Improving Usability, Safety and Patient Outcomes with Health Information Technology
F. Lau et al. (Eds.)

doi:10.3233/978-1-61499-951-5-303

Uncovering the Mysteries of Electronic Medication Reconciliation

Kristie MCDONALD[a,1], Douglas ARNDT[a], and Lonn MYRONUK[a]
[a]*Island Health Authority, Victoria, British Columbia, Canada*

Abstract. Island Health Authority ordering providers and staff continue to experience challenges related to electronic medication reconciliation. A *Think Tank* was created to seek a deeper understanding of the reasons why end users were experiencing challenges with documenting home medications, managing conversion failures, and writing prescriptions. Strategies to improve configuration, education, and process are underway.

Keywords. electronic medication reconciliation, end user experience, synonyms, conversion failures, medication order sentences

1. Introduction

Electronic medication reconciliation (eMedRec) is a complex process. For some, medication reconciliation is a new concept; for many, the first implementation of eMedRec within Island Health Authority's Nanaimo Regional Hospital (NRGH) may have had unintended consequences on ordering practices, end user experiences, and the delivery of patient care. An Island Health Authority interdisciplinary *Think Tank* was formed to closely examine eMedRec.

Think Tank participants consisted of clinical informaticists, providers, pharmacists, pharmacy informaticists, medication safety and professional practice consultants, and educators. Workflow analysis and detailed testing were conducted over a series of four workshops. Simulating best possible medication history (BPMH) processes, included reviewing content on prescriptions, physician home medication lists, and interviewing a patient as well as provider reconciliation workflows, participants observed the flow of data and how it 'behaved' differently when using different medication synonym orders. Through didactic conversation, open dialogue, and interprofessional discourse, knowledge from multiple perspectives was shared. This supported a deeper understanding of *why* the data behaved differently; some of the mystery and unknowns were uncovered. This paper describes eMedRec definitions and processes, highlights end user experiences, and provides recommendations.

2. eMedRec Definition and Processes

Medication reconciliation (MedRec) is defined as a systematic process in which healthcare providers collaborate with patients, families, and other care team members to

[1] Corresponding Author. Email: Kristina.mcdonald@viha.ca

ensure that comprehensive and accurate medication information is communicated across transitions of care [1]. It is a term that is used to describe *both* (1) an over-arching process that includes multiple disciplines as the patient is admitted, transferred, and discharged across care venues and (2) a discrete task of ordering providers deciding which medications to stop, start, and continue, and resolve discrepancies[2]. Traditionally, MedRec has been conducted on paper; integration of an electronic health record (EHR) supports electronic medication reconciliation (eMedRec).

eMedRec begins with a BPMH. Multiple sources of medication information are reviewed; an electronic home medication list is documented and available for all current and future encounters. During admission reconciliation, the provider reviews the home medication list, resolves discrepancies, and places electronic inpatient orders. As the patient transitions into the next level of care, transfer reconciliation is performed. When the patient is ready to be discharged, the home medications and inpatient orders are reviewed, discrepancies are resolved and, when required, prescriptions are created. A discharge medication list automatically populates into a discharge document. Finally, through either a printed handout or electronic distribution, changes or additions to home medications are communicated to the patient and those providing support.

While the intent and processes of medication reconciliation may seem clear, end users continue to express concerns. As eMedRec adoption and compliance are low, patients continue to be discharged without a clear understanding of their home medication regimen.

3. Background

Island Health Authority (IHA) utilizes *Cerner Millennium* (CM), a proprietary electronic health record (EHR). Electronic medication orders and medication documentation are among many of the integrated processes. Historically, IHA's medication order catalogue supported primary care providers; custom order sentences were built in the outpatient venue for both home medication documentation and prescriptions. While this custom build supported primary care medication management, it did not support robust eMedRec processes.

