Insights into the Impact of Med Rec Implementation at admission in Acute and Long Term Care Settings in Alberta

by

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Institute of Health Policy, Management & Evaluation
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Abstract

Introduction: Adverse drug events (ADEs) pose a significant public health problem. Clinical tools have attempted to mitigate impact of ADEs. Medication reconciliation (Med Rec) has been created as clinical process intended to address limitations associated with use of clinical tools. In Alberta, Medication Reconciliation (MRQA Med Rec), has been concurrently implemented in hospitals and continuing care facilities with aim of reducing ADE-related healthcare utilization by ensuring that medication changes are adequately documented.

Primary Objective: To evaluate effectiveness of intervention in Alberta’s healthcare settings.

Secondary Objectives: 1) To characterize Alberta’s healthcare institutions participating in intervention and compare with non-participating institutions; 2) To determine consistency of implementation by assessing Quality Audit Bundle Compliance at Admission; 3) To evaluate whether intervention’s impact differs among care settings; and 4) To assess impact of organizational factors on intervention’s effectiveness between/within settings.

Data collection: Administrative data obtained from the period between June 1st 2013 and March 31st, 2015 – was linked by facility identifier.

Analysis: Outcomes associated with ADE related healthcare utilization, were analyzed using repeated measures with the generalized linear model in SAS.

Results: Alberta has 328 healthcare facilities, whereas only 116 have implemented intervention. Intervention’s implementation in hospitals was not associated with changes in number of ADE related ED visits (p-value =0.1090) but may be associated with changes in number of ADE related hospitalizations (p-value <.0001). Implementation of MRQA Med Rec in publicly funded LTC facilities could not be associated with changes in number of ADE related ED visits (p-value =.5957) and number of ADE related hospitalizations (p-value=.2039). Assessment of Audit Bundle revealed that intervention was not implemented with fidelity in either care setting.
Conclusions: This was the first study to assess the impact of Med Rec at a system level. It is the first to measure and consider fidelity of intervention and its influence on outcomes. LTC cohort examined in this study was compromised exclusively of publicly funded LTC facilities. Further research is required to assess impact of intervention in LTC facilities on ADE related events, to identify optimal implementation process, and determine timeframe over which intervention is likely to confer benefits.
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Chapter 1: Introduction

The use of drugs to treat various ailments is a long-standing practice. Any substance that is capable of producing a therapeutic effect can also produce unwanted or adverse drug events (ADEs). Risks and consequences of such effects range from almost zero to very high. Over time, there have been various strategies aimed at reducing the rate of ADEs. Even though drug usage increased and drug-manufacturing processes and standards have been modernized, issues around consistency of use of medication safety strategies prevail.

The thesis begins with the brief introduction of history of drugs, followed by an overview of various categories of ADEs, medication safety interventions and introduction of organizational factors previously associated with organizational effectiveness as related to patient safety.

1.1 History of medication use

1.1.1 Pre-Greek to 15th century

During the Stone Age humans identified various edible plants that were able to cure ailments and soothe a fever. (1) The oldest Babylonian texts on medicine date back to the Old Babylonian period in the early years of the 2nd millennium Before Christ (BC). The most extensive Babylonian medical text, the Diagnostic Handbook (seen in Figure 1.1) was written by the physician Esagil-kin-apli (1069-1046 BC) of Borsippa. (2) The Handbook introduced the methods of therapy and etiology, and the use of empiricism, logic and rationality in diagnosis, prognosis and therapy. In India, Atharva-veda (seen in Figure 1.1), the sacred text of Hinduism introduced the concept of prescription.
In 700 BC Greeks created a humoral medicine system where treatment attempted to restore the balance of humors within the body. Greek Physician, Pedanius Dioscorides wrote *De Materia Medica* (seen in Figure 1.2) (5) that was focused on use of various medical substances. The earliest Chinese manual on use of herbal medicine, *Shennog Bencao Jing* (seen in Figure 1.2) (6), dates back to the 1st Century Anno Domini (AD).

The first pharmacies were established in Baghdad in 754. (7) These drug stores became...
state-regulated by the 9th century. (7) In Iraq, Abu al-Qasim al-ZAhrawi (Abulcasis) pioneered the preparation of medicines through sublimation and distillation. Abulcasis’ *Liber servitoris* (seen in Figure 1.3) provided recipes and explanations on how to prepare basic mixtures for the complex drugs that were used at the time to treat various ailments.

