAME	Rabeprazole (40 mg)				
SAME	Ramipril (10 mg)				
SAME	Tamsulosin CR (0.4 mg)				
SAME	Atorvastatin (20 mg)				
SAME	Salbutamol 100 mcg				
SAME	Lorazepam 0.25 mg				

Figure B7. A daily medication plan for a patient

Brian Baker

My Daily Medication Plan

University Heights Hospital
Dr. George Mitchells
June 24, 2013




What time do I take this?	What does it look like?	What is it called?	How much do I take?	How do I take it?	Why am I taking it?	Comments
Morning / Breakfast 		Amlodipine (2.5 mg)	1 tablet	By mouth	Blood pressure	
		ECAspirin (81 mg)	1 tablet	By mouth	Prevents clots	
		Bupropion SR (150 mg)	1 capsule	By mouth	Depression	
		Digoxin (0.0625 mg)	1 tablet	By mouth	Heart Rate	
		Levothyroxine (0.1 mg)	1 tablet	By mouth	Thyroid	
		Metformin (500 mg)	2 tablets with breakfast	By mouth	Blood sugar	
		Metoprolol (12.5 mg)	½ tablet	By mouth	Blood pressure	
		Rabeprazole (40 mg)	1 tablet	By mouth	Stomach acid	
		Ramipril (10 mg)	1 capsule	By mouth	Blood pressure	
	Tamsulosin CR (0.4 mg)	1 capsule	By mouth	Urinary flow		
Evening / Dinner 		Metformin (500 mg)	2 tablets with dinner	By mouth	Blood sugar	
Night / Bedtime 		Atorvastatin (20 mg)	1 tablet at bedtime	By mouth	Cholesterol	
		Metoprolol (12.5 mg)	½ tablet at bedtime	By mouth	Blood pressure	
Only If You Need It		Salbutamol 100 mcg	1 puff every 4 hours if you are having trouble breathing	Breathe it in	Breathing	
		Lorazepam 0.25 mg	1 tablet at bedtime if you are having trouble sleeping	Under tongue	Sleep	

Figure B8. A daily medication plan for a patient

References

- The Advisory Board Company. (2007). *Electronic Medication Reconciliation: A Growing Mandate*. Washington, D.C.
- Accreditation Canada, the Canadian Institute for Health Information, the Canadian Patient Safety Institute, and the Institute for Safe Medication Practices Canada. (2012). *Medication Reconciliation in Canada: Raising The Bar – Progress to date and the course ahead*. Ottawa, ON: Accreditation Canada.
- Accreditation Canada. Required Organization Practices. <http://www.accreditation.ca/sites/default/files/rop-handbook-2014-en.pdf> (Accessed June 19, 2013).
- Accreditation Canada.(2013) eMedication Reconciliation (The Ottawa Hospital). Retrieved January 5, 2017 from <https://accreditation.ca/emedication-reconciliation-ottawa-hospital>
- Agrawal, A. (2009). Medication errors: prevention using information technology systems. *British journal of clinical pharmacology*, 67(6), 681-686.
- Agrawal, A., & Wu, W. Y. (2009). Reducing medication errors and improving systems reliability using an electronic medication reconciliation system. *Joint Commission Journal on Quality and Patient Safety*, 35(2), 106-114.
- Ash, J., Kilo, C. M., Shapiro, M., Wasserman, J., McMullen, C., Hersh, W. (2011). *Roadmap for provision of safer healthcare information systems: Preventing e-Iatrogenesis*. Washington, D. C.: Institute of Medicine.
- Bails, D., Clayton, K., Roy, K., & Cantor, M. N. (2008). Implementing online medication reconciliation at a large academic medical center. *Joint Commission Journal on Quality and Patient Safety*, 34(9), 499-508.
- Bates, D. W., Spell, N., Cullen, D. J., Burdick, E., Laird, N., Petersen, L. A., & Leape, L. L. (1997). The costs of adverse drug events in hospitalized patients. *JAMA: the journal of the American Medical Association*, 277(4), 307-311.
- Bedell, S. E., Jabbour, S., Goldberg, R., Glaser, H., Gobble, S., Young-Xu, Y., & Ravid, S. (2000). Discrepancies in the use of medications: their extent and predictors in an outpatient practice. *Archives of Internal Medicine*, 160(14), 2129.
- Belden J, Plaisant C et al. (2014). *Inspired EHRs: Designing for Clinicians*. Chapter 3 Medication Reconciliation. Retrieved January 23, 2017 from <http://inspiredehrs.org/designing-for-clinicians/medication-reconciliation.php>
- Boockvar, K. S., Santos, S. L., Kushniruk, A., Johnson, C., & Nebeker, J. R. (2011). Medication reconciliation: barriers and facilitators from the perspectives of resident physicians and pharmacists. *Journal of Hospital Medicine*, 6(6), 329-337.
- Borycki, E. M, & Kushniruk, A. W. (2005). Identifying and preventing technology-induced error using simulations: Application of usability engineering techniques. *Healthcare Quarterly*, 8, 99-105.
- Borycki, E. M., & Kushniruk, A. W. (2008). Where do technology-induced errors come from? Towards a model for conceptualizing and diagnosing errors caused by technology. *Human, Social and Organizational Aspects of Health Information Systems*. Hershey, NY: Idea Group.