In early 2014 IHA initiated IHealth; an organizational transformative change supporting the vision of *"One Person, One Record, One Plan for Health and Care"*[2]. Medication orders and medication reconciliation processes were included in system, integration, and end user testing events leading up to implementation. Workflow testing included nurses or pharmacy technicians reviewing multiple sources of information and interviewing the patient and/or family to complete electronic home medication documentation. Home medications were available for ordering providers to electronically reconcile. Inpatient orders were managed using admission and transfer reconciliation interfaces; at time of discharge both reconciled and non-reconciled home medications were available to prescribe, stop, or continue. Ordering providers printed the prescription; the discharge medication list automatically populated discharge documentation. IHA staff and ordering providers tested workflows using the historical medication catalogue; order conversions at time of reconciliation appeared appropriate; order sentences appeared to support workflow. Based on all testing cycle feedback,

[2] MedRec refers to the over-arching process of medication reconciliation; discrete acts of provider ordering will be written as "admission reconciliation", "discharge reconciliation", and "transfer reconciliation".

IHealth leadership supported implementation with a back-up plan to revert to paper reconciliation processes and hand written prescriptions. As of March 2016 eMedRec went live in congruence of a fully integrated EHR including inpatient ordering and electronic documentation at IHA's NRGH. Unfortunately, a decision to integrate *PharmaNet* negatively affected end user experience.

PharmaNet is British Columbia's provincial pharmacy dispensing database. Pharmacists working in community pharmacies record the medications dispensed when patients fill prescriptions. The database provides medication information such as the product name (e.g. 'morphine extended release'), the number of units provided for the dose (e.g. '1') and the drug form (e.g. '1 tablet'). By selecting '*External Rx History'* in CM clinicians are provided with a side-by-side view of dispensed medications from *PharmaNet* as well as previously documented home medications. The ability to review recently dispensed medications while updating a home medication list supports best possible medication history processes. Unfortunately, the decision to integrate *PharmaNet* was made shortly prior to implementation. As it required a different order sentence strategy, one that aligned with CM standard order sentences rather than historical custom sentences, the hybrid medication catalogue had not been robustly tested with end users. End users expressed challenges shortly after implementation, adoption of eMedRec was impacted.

Many ordering providers reverted back to a hybrid medication reconciliation process. A printed home medication list from *PharmaNet* was used to electronically add home medications to inpatient orders; providers returned to handwritten prescriptions and manual documentation of home medications in discharge notes. With poor adoption of eMedRec, a decision to remove the automated discharge medication list from patient handouts was made. Indeed, medication reconciliation processes remain an accreditation concern for both hybrid and electronic processes.

4. End User eMedRec Experiences

Within NRGH, Specialty and Primary Care Providers provide care for approximately 200 admitted patients. On average, eMedRec is being completed for 40% of admissions and 37% of discharges from inpatient care. Of all admitted patients, 23% are receiving a full eMedRec. These rates have been declining [3]. Frustration, confusion, and loss of trust in the system are a few of the emotions that have been expressed. While some providers have persevered, others no longer utilize eMedRec tools. Indeed throughout the workshops, the *Think Tank* also experienced data behaving in a seemingly mysterious or unpredictable fashion. Through a lens of curiosity and focused effort, members of the *Think Tank* identified three of the most challenging components to navigate:

1. Search struggles with result returns when searching for medication orders,
2. Conversion confusion regarding auto conversion and failure resolution, and
3. Prescription paralysis related to difficulty with prescribing

4.1. Search Struggles

End users search for medications when documenting BPMH and/or creating prescriptions. Complaints center on ubiquitous search returns. Ultimately, the root cause is a design decision to use a system setting that employs a proprietary search algorithm intended for ease of use. The unintended consequence on the end user is the cognitive

overload sorting through a large number of search returns. Teams who are responsible to meet the needs of end users are challenged in finding the optimal number of order sentences to be returned by searches. While search tips, such as entering the medication name, drug form, and dose will refine the number of returns, end users are reluctant to modify search practices.

4.2. Conversion Confusion

Within CM there are two separate venues: (1) outpatient which involves home medications and prescriptions, and (2) inpatient which involves inpatient medications and order sets. These two venues are architected to exist as distinctly different lists within the patient's health record. As such there is a necessity for *conversion* of medication orders from one venue to another at different stages within the eMedRec process. For example, home medications and prescriptions are converted to inpatient medication upon admission and vice versa upon discharge. Generally, this transformation happens automatically within the system. Complex conversion logic directs the behavior of a medication order at points of conversion such as a home medication converting to an inpatient order and an inpatient order converting to a prescription.