There were many other notable names in the Middle Eastern history of pharmacopoeia such as Al-Biruni (*Kitab al-Saydalah (The Book of Drugs)*), Ibn Sina (*The Canon of Medicine*); Al-Mardini, and Ibn al-Wafid (*De Medicinis universalibus et particularibus* and *Medicamentis simplicibus*).(7) (8)

![Image](image.png)

**Figure 1-3:** Adapted from Abulcasis’ *Liber servitoris*

The first pharmacy-like stores appeared in Europe during the 12th Century. The oldest European pharmacy was established in 1221 in the Church of Santa Maria Novella in Florence, Italy. (seen in Figure 1.4) (9) Presently, it is a home to a perfume museum. The Republic of Venice is considered the basis for modern health policies, as it was the first state that required
drug ingredients contained in the product to be publicly listed. (9)

Figure 1-4: Adapted from *Farmacia di Santa Maria Novella in Florence*

1.1.2 16th Century to present

In the late 1500s, Ambroise Paré’s most significant discovery was to replace the traditional treatment of gunshot wounds by dressing the wounds with a mix of egg yolk, oil of roses and turpentine. (1) In 1658 the first patient underwent the successful kidney stone removal without an effective painkiller. He was offered a mix of rose water, egg whites and liquorice to soothe the pain. (1) In the 18th Century England’s physician William Withering observed that his country patients use an extract of herbs to alleviate dropsy. (1) William confirmed that the active ingredient was the foxglove. In Withering’s *Account of the Foxglove* (1785), he provided clinical details of how to prescribe extract of foxglove in the treatment of dropsy and suggested that it may be of use for the treatment of heart disease. (1) Edward Jenner, the “father of vaccination”, noticed that even in a long line of inoculation (taking new vaccine from each successive patient suffering from the disease) the vaccination against Small Pox still conferred immunity. (1) The 19th Century symbolizes the rise of modern medicine. In the late 19th Century, Paul Ehrlich prophesied the role of modern-day pharmaceutical research. He foretold that laboratories would create “magic bullets”, substances that would seek out specific disease-causing agents. (10) During the First World War A. Carrel and H. Dakin developed the Carrel-Dakin method of
treating wounds with a germicide in order to prevent gangrene. (11)

1.2 Adverse drug events

Past tragedies powerfully remind us of the significance of ADEs and the importance of safety medication strategies aimed at reducing their incidence. The thalidomide disaster of 1961 provoked national and international action towards assuring the safety of medicinal drugs and reducing the risk of ADEs.(12) Chinoform chelate, the underlying cause of green tongue and green urine in patients with subacute myelooptic neuropathy was withdrawn from the market in 1970.(13) The co-administration of anticancer agents (sorivudine and fluorouracil) produced fatal agranulocytosis.(13) In 1993, sorivudine was withdrawn from the market after being on sale for only one month. Other remarkable ADEs were: *quadriceps contracture* that was induced by the recurrent administration of muscular injection products and *Creutzfeldt-Jakob disease* caused by the transplantation of human dry cranial Dura matter. (13)

1.2.1 Definition of ADEs

An incident refers to any irregularity in the process of medication use. It might represent and ADE, potential ADE, preventable ADE or none of these. (14) Essentially it is a ‘catch all’ term for what to call something before it can be classified. There are several ways to categorize incidents: actual (ADEs) v potential; preventable v non-preventable; ameliorable v non-ameliorable. (14)

Most drugs produce therapeutic and unwanted effects. Unwanted drug effects are labeled as side effects or ADEs. (15) The Institute of Safe Medical Practice (ISMP) defines ADEs as injuries from a medicine or lack of an intended medicine. (16) ADEs that involve an element of error (including both omission or commission) are often referred to as preventable ADEs, while errors that reach a patient but do not cause any harm are referred to as potential ADEs. (17) Note
that the term `side effect’ should not be used interchangeably with ADE. It is a term that is frequently used when one refers solely to a drug’s unintended effects that occur within the therapeutic range. (15) Occasionally, some drug’s side effects become the drug’s primary therapeutic effect. An example is minoxidil, launched in late 1970s as treatment for hypertension. It was observed that many of the bald patients taking minoxidil started to grow back their hair. Ten years later minoxidil cream was advertised as a treatment for hair loss and that has become the primary use of the drug. (18) Following an ADE, a causality scale like Naranjo (seen in Figure 1.5) (14) is applied and the ADE is assessed by clinicians as certain, probable, possible and doubtful. The scale consists of 10 questions that are answered as either Yes; No, or Do not know. (19) Different values (-1; 0; +1; +2) are assigned to each answer.

Potential ADE is defined as an incident with the potential to cause an injury but which does not actually result in an injury, either because of specific circumstances, chance, or because the error was intercepted and corrected. (14) An example of potential ADE would be if an order is written for an overdose of medication but the error was intercepted by the pharmacist. Preventable ADE is an injury that results from a mistake that occurred at any stage in the medication use. For example, coma that occurred as a result of sedative overdose. (14) Non-preventable ADE is an injury due to a medication where there is no error in the medication process. An example of non-preventable ADE would be an allergic reaction in a patient not previously known to be allergic to the medication. An ameliorable ADE is an injury of which the severity/duration could have been significantly reduced if different actions had been taken. An example of ameliorable ADE would be a sexual dysfunction lasting several months while taking a SSRIs. A non-ameliorable ADE is an injury in which there is no reasonable way to reduce the severity or duration such as bradycardia after the first usual dose of beta blocker. Some ADE
categories are depicted in Figure 1.6. (14) This thesis was focused on preventable ADEs as they:

1) inflict (severe) harm in patients; 2) can be prevented; 3) can be identified in administrative data sources.