Borycki, E. M., Kushniruk, A. W., & Carvalho, C. (2013). A Methodology for Validating Safety Heuristics Using Clinical Simulations: Identifying and Preventing Possible Technology-Induced Errors Related to Using Health Information Systems. *Computational and Mathematical Methods in Medicine*.

<http://www.hindawi.com/journals/cmmm/2013/526419/>

Borycki, E. M., Kushniruk, A., Keay, E., Nicoll, J., Anderson, J., & Anderson, M. (2009). Toward an integrated simulation approach for predicting and preventing technology-induced errors in healthcare: implications for healthcare decision-makers. *Healthcare Quarterly*, 12, 90-96.

Borycki, E. M., Kushniruk, A. W., Kuwata, S., & Kannry, J. (2006). Use of simulation approaches in the study of Clinician Workflow. In *AMIA Annual Symposium Proceedings* (Vol. 2006, p. 61). American Medical Informatics Association.

Bourne, R. S., & Choo, C. L. (2012). Pharmacist proactive medication recommendations using electronic documentation in a UK general critical care unit. *International journal of clinical pharmacy*, 34(2), 351-357.

Cadwallader J, Spry K, Morea J, Russ AL, Duke J, and Weiner M. (2013) Design of a Medication Reconciliation Application Facilitating Clinician-Focused Decision Making with Data from Multiple Sources. *Appl Clin Inform*. 4(1): 110–125.

Canada Health Infoway. EMR, EHR, and PHR – Why all the confusion? Retrieved February 20, 2017 from: <https://www.infoway-inforoute.ca/en/what-we-do/digital-health-and-you/understanding-ehrs-emrs-and-phrs>

Canadian Patient Safety Institute (2015). Measures – Medication Reconciliation. Retrieved March 15, 2017 from: <http://www.patientsafetyinstitute.ca/en/toolsResources/psm/pages/medrec-measurement.aspx>

Canadian Patient Safety Institute and ISMP Canada (2017). Medication Reconciliation in Acute Care Getting Started Kit, version 4. Retrieved March 15, 2017 from: <https://www.ismp-canada.org/medrec/>

Canadian Patient Safety Institute and ISMP Canada (2017). Medication Reconciliation in Long Term Care: Getting Started Kit, version 3. Retrieved March 15, 2017 from: <https://www.ismp-canada.org/medrec/>

Canadian Patient Safety Institute and ISMP Canada (March 2015). Medication Reconciliation in Home Care Getting Started Kit, version 2. Retrieved January 6, 2017 from: <https://www.ismp-canada.org/medrec/>

Canadian Pharmacists Association (CPhA) (November 2016). CPhA Opioid Action Plan. Retrieved March 2, 2017 from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/CPhA_OpioidActionPlan-18Nov16.pdf

Chan, T. C., Killeen, J. P., Castillo, E. M., Vilke, G. M., & Guss, D. A. (2007). 225: Impact of electronic medication reconciliation on triage times for patients seen in the emergency department. *Annals of Emergency Medicine*, 50(3), S71-S71. doi: 10.1016/j.annemergmed.2007.06.208.

Cimino, J. J., Bright, T. J., & Li, J. (2007). Medication reconciliation using natural language processing and controlled terminologies. *Studies in health technology and informatics*, 129(1), 679.

Comer, D., Couto, J., Aguiar, R., Wu, P., Elliott, D.J. (2015). Usefulness of pharmacy claims for medication reconciliation in primary care. *American Journal of Managed Care*, 21(7):486-93.

Doran, G. T. (1981). There's a S.M.A.R.T. way to write management's goals and objectives. *Management Review*, 70(11) (AMA FORUM), 35–36.