Conversion logic is based on order synonym types; order synonyms are not physical products but, rather, *refer* to medication orders that will ultimately result in a dispensed product. Synonyms range from general such as generic (Primary) and brand name (Brand Name) to specific products such as product level synonyms (PLS). PLS will include either the generic or brand name in the description displayed to the end user; they also include specific details such as strength and drug form. Different types of synonyms may be used for the different venues of care delivery.

Table 1. Synonym Types and Examples in Inpatient and Outpatient Venues[3]

Synonym Type	Orderable Example	Inpatient/Outpatient Venue
Primary	Metoprolol	Both
Brand Name	Betaloc	Both
C-Dispensable	Metoprolol inj	Both
M-Generic	***Not currently built***	Inpatient
N-Trade	***Not currently built***	Inpatient
Y-Generic	Metoprolol 100 mg oral tablet	Outpatient
Z-Trade	Apo Metoprolol 100 mg oral tablet	Outpatient

As BPMH is the first step of the eMedRec process, what synonyms are used to document home medications will affect auto conversion. Each synonym type follows its own conversion, or hierarchy path, to determine an appropriate match (Table 2). For example, a primary synonym will only convert to a primary synonym. A brand synonym will convert to a brand synonym, if a brand synonym is not available it will look for an 'N' synonym, if an 'N' is not available, it will look for a 'C' synonym, if a 'C' synonym is not available it will look for a 'primary' synonym. If there is no primary synonym, the end user will experience a conversion failure.

Table 2. Synonym Conversions from Home Medications to Inpatient Medications[4]

From Synonym Type	To Synonym Type for Matches
Primary	Primary
Brand	Brand>N>C>Primary
C-Dispensable	C>M>Primary
M-Generic	M>C>Primary>M other
N-Trade	N>Brand>N other > C> Primary
Y-Generic	M>C>Primary>M other
Z-Trade	N>Brand>N other>C>Primary

Auto conversion failures can happen due to multiple reasons such as lack of a therapeutic substitution build, vendor limitations with respect to PLS auto conversion, and differences between medications available in the community versus hospital/provincial formulary. Troubleshooting auto conversion failures by pharmacy informatics is complex and often completed retrospectively.

The end user experiences conversion failures by a window that disrupts their ordering process. While the content in the window is intended to support clinical decision-making about alternative medications, there are several concerns from an end user perspective:

- Auto conversion failures display too often and for commonly ordered medications.
- End users remain unsure which alternative to select as they may be unfamiliar with the alternative medications listed.
- Prior to implementation, substitution to alternate medications would have been completed by pharmacists.

Another layer of complexity is experienced during reconciliation. Because of the conversion logic, the appearance of orders may automatically change. PLS are commonly used in the outpatient venue and are expressed using a volume dose due to the strength and form being a part of the synonym (e.g. *metoprolol (metoprolol tartrate 100 mg oral tablet)*. Upon conversion to the inpatient venue, non-PLS (e.g. *metoprolol*) are often used and will express the dose as a strength (e.g. *100 mg).* A further confounding issue is the use of a simplified clinical display line (CDL) in eMedRec which does not display all order sentence details. For example the order *morphine (Sandoz SR 60 mg/8hr oral tablet, extended release) 1 tab,* converts to primary *morphine 60* mg with details of the extended release formulation captured within drug form. As the drug form is not displayed as part of the simplified CDL, some end users have mistakenly inferred that their order converted to an immediate release formulation. The concern expressed is that there could be potential harm to the patient. As those end users would not realize that their order is still the same medicinal product, this creates incongruence in their experience.

One final challenge remains with conversion: synonyms that are PLS will convert smoothly at time of prescribing. To the ordering provider, this means that when a home medication that had been originally documented using an order sentence representing a 'C dispensable' synonym at time of admission, dispensing quantity may not automatically complete at time of creating a prescription. Further, in CM current build, only PLS will successfully support e-prescription processes. While IHA continues to print prescriptions, there is keen interest to support future functionality such as the ability to electronically send a prescription to a patient's community pharmacy.