![Adverse Drug Event Probability Scale](image)

**Figure 1-5:** Adapted from Adverse Drug Event Probability Scale (Naranjo Scale)
1.2.2 Categories of ADEs

Review of literature indicated that there are at least five categories of preventable ADEs (20) including: 1) Adverse drug reaction (ADR); 2) Medication error; 3) Therapeutic failure; 4) Adverse drug withdrawal event, and 5) Drug overdose.

1.2.2.1 Adverse drug reaction

Adverse drug reactions (ADRs) are special categories of ADE in which a causative relationship between a drug and an adverse outcome can be established. ADR is defined as harmful or unpleasant reaction, directly resulting from an intervention related to the use of a medicinal product.(15) ADRs can be: 1) Dose-related (Augmented); 2) Not-dose-related (allergic and idiosyncratic)(12); 3) Dose-related and time-related (Chronic); 4) Time-related (Delayed); 5) Withdrawal (End of use); and 6) Failure of therapy (Failure).(21) Timing, the pattern of illness, the results of investigations, can help attribute causality to a suspected adverse drug reaction.
Dose related ADRs are of particular concern if drugs have narrow therapeutic index as there is little difference between the toxic and therapeutic doses. An example of a narrow therapeutic index would be the hemorrhage following the use of oral anticoagulants.

### 1.2.2.2 Medication error

A medication error is defined as a preventable event that may lead to inappropriate medication use or patient harm. (22) It is a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient. Medication errors can occur: 1) during medication selection process; 2) during manufacturing of the formulation to be used (i.e. inappropriate strength, contaminants or adulterants); 3) as a result of misleading packaging; 4) when medication is dispensed (i.e. inadequate strength, wrong formulation or label); 4) when wrong dose of the medication is administered (e.g. inappropriate route, frequency and/or duration); and 5) during medication use (e.g. erroneous therapy alteration). (22) Factors responsible for medication errors contribute towards prescription errors (e.g. over-prescribing; under-prescribing; ineffective prescribing etc.). (23) They include: lack of knowledge, using the wrong drug name, dosage form, abbreviation, and incorrect dosage calculations. (23) The precise prevalence of medication errors is not known as most errors pass unnoticed, or are not reported. Nonetheless, from 1990 to 2000 the number of deaths from medication errors in US hospitals increased from 2876 to 7381. (24) The following factors have been attributed to contributing to the increase risk of medication errors: 1) increased patient population; 2) new drugs that emerged and are increasingly difficult to use safely and effectively; 3) more complex and specialized medical care; and 4) an aging population. (24, 25)

In Canada, most studies of medication error were based on data gathered from clinical records, which often yield incomplete information. (26-29) After the first year of mandatory
reporting (2013), Ontario hospitals disclosed that 36 patients had suffered severe adverse events — 10 of them fatal — because of medication errors. The most cited reasons responsible for critical incidents were: communication factors, drug product confusion and distractions and/or frequent interruptions. In 2016, it was reported that ADEs remain the most frequent of all harmful events that occur in a hospital. Report noted that: 37% of harmful event were ADE related; 37% of harmful events resulted from hospital acquired infections; 23% resulted from procedure associated conditions; and 3% accounted for patient accidents. (30) As people are increasingly being cared for at home and are often prescribed high-alert medications such as painkillers, medication error prevalence may be underestimated. (31) Thus, the risk of medication errors can be even greater, especially in persons with multiple health problems taking multiple drugs.

In 2003, the Health Quality Council of Alberta (HQCA) surveyed Albertans to assess their perceptions of and actual experiences with health services. (32) Findings indicated that 14 percent (n=210) of those surveyed reported that they or a family member experienced a medical error within the past year that resulted in serious harm, such as death, disability, or prolonged treatment and that most common medical error were related to medication (n=123, 22.8%). (31, 32)

1.2.2.3 Therapeutic failure

Therapeutic failure is the second most common category of ADEs. (33) It occurs when expected drug effects do not occur following prescribed pharmacological treatment. (34) This includes any clinical event that could be related to a low prescribed dose or lack of compliance. Therapeutic failure can occur at every step of the therapeutic chain such as: 1) development; 2) regulation; 3) marketing; 4) distribution; 5) prescription; 6) dispensing; and 7) drug use. (35) It
may be a result of: 1) inappropriate diagnosis; 2) Selection of inadequate drug or dosage; 3) Use of an adulterated or fake drug; 4) patient's non-adherence; 5) drug's poor bioavailability or lack of efficacy; 6) medication error; and 7) result from a combination of several of the above. (34, 35)