Dormuth, C.R., Miller, T.A., Huang, A., Mamdani, M.M., Juurlink, D.N. (2012). Effect of a centralized prescription network on inappropriate prescriptions for opioid analgesics and benzodiazepines. *Canadian Medical Association Journal*, 184(16): E852-E856.

Eysenbach, G. (2005). Using the Internet for surveys and research (pp. 129-143). In J. G. Anderson and C. Aydin (Eds.). *Evaluating the Organizational Impact of Health Care Information Systems*. New York: Springer Verlag.

Evans, A. S., Lazar, E. J., Tiase, V. L., Fleischut, P., Bostwick, S. B., Hripcsak, G., ... & Kerr, G. (2011). The role of house staff in implementing medication reconciliation on admission at an academic medical center. *American Journal of Medical Quality*, 26(1), 39-42.

Farfán, S. F., Terrón, C. M., Castellanos, C. Y., Serrano, B. P., Moner, C. D., & Robles, V. M. (2011). Patient Summary and medicines reconciliation: application of the ISO/CEN EN 13606 standard in clinical practice. *Studies in health technology and informatics*, 166, 189.

Fernandes, O.A., Etchells, E.E et al. (March 2010). Impact of a Centralized Provincial Drug Profile Viewer on the Quality and Efficiency of Patient Admission Medication Reconciliation. Retrieved on March 3, 2017 from: <https://www.infoway-inforoute.ca/en/component/edocman/2936-impact-of-a-centralized-provincial-drug-profile-viewer-on-the-quality-and-efficiency-of-patient-admission-medication-reconciliation/view-document>

Forster, A. J., van Walraven, C., Asmis, T. R., Clark, H. D., Al Saied, G., Code, C. C. Ottawa Hospital Patient Safety Study. (2004). Ottawa hospital patient safety study: Incidence and timing of adverse events in patients admitted to a Canadian teaching hospital. *CMAJ : Canadian Medical Association Journal = Journal De l'Association Medicale Canadienne*, 170(8), 1235-1240. doi: 10.1503/cmaj.1030683.

García-Molina Sáez C, Urbieta Sanz E, Madrigal de Torres M, Vicente Vera T, Pérez Cárceles MD.(2016) Computerized pharmaceutical intervention to reduce reconciliation errors at hospital discharge in Spain: an interrupted time-series study. *Journal of Clinical Pharmacy and Therapeutics*, 41(2), 203-8. doi: 10.1111/jcpt.12365.

Gleason, K. M., McDaniel, M. R., Feinglass, J., Baker, D. W., Lindquist, L., Liss, D., & Noskin, G. A. (2010). Results of the medications at transitions and clinical handoffs (MATCH) study: An analysis of medication reconciliation errors and risk factors at hospital admission. *Journal of General Internal Medicine*, 25(5), 441-447. doi:10.1007/s11606-010-1256-6.

Gleason KM, Brake H, Agramonte V, Perfetti C. Medications at Transitions and Clinical Handoffs (MATCH) Toolkit for Medication Reconciliation. (Prepared by the Island Peer Review Organization, Inc., under Contract No. HHS2902009000 13C.) AHRQ Publication No. 11(12)- 0059. Rockville, MD: Agency for Healthcare Research and Quality. Revised August 2012.

Hasan, S., Duncan, G. T., Neill, D. B., & Padman, R. (2011). Automatic detection of omissions in medication lists. *Journal of the American Medical Informatics Association*, 18(4), 449-458.

Hasan, S., Duncan, G. T., Neill, D. B., & Padman, R. (2008). Towards a collaborative filtering approach to medication reconciliation. In *AMIA Annual Symposium Proceedings* (Vol. 2008, p. 288). American Medical Informatics Association.

Health Canada (2016). Good Label and Package Practices. Guide for Prescription Drugs. Retrieved on January 17, 2017 from: http://www.hc-sc.gc.ca/dhp-mps/alt_formats/pdf/pubs/medeff/guide/2016-label-package-practices-pratiques-etiquetage-emballage-rx/glppg-gbpee-rx-eng.pdf

HealthIT.gov. Benefits of EHR. Retrieved on January 15, 2017 from: <https://www.healthit.gov/providers-professionals/health-care-quality-convenience>

Heyworth L, Paquin AM, Clark J, Kamenker V, Stewart M, Martin T, Simon SR. (2014). Engaging patients in medication reconciliation via a patient portal following hospital discharge. *J Am Med Inform Assoc.*, 21(e1):e157-62.