4.3. Prescription Paralysis

There are many nuances to navigate when creating a prescription during discharge reconciliation. While some aspects of the user interface simply require familiarity gained through practice, others seem to remain ongoing challenges for users to make sense of even with repeated exposure. For example, navigating dispense quantity is a significant undertaking. Due to regulatory requirements for prescriptions, dispense quantity is a required field; the prescriber is unable to sign the prescription without entering how many/how much medication should be dispensed. End users report the dispense quantity field for order entry behaves erratically. The *Think Tank* identified the following:

- Prescriptions 'behave' according to how the home medications were originally documented during BPMH. Prescriptions inherit properties from medication synonyms through conversion during medication reconciliation. Depending on the synonym used, the dispense quantity may or may not auto calculate. Unfortunately for end users, synonyms are indistinguishable in appearance, giving rise to an experience of inconsistent or unpredictable behavior of the "dispensequantity" field.
- In some cases, system settings can affect calculation of dispense quantity.
- By design, as-needed ("PRN") medications will not auto populate a dispense quantity.
- How the dose is documented can affect whether dispense quantity can be calculated

Challenges are not isolated to the nuances of the dispense field. Incorrect printer mapping, especially as an ordering provider moves throughout a facility, leads to frustration.

5. Discussion and Recommendations

Prior to the *Think Tank* sessions, understanding of synonyms and conversion logic was only understood by Pharmacy Informatics; appreciation for the deep loss of trust in the system was understood by providers and educators as they are closer to the front-line. As participants shared stories and knowledge, risks were tracked and analyzed, education and practice gaps were uncovered, and mitigation strategies unfolded. It was through the common and vested interest of the *Think Tank* interdisciplinary working group that the dependencies on synonym, order sentence, and conversion strategies for both outpatient (home medications & prescriptions) and inpatient (inpatient orders) venues on end user experiences became readily apparent. Recommendations include but are not limited to:

- Review vendor's assessment of CM system parameters and recommendations to improve auto conversion rates and ordering practices:
    - Move toward vendor-supplied synonyms using CM's medication database *Multum*)
    - Inactivate many of the custom C-dispensable synonyms
    - Review order sentences of custom synonyms and apply them to new *Multum* supplied synonyms
    - Inactivate or hide some of the brand primary synonyms to reduce clutter

    - Decide which synonyms to use for which inpatient orders (e.g. some may be best represented by brand/primary; others by product level such as M, N, Y, Z)
- Review *Think Tank* recommendations with Executive Steering to determine which will be actioned
- Develop a plan for implementation of *Think Tank* recommendations
- Host change management events
- Provide education to fill current state gaps
- Establish a governance structure that will clearly outline roles, responsibility, monitoring, and accountability
- Implement and support front line users with changes
- Create a permanent Working Group to continue to enhance eMedRec process
- Build provincial networks to share ideas related to eMedRec

While eMedRec continues to be a complex process, it is vital to remain curious and unrelenting in uncovering remaining challenges. A *Think Tank* or small working group can provide further insight through interprofessional discussion and discourse, testing of system enhancements, and providing end users with the ability to provide ongoing feedback. Patients' care remains at the heart of why healthcare exists; unsolved challenges of eMedRec should not result in a discharge medication list that is a 'mystery' to providers or patients. Patients deserve to have a clear understanding of which medications they should be taking following discharge in order to stay safe.

References

[1] The Electronic Medication Reconciliation Group. *Paper to electronic medrecimplementation toolkit*, 2nd Edition. ISMP Canada and Canadian Patient Safety Institute, 2017.
[2] Island Health Authority. *IHealth*, (2018). Retrieved from:http://ihealth.islandhealth.ca/
[3] Island Health Authority. *Third party ihealth review-recommendations status report,* (2018). Retrieved from: https://intranet.viha.ca/ihealth/Documents/third-party-ihealth-review-board-status-report-january-2018.pdf
[4] Cerner. *Configure medication process synonyms*,(2018). Retrieved from: https://wiki.cerner.com/display/public/reference/Configure+Medication+Process+Synonyms
[5] Cerner. *Medication reconciliation convert logic*,(2018). Retrieved from:https://wiki.ucern.com/display/public/courses/Medication+Reconciliation+Convert+Logic