1.2.2.4 Adverse drug withdrawal events

Adverse drug withdrawal events (ADWEs) are the least common type of medication-related ADEs. (32, 33, 36) ADWEs are defined as a set of clinical symptoms that are associated with the cessation of a drug usually within 4 months of its being discontinued. (32, 33) Adverse drug withdrawal symptoms can vary in their severity. They can range from nausea, to seizures and hypertensive crisis. Information on ADWEs can be found in the package insert of the drug. (36) Clinical manifestation of an ADWE may be either physiological withdrawal reaction of the drug or an exacerbation of the underlying disease itself. Past studies have identified several risk factors associated with ADWEs such as: 1) multiple diagnoses; 2) multiple medications; 3) extended nursing home stays; and 4) hospitalizations. (37-39) Also, studies indicate that the most common medications that have been associated with ADWE were: 1) cardiovascular; 2) central nervous system (CNS) and 3) gastrointestinal (GI) drugs. (37-39)

1.2.2.5 Accidental medication overdose

Accidental medication overdose refers to serious, and sometimes fatal, adverse drug reaction that is a result of exaggeration of the drug’s therapeutic effects. (15) It is an unintended incident following the use of more than the recommended drug dose. It may occur for a variety of reasons: 1) when the effects of the drug are at heightened level of the therapeutic effects seen with regular use; 2) when side effects become more pronounced; and 3) when other effects take place, which would not occur with normal use. There has been an increased public awareness of
the importance and implications of medication overdose as a result of frequent unintentional
overdoses of pain relievers. (40)

1.2.3 Mechanisms of action of ADEs

ADEs can result from abnormal pharmacokinetics and synergistic effects.

1.2.3.1 Abnormal pharmacokinetics

Pharmacokinetics refers to the movement of drugs into, through, and out of the body. It includes a drug’s: 1) absorption; 2) bioavailability; 3) distribution; 4) metabolism; and 5) excretion. (41-43) Abnormal pharmacokinetics can arise from: genetic factors or comorbid disease states. (34)

1.2.3.1.1 Genetic factors

Abnormal drug metabolism may occur as a result of inherited factors of either Phase I oxidation (inheriting abnormal alleles of cytochrome P450; or abnormal butyrylcholinesterase) or Phase II conjugation (inheriting abnormal N-acetyltransferase). (34)

1.2.3.1.2 Comorbid disease states

Comorbid disease states are caused by conditions that simultaneously yet independently affect two organs. For instance, conditions that cause renal (i.e. kidney failure) and/or hepatic insufficiency (i.e. Hepatitis C) may alter drug metabolism. (43)

1.2.3.2 Synergistic effects

Synergism refers to the effect caused when one is exposed to two or more entities (drugs/disease) at the time. These result in health effects that are greater than the sum of the effects of individual entities. (44) Synergistic effects can occur between a drug or/and a disease or more than one drug usage. When the drug-drug interaction results in an increase in the effects of one or both of the drugs the interaction is called synergistic effect. (45) An additive synergy
happens when the final effect is equal to the sum of the effects of the two drugs. If the final effect is much greater than the sum of the two effects, it is called *enhanced synergy*. The opposite effect to synergy is called antagonism. Two drugs are considered antagonistic when their interaction results in decrease in the effects of one or both of the drugs. Both synergistic and antagonistic drug effects have the potential to evoke an ADE. (45)

The following evidence illustrates the magnitude of ADEs in different healthcare settings.

### 1.2.4 Evidence - medication discrepancies, ADEs and patient safety

ADEs represent a significant patient safety concern for Canadians. Annually 33,500 Canadians are hospitalized due to an ADE and 1,500 of them die from an ADE. (46) In Canada (2013) one in 200 seniors was hospitalized because of an ADE. (47, 48)

Previous evidence demonstrates that medication discrepancies during care transfers resulting in ADEs may cause adverse patient outcomes. In Canada, published studies have demonstrated that about 50 percent of patients experience unintentional medication discrepancies upon admission to acute care hospitals (49) and at least 40 percent of patients’ experience discrepancies at hospital discharge. (50-52) The Canadian Adverse Events Study (2004) reviewed patient charts from admissions to four randomly selected hospitals in five provinces. The results indicated that 3.1 percent of hospitalized patients experienced some type of ADE from which one can estimate that the number of deaths due to an ADE in hospital is about 3,600.(53) Wu et al. reported that up to one-quarter of Canadian patients who visit EDs due to ADRs are admitted to hospital.(54) In addition, the authors demonstrated that ED visits and hospital admissions due to ADEs cost Canadian healthcare an estimated $35.7 million, with over 80 percent of those costs arising from hospitalization.(54)
ADEs are also a significant concern for Long-Term home residents. A study by Gurwitz et al. revealed that LTC residents are at increased risk of ADEs and that the risk is especially high during care transfers. (55) The study noted that the overall rate of ADEs in LTC homes was 9.8 per 100 resident-months, with a rate of 4.1 preventable ADEs per 100 resident-months. (55)