Hron JD, Manzi S, Dionne R, Chiang VW, Brostoff M, Altavilla SA, Patterson AL, Harper MB. (2015) Electronic medication reconciliation and medication errors. *Int J Qual Health Care*, 27(4), 314-9. doi: 10.1093/intqhc/mzv046.

Institute of Medicine. (2011). Health IT and patient safety: Building safer systems for better care. Washington, D.C.: Institute of Medicine.

Institute for Safe Medication Practices US (2006). ISMP Survey of Medication Reconciliation, available at: <http://www.ismp.org/survey/survey200604r.asp>

ISMP Canada (2016) Delayed Treatment after Transitions of Care: A Multi-Incident Analysis. Volume 16, Issue 7. Retrieved on January 18, 2017 from: <https://www.ismp-canada.org/download/safetyBulletins/2016/ISMPCSB2016-07-DelayedTreatment.pdf>

ISMP Canada and Safer Healthcare Now! (February, 2012). National Medication Reconciliation Strategy - Identifying Practice Leaders for Medication Reconciliation in Canada. Retrieved Feb 28, 2014 from: http://www.ismp-canada.org/download/MedRec/Identifying_Practice_Leaders_for_Medication_Reconciliation_in_Canada.pdf

Jha, A. K., Kuperman, G. J., Rittenberg, E., Teich, J. M., & Bates, D. W. (2001). Identifying hospital admissions due to adverse drug events using a computer-based monitor. *Pharmacoepidemiology and drug safety*, 10(2), 113-119.

Joint Commission. (2010). Transforming Chaos to Quality: Implementing Medication Reconciliation. *Joint Commission Benchmark*, 12(4).

Long J, Yuan MJ, Poonawala R. (2016) An Observational Study to Evaluate the Usability and Intent to Adopt an Artificial Intelligence-Powered Medication Reconciliation Tool. *Interact J Med Res*. 5(2):e14

Kalb, K., Shalansky, S., Legal, M., Khan, N., Ma, I., & Hunte, G. (2009). Unintended medication discrepancies associated with reliance on prescription databases for medication reconciliation on admission to a general medical ward. *The Canadian Journal of Hospital Pharmacy*, 62(4), 284.

Kramer, H.S., Gibson, B., Livnat, Y., Thraen, I., Brody, A.A., Rupper, R. (2016). Evaluation of an electronic module for reconciling medications in home health plans of care. *Applied Clinical Informatics*, 7(2): 412-424.

Kuo, A., Monkman, H., Kushniruk, A., Borycki E. (2013). P to E Project: Transitioning to Electronic MedRec Final Report. Victoria, British Columbia: AE Informatics.

Kushniruk, A., Beuscart-Zephir, M.C., Grzes, A., Borycki, E., Watbled, L., Kannry, J. (2010). Increasing the safety of healthcare information systems through improved procurement: Toward a framework for selection of safe healthcare systems. *Healthcare Quarterly*, 13:53-8.

Kushniruk, A., Borycki, E. (2006). Low-cost rapid usability engineering: designing and customizing usable healthcare information systems. *Healthcare Quarterly*, 9(4):98-100, 102.

Kushniruk, A., Borycki, E., Kuwata, S., & Kannry, J. (2006). Predicting changes in workflow resulting from healthcare information systems: Ensuring the safety of healthcare. *Healthcare Quarterly*, 9, 114-118.

Kushniruk, A., Nohr, C., Jensen, S., & Borycki, E.M. (2013). From usability testing to clinical simulations: Bringing context into the design and evaluation of usable and safe health information technologies. *Yearbook of Medical Informatics* 8(1):78-85.

Kushniruk, A. W., Patel, V.L. (2004). Cognitive and usability engineering approaches to the evaluation of clinical information systems. *Journal of Biomedical Informatics*, 37(1), 56-76.

Kushniruk, A.W., Triola, M., Borycki, E., Stein, B., Kannry, J. (2005). Technology induced error and usability: The relationship between usability problems and prescription errors when using a handheld application. *International Journal of Medical Informatics*, 74.519-526.

Lesselroth, B., Adams, S., Felder, R., Dorr, D. A., Cauthers, P., Church, V., & Douglas, D. (2009). Using consumer-based kiosk technology to improve and standardize medication reconciliation in a specialty care setting. *Joint Commission Journal on Quality and Patient Safety*, 35(5), 264-271.