A Canadian study focusing on the home and community care sector noted that a significant number of patients experienced adverse events (AEs), one-third of which were considered preventable. (47) The retrospective chart review indicated that for the community care patients AE rate was 13.2 per 100 home care cases [95% confidence interval (CI): 10.4-16.6%, standard error 1.6%]. 32.7% (20 of 61 AEs) of the AEs were rated as having >50% probability of preventability; 6 deaths (10.9% of patients with an AE; 1.4% of all patients) occurred in AE-positive patients while the most common AEs were adverse drug events. (47) Another study reported that up to one-third of community care patients had evidence of a potential medication problem. (56) The purpose of the study was to determine the frequency of possible medication errors in a population of older community care patients according to expert panel objective criteria. The study utilized two sets of consensus-based expert panel criteria (Home Health & Beers criteria) to define possible medication inaccuracies. Results indicate that the 6,718 study subjects took a median of five drugs; 19% were taking nine or more medications. A possible medication error was identified for 19% of patients according to Home Health Criteria, 17% according to the Beers criteria, and 30% according to either. (56) Possible errors increased with the number of medications taken - when patients taking one to three medications were compared with those taking nine or more drugs, the percentages with possible errors were, respectively, 10% and 32% for the Home Health Criteria, 8% and 32% for the Beers criteria, and 16% and 50% for both. (56)
1.2.5 Risk factors associated with ADEs

Prevention efforts to reduce medication discrepancies and ADEs should be targeted at risk factors that have been associated with their occurrence. While many factors may be common to different settings, some factors may be setting-specific.

Risk factors that have been associated with ADEs include(55): 1) certain drug classes (including antibiotics, antineoplastic drugs, non-steroidal anti-inflammatory drugs and analgesics); 2) patient’s characteristics: age and sex; 3) the presence of comorbidities; 4) the number of drugs a patient is taking (polypharmacy); 5) whether or not a patient has recently started a new drug therapy; 6) the number of pharmacies visited; 7) the number of prescribers used; 8) whether or not a patient had been hospitalized during the previous year; and 9) organizational factors such as staffing intensity that have been associated with poor quality of care.

There have been many “pharmacovigilant” attempts to deal with ADEs. Starting in the late 1960s, interventions and regulations have been created to reduce the incidence of ADEs. What follows is a brief history of pharmacovigilance and the development of laws in the field of ADEs.

1.2.6 History of medication safety interventions aimed at reducing ADEs

The term “pharmacovigilance” initially appeared in France in the late 1960s.(57) World Health Organization (58) defines pharmacovigilance as: set of activities focused on detection, assessment, understanding and prevention of ADEs or any other possible drug-related problems.(59) It is focused on: 1) small molecules that are found in traditional medicinal products; 2) biologics; 3) vaccines; 4) other cellular products; 5) blood products; 6) herbal medicines; 7) traditional and complementary medicines; and 8) medical devices. At times
pharmacovigilance has been regarded as somewhat being synonymous with post marketing surveillance for adverse drug reactions. (59)

German toxicologist Louis Lewin is considered the father of modern history of the development of pharmacovigilance; he published the first book on adverse drug effects in 1881, *Die Nebenwirkungen der Arzneimittel.* (60) In the 1880s, several English doctors, supported by Ernest Hart, launched a campaign against the marketing of patent medicines that contained useless or toxic ingredients. The Patent Medicine Bill (1884), which sought to control medication, failed because of pressure from the Society of chemists and pharmacists. (61) In the United States, in the early 1900s, public concern about adulterated and misbranded drugs culminated in the publication of 11 articles by Samuel Hopkins Adams in Collier’s Weekly. (61) “The Great American Fraud,” by SH Adams exposed many of the false claims made about patent medicines. This led to 1906 Pure Food and Drugs Act, which established the forerunner of the Food and Drug Administration (FDA). (61) Legislations such as Patent Medicine Bill could be perceived as initial efforts to mitigate the likelihood of ADEs.

From early 1900s to late 1990s a series of books were entirely devoted to descriptions of ADEs. The 20th Century revelation of adverse drug reactions created changes in legislation such as: The Therapeutic Substances Act of 1925; the Medicines Act of 1968; Federal Food, Drug and Cosmetic Act 1937 which gave increased powers to FDA. (60)

In Canada, the legislative requirements regarding the reporting of ADEs are covered under the Food and Drugs Act (1985) and Regulations. (62) National adverse reaction reporting activities are coordinated by the Marketed Health Products Directorate (MHPD) of Health Canada. Regional centres (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Atlantic) perform initial reviews of the quality and completeness of the reports, which are
then processed and additionally analyzed at the National Office. (62) Drug manufacturers are legally responsible to inform Health Canada with any important safety information for drugs that are sold in Canada. The Canadian Adverse Reaction Monitoring Program (CADRMP) of the MHPD collects reports of suspected events to health products. Reporting by health professionals and consumers (annually ~ 10,000) to CADRMP is on voluntary basis whereas and manufactures and distributors who are required to submit reports according to the Food and Drug Regulations. (62) Canada vigilance adverse reaction online database contains information (as of 1965) about suspected adverse reactions to health products. (62)

ADEs continue to be the single largest source of errors in the health care system, which continue to place patients at risk. To this day, reduction in the incidence of ADEs remains a top patient safety priority across the continuum of care. (63) To mitigate ADEs, organizations have attempted to implement various clinical tools to reduce the rate of ADEs at all care settings and during transitions of care. The tools have been designed for older patients that are identified to be at an increased risk for ADEs across the various healthcare settings. The most commonly reported tools include: 1) Classen’s trigger tool; 2) Beers Criteria; 3) Home health criteria; 4) the FORTA; 5) Stop and Start criteria; 6) Medscheck, and ‘process’ tool: 7) Med Rec, all of which were described in the next section.

1.2.7 Clinical tools and initiatives aimed to reduce ADEs

1.2.7.1 Classen’s trigger tool

In early 1990s, Classen developed a computerized methodology for detecting ADEs. (64-68) The tool used sentinel signals, referred to as triggers, identified in a patient’s medical record by customized software. Software was linked to an electronic medical record that contained
hospital pharmacy record. The fiscal and technological constraints encountered in many hospitals limit trigger tool’s applicability.

1.2.7.2 Beers criteria

Beers Criteria for Potentially Inappropriate Medication Use in Older Adults (Beers List), initially created in 1991, is a guideline for healthcare professionals to assist in improving the safety of prescribing medications for older adults. (69) It is the most commonly used criteria to assist clinicians in preventing ADEs in older adults. The list emphasizes reduction in prescribing of unnecessary drugs to reduce problems of polypharmacy and adverse drug reactions. Criteria are comprised of two comprehensive lists of medications that should be avoided in older adults, one list independent of diagnosis and the other considering the diagnosis while a third list contains medications to be used with caution. (70) Beers criteria have several limitations: 1) some relevant medications are missing and others could be taken off the list; 2) there are therapeutic duplications; and 3) some common drug-drug interactions are not addressed.

1.2.7.3 Home health criteria

Home health criteria were developed with the assistance of an expert panel specifically for use in the home healthcare setting.(71) Criteria are meant to identify home healthcare patients whose patterns of medication use, signs and symptoms provide sufficient evidence of risk of a clinically important adverse drug event to warrant patient reassessment.(71) Criteria includes four types of possible medication errors: 1) unnecessary therapeutic duplication – (i.e. concurrent use of two or more drugs from the same class); 2) possible errors for cardiovascular medications such as: poorly controlled hypertension (blood pressure 180/110, regardless of medication); orthostasis; bradycardia (pulse 55/minute and on a beta-blocker, verapamil, diltiazem, thyroxin, or digoxin); and hypotension (systolic 90, or 100 with symptoms of
dizziness, and on an antihypertensive, diuretic, or nitrate); 3) possible errors for psychotropic drugs such as: use of benzodiazepines, tricyclic antidepressants, or antipsychotics with signs of confusion or a fall in the past 3 months, or either of the latter two classes of drug with orthostasis; and 4) possible errors with nonsteroidal anti-inflammatory drugs (NSAIDs) (other than aspirin 325 mg/day) in populations at high risk of peptic ulcer complications, including persons age 80 and older or persons concurrently taking anticoagulants or oral corticosteroids.(71)

1.2.7.4 Stop and start criteria

Screening Tool in Older Persons for Potentially Inappropriate Prescriptions and Screening Tool to Alert Doctors to the Right Treatment (Stop and Start) criteria is a screening tool for older persons’ prescriptions that incorporates criteria for potentially inappropriate drugs called STOPP and criteria for potentially appropriate, indicated drugs called START.(72) The STOPP criteria contain 65 clinically significant criteria for potentially inappropriate prescribing in older persons.(73) STOPP criteria are not comprehensive, and older adults are admitted to hospitals with ADEs from medications that are not identified by the tool. The STOPP criteria have been designed for use in tandem with the START criteria. (74) START criteria consist of 22 evidence-based prescribing indicators for commonly encountered diseases in older persons. (73) Both START criteria STOPP criteria are validated and contain information regarding the more common instances of inappropriate omission of potentially beneficial medications. (73, 74)

1.2.7.5 The FORTA (Fit FOR The Aged)

The tool has been developed in Germany. (75) It identifies medications rated in four categories: 1) clear benefit; 2) proven but limited efficacy or some safety concerns; 3) questionable efficacy or safety profile, consider alternative; 4) clearly avoid and find alternative.
(75) The ratings are based on the individual patient's indication for the medication. It has been validated by panel of geriatricians, and is undergoing clinical evaluation. (75)