Lesselroth, B. J., Felder, R. S., Adams, S. M., Cauthers, P. D., Dorr, D. A., Wong, G. J., & Douglas, D. M. (2009b). Design and implementation of a medication reconciliation kiosk: the Automated Patient History Intake Device (APHID). *Journal of the American Medical Informatics Association*, 16(3), 300-304.

Lesselroth, B. J., Holahan, P. J., Adams, K., Sullivan, Z. Z., Church, V. L., Woods, S., . . . Dorr, D. A. (2011). Primary care provider perceptions and use of a novel medication reconciliation technology. *Informatics in Primary Care*, 19(2), 105.

Marien S, Krug B, and Spinewine A. (2016) Electronic tools to support medication reconciliation - a systematic review. *J Am Med Inform Assoc*. Jun 14. pii: ocw068. doi: 10.1093/jamia/ocw068

Markowitz, E., Bernstam, E. V., Herskovic, J., Zhang, J., Shneiderman, B., Plaisant, C., & Johnson, T. R. (2011). Medication Reconciliation: Work Domain Ontology, Prototype Development, and a Predictive Model. In *AMIA Annual Symposium Proceedings* (Vol. 2011, p. 878). American Medical Informatics Association.

Mekonnen AB, Abebe TB, McLachlan AJ, Brien JE. (2016) Impact of electronic medication reconciliation interventions on medication discrepancies at hospital transitions: a systematic review and meta-analysis. *BMC Medical Informatics and Decision Making*, 16(1), 112. Published online 2016 Aug 22. doi: 10.1186/s12911-016-0353-9

Moore, P., Armitage, G., Wright, J., Dobrzanski, S., Ansari, N., Hammond, I., & Scally, A. (2011). Medicines reconciliation using a shared electronic health care record. *Journal of Patient Safety*, 7(3), 148-154.

Mueller SK, Sponsler KC, Kripalani S, Schnipper JL. (2012) Hospital based medication reconciliation practices a systematic review. *Archives of Internal Medicine*, 172(14), 1057–69.

Murphy, E. M., Oxencis, C. J., Klauck, J. A., Meyer, D. A., & Zimmerman, J. M. (2009). Medication reconciliation at an academic medical center: implementation of a comprehensive program from admission to discharge. *American Journal of Health-System Pharmacy*, 66(23), 2126-2131.

Neufeld, N., Williams, K. (2012). Engaging physicians in medication reconciliation: Positive recognition program increases compliance with medication reconciliation by resident. Presented at the SHN National Teleconference.

O’Laughlin, J., Renaud, L., Richard, L., Sanchez Gomez, L., & Paradis, G. (1998). Correlates of the sustainability of community-based heart health promotion interventions. *Preventive Medicine*, 27, 702–712.

Owen, M. C., Chang, N. M., Chong, D. H., & Vawdrey, D. K. (2011). Evaluation of Medication List Completeness, Safety, and Annotations. In *AMIA Annual Symposium Proceedings* (Vol. 2011, p. 1055). *American Medical Informatics Association*.

Palojoki, S., Makela, M., Lehtonen, L., Saranto, K. (2016). An analysis of electronic health record–related patient safety incidents. *Health Informatics Journal*, 7, 1-12.

Plaisant, C., Wu, J., Hettinger, A.Z., Powsner, S., Shneiderman, B. (2015) Novel user interface design for medication reconciliation: an evaluation of Twinlist. *Journal of the American Medical Informatics Association*, 22(2), 340-9.

Phansalkar, S., Her, Q.L., Tucker, A.D., Filiz, E., Schnipper, J., Getty, G., Bates, D.W. (2015). Impact of incorporating pharmacy claims data into electronic medication reconciliation. *American Journal of Health-System Pharmacy*, 72(3), 212-7.

Platte, B., Akinci, F., & Güç, Y. (2010). Assessing the accuracy of drug profiles in an electronic medical record system of a Washington state hospital. *The American Journal of Managed Care*, 16(10), e245-E250.

Poon, E. G., Blumenfeld, B., Hamann, C., Turchin, A., Graydon-Baker, E., McCarthy, P. C., ... & Broverman, C. A. (2006). Design and implementation of an application and associated services to support interdisciplinary medication reconciliation efforts at an integrated healthcare delivery network. *Journal of the American Medical Informatics Association*, 13(6), 581-592.

Salemi, C. S., & Singleton, N. (2007). Decreasing medication discrepancies between outpatient and inpatient care through the use of computerized pharmacy data. *The Permanente Journal*, 11(2), 31.