1.2.7.6 MedsCheck program

MedsCheck was initially launched on April 1, 2007. (76) It has been created as a medication review service created for Ontarians taking a minimum of three medications for a chronic condition. MedsCheck is a no cost to the patient service, conceptualized as a one-on-one 30-minute annual appointment with a pharmacist. (76) Goals of the program are to: 1) review medications; 2) help a patient better understand their medication therapy; 3) ensure that medications are taken as prescribed; and 4) establish a medication history. (76) The expanded MedsCheck program was launched in 2010. It was created for Ontarians who were ineligible for the original MedsCheck. (76)

The expanded programs now cover: 1) residents of licensed LTC Homes; 2) Ontarians with diabetes and 3) home-bound Ontarians who are not able to attend their community pharmacy for the service. (76) MedsCheck consultation that is provided to a patient within one-year timeframe is referred to as the MedsCheck Follow-up. The MedsCheck Follow-up builds on the annual MedsCheck and may be conducted: 1) following hospital discharge; 2) following pharmacist’s documented decision; 3) If requested by a health care professional such as: physician, registered nurse, or nurse practitioner; 4) before a planned hospital admission; and 5) following a MedsCheck for Diabetes consultation. (77)

Previous tools designed to mitigate ADEs: 1) have fiscal and technological constrains limiting their applicability; 2) are not comprehensive enough to address all drug-drug interactions; and 3) are designed for specific populations rather than to be implemented at
vulnerable moments during which patients are at an increased risk for ADEs; 3) have not been standardized for implementation across organizations and jurisdictions. (64-76)

1.2.7.7 Med Rec

Medical Reconciliation (Med Rec) is defined as the formal process of identifying comprehensive and accurate lists of medications that patients take, and using these to provide accurate medications for patients at each transition of care. (78) There are a myriad of approaches by which medication reconciliation is achieved, including: Med Rec educational approaches; Med Rec approaches using standardized Med Rec tools; pharmacists-, nurse-, or physician-and-pharmacist-led Med Rec approaches; and IT-based Med Rec approaches. Med Rec educational approaches are focused on improving patients’ knowledge of their medications. Some healthcare setting use a standardized Med Rec tool since the use of a standardized medication form facilitates an accurate list that is accessible and visible. The forms are available on the IHI and Joint Commission Web sites. Health care provider led Med Rec approaches (pharmacists-, nurse-, or physician-and-pharmacist) involve several steps such as: 1) medication history taking; 2) medication reconciliation; 3) patient counselling, including post discharge communication with the patient; and 4) communication with the outpatient providers. IT-based Med Rec approaches use an IT application that has been designed to facilitate the process; and it is integrated into the internally developed computerized provider order entry (CPOE) systems.

For a brief summary of some Med Rec approaches, please see Appendix A. Med Rec initiatives are of two distinct types: those that employ clinical tools, and those that focus on clinical processes. Table 1.1 below offers a brief summary of previously discussed tools and a process designed to mitigate the impact of ADEs among various (at risk) populations.
Table 1-1: Summary of tools used to mitigate the impact of ADEs

<table>
<thead>
<tr>
<th>Name</th>
<th>Category</th>
<th>Purpose</th>
<th>Population</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beers Criteria</td>
<td>Clinical tool</td>
<td>Guideline for healthcare professionals to assist in improving the safety of prescribing medications</td>
<td>Older adults</td>
<td>Missing relevant medications / others could be taken off the list Contains therapeutic duplications Some common drug-drug interactions are not addressed.</td>
</tr>
<tr>
<td>Home Health Criteria</td>
<td>Clinical tool</td>
<td>Identify patterns of medication use, and symptoms provide sufficient evidence of risk of a clinically important ADE to warrant reassessment</td>
<td>Home patients</td>
<td>Limited application</td>
</tr>
<tr>
<td>STOP and START criteria</td>
<td>Clinical tool</td>
<td>Screening criteria for potentially inappropriate drugs - STOPP and appropriate, indicated drugs - START</td>
<td>Older adults</td>
<td>Not comprehensive</td>
</tr>
<tr>
<td>FORTA</td>
<td>Clinical tool</td>
<td>Identifies medications rated in 4 categories: 1) clear benefit; 2) proven but limited efficacy/some safety concerns; 3) questionable efficacy or safety profile, consider alternative; 4) clearly avoid and find alternative</td>
<td>Not specified</td>
<td>German, limited generalizability</td>
</tr>
<tr>
<td>MedsCheck</td>
<td>Clinical tool</td>
<td>Conceptualized as a one-on-one 30 minute annual medication review appointment with a pharmacist</td>
<td>Ontarians taking a min of 3 medications for a chronic condition</td>
<td>Not designed for care transitions when ADEs are more likely to occur</td>
</tr>
<tr>
<td>Med Rec</td>
<td>Clinical process</td>
<td>Creates a comprehensive and accurate list of medications a patient is taking, and using that list to provide accurate medications for patient at each transition of care.</td>
<td>Patients at each transition of care</td>
<td>Time consuming</td>
</tr>
</tbody>
</table>
The following section describes how the implementation of different Med Rec approaches impacted patient safety and quality of patient care.