Sardaneh A.A., Burke R., Ritchie A., McLachlan A.J., Lehnbohm E.C. (2017). Pharmacist-led admission medication reconciliation before and after the implementation of an electronic medication management system. *International Journal of Medical Informatics*, 101, 41-49.

Schnipper, J. L., Liang, C. L., Hamann, C., Karson, A. S., Palchuk, M. B., McCarthy, P. C., ... & Bates, D. W. (2011). Development of a tool within the electronic medical record to facilitate medication reconciliation after hospital discharge. *Journal of the American Medical Informatics Association*, 18(3), 309-313.

Schnipper J.L. , *ISMP Canada and Safer Healthcare Now!* National MedRec Call: Got Med Wreck? Targeted Repairs from the Multi-Center Medication Reconciliation Quality Improvement Study (MARQUIS)(January 2014).(Accessed February 20, 2014) <http://www.saferhealthcarenow.ca/EN/events/NationalCalls/2014Webinars/Documents/2014-01-14%20-%20MedRec/EN%20Got%20MedRec%20Wrecked%20-%20The%20MARQUIS%20Study%2001%202014.pdf>

- Silva, P. A. B., Bernstam, E. V., Markowitz, E., Johnson, T. R., Zhang, J., & Herskovic, J. R. (2011). Automated medication reconciliation and complexity of care transitions. In *AMIA Annual Symposium Proceedings* (Vol. 2011, p. 1252). American Medical Informatics Association.
- Stock, R., Scott, J., & Gurtel, S. (2009). Using an electronic prescribing system to ensure accurate medication lists in a large multidisciplinary medical group. *Joint Commission Journal on Quality and Patient Safety*, 35(5), 271-279.
- Taha, H., Abdulhay D., Luqman N., Ellahham S. (2016). Improving admission medication reconciliation compliance using the electronic tool in admitted medical patients. *BMJ Quality Improvement Reports*. doi:10.1136/bmjquality.u209593.w4322
- Tamblyn, R., Huang, A. R., Meguerditchian, A. N., Winslade, N. E., Rochefort, C., Forster, A., ... & Reidel, K. E. (2012). Using novel Canadian resources to improve medication reconciliation at discharge: study protocol for a randomized controlled trial. *Trials*, 13(1), 150.
- Turchin, A., Gandhi, T. K., Coley, C. M., Shubina, M., & Broverman, C. (2007). The use of electronic medication reconciliation to establish the predictors of validity of computerized medication records. *Studies in Health Technology and Informatics*, 129(Pt 2), 1022.
- Turchin, A., Hamann, C., Schnipper, J. L., Graydon-Baker, E., Millar, S. G., McCarthy, P. C., ... & Broverman, C. A. (2008). Evaluation of an inpatient computerized medication reconciliation system. *Journal of the American Medical Informatics Association*, 15(4), 449-452.
- Vawdrey, D. K., Chang, N., Compton, A., Tiase, V., & Hripcsak, G. (2010). Impact of electronic medication reconciliation at hospital admission on clinician workflow. In *AMIA Annual Symposium Proceedings* (Vol. 2010, p. 822). American Medical Informatics Association.
- Warholak, T. L., McCulloch, M., Baumgart, A., Smith, M., Fink, W., & Fritz, W. (2009). An exploratory comparison of medication lists at hospital admission with administrative database records. *Journal of Managed Care Pharmacy: JMCP*, 15(9), 751.
- White, C. M., Schoettker, P. J., Conway, P. H., Geiser, M., Olivea, J., Pruett, R., & Kotagal, U. R. (2011). Utilising improvement science methods to optimise medication reconciliation. *BMJ Quality & Safety*, 20(4), 372-380.
- Zed, P. J., Lacaria, K., Purssell, R. A., Abu-Laban, R. B., Balen, R. M., Loewen, P. S., . . . Samoy, L. J. (2008). Incidence, severity and preventability of medication-related visits to the emergency department: A prospective study. *CMAJ : Canadian Medical Association Journal = Journal De l'Association Medicale Canadienne*, 178(12), 1563-1569. doi: 10.1503/cmaj.071594.
- Zhu, X., Gold, S., Lai, A., Hripcsak, G., & Cimino, J. J. (2009, February). Using Timeline Displays to Improve Medication Reconciliation. In *eHealth, Telemedicine, and Social Medicine, 2009. eTELEMED'09. International Conference on* (pp. 1-6). IEEE.