1.2.7.7.1 Empirical support of Med Rec approaches

Healthcare provider-assisted Med Rec approaches

In their systematic review of hospital-based Med Rec practices, Mueller et al. note that ADEs occur in up to 40 percent of hospitalized patients and in up to 17 percent of patients following hospital discharge.(79) The authors found that most pharmacist-related Med Rec initiatives effectively reduced medication discrepancies with potential to cause patient harm and decreased the incidence of preventable adverse events.(79) In the systematic review, Chhabra et al. (2012) evaluated the studies of Med Rec interventions in patients transferred to and from LTC settings.(80) Their results indicate that pharmacist-assisted Med Rec in care transitions: 1) lowered odds of discrepancy related ADEs in post-intervention group among nursing home patients returning from the hospital (adjusted OR=0.11; 95% CI=0.01-1); 2) illustrated reduction in hospital usage (RR=0.38; 95% CI=0.15-0.22); 3) demonstrated 78 percent reduction in the risk of death (adjusted hazard ratio = 0.22; 95% CI=0.06-0.88); 4) illustrated trends toward increased ambulatory care visits (adjusted incidence rate ratio=1.17; 95% CI=0.99-1.37); 5) reduced medication errors in the Med Rec group (0.53 error/patient) as compared to the control group (1.06 errors/patient); and, 6) led to an absolute increase of 10.7 percent in the proportion of patients transferred without medication errors.(80) By contrast, Gizzi et al. (2010) could not provide strong evidence of the effectiveness of a Med Rec intervention for elderly patients taking multiple medications transferred from LTC facility to hospitals.(81)

Educational Med Rec Approaches & Approaches Using a Standardized Med Rec Tool

Med Rec educational approaches and approaches using standardized Med Rec tool
demonstrated improvement in medication discrepancies (82-85) and reductions in ADEs. (86) For example, a study by Midlöv et al. described the use of a physician-generated medication report for elderly patients returning to nursing homes. The report included a brief summary of the hospitalization, medications on discharge, and detailed medication changes made during hospitalization and reasons for those changes. This intervention reduced ADEs from 8.9 percent before the intervention to 4.4 percent after the intervention ($P = .049$). (86) Gillespie et al. (2009) evaluated a comprehensive educational intervention for older patients. (87) In this randomized control trial (RCT), the pharmacist reconciled medications during hospital admission and discharge. The intervention included patient and provider medication counselling during hospitalization, as well as communication with the primary care physician on discharge, and follow-up communication with the patient 2 months following discharge.(87) This intervention reduced the odds of all hospital visits by 16 percent (odds ratio, 0.84; 95% CI, 0.72-0.99), including a 47 percent reduction in ED visits and an 80 percent reduction in drug-related readmissions in the 12 months after hospital discharge.(87) Koehler et al. (2009) reported on a similar intensive intervention but utilized pharmacy residents instead of licensed pharmacists.(88) This intervention reduced 30-day ED visits and hospital readmissions (10 percent in the intervention group versus 38.1 percent in the control group, $P = .04$).

**IT based Med Rec interventions**

Boockvar and colleagues (2011) found that implementation of IT assisted Med Rec intervention was associated with fewer ADEs caused by admission prescribing changes that were errors (adjusted odds ratio, 0.57; 95% CI, 0.33-0.98, $p=0.04$) but not with ADEs caused by all admission prescribing changes (adjusted odds ratio, 1.04; 95% CI, 0.68-1.61, $p=0.86$).(89) Showalter and al. (2011) found that implementation of standardized electronic discharge
instructions with embedded computerized medication reconciliation was not associated with a change in the primary composite outcome (adjusted OR 1.04, 95% CI 0.98–1.10) or the secondary outcome of 30-day ED visits (adjusted OR 0.98, 95% CI 0.98–1.10). There was an unexpected small but statistically significant increase in 30-day readmissions (adjusted OR 1.08, 95% CI 1.01–1.16). (90)

Past research has noted that Med Rec interventions have the potential to improve quality of patient care by ensuring the best possible medication history (which is the core of MRQA Med Rec Intervention) (50); by reducing the rate of medication discrepancies and likelihood of ADEs. Past studies have noted that Med Rec: decreased the rate of medication errors by 70 percent and reduced ADEs by over 15 percent (91); reduced potential ADEs by 80 percent; within three months of implementation (51); and intercepted 75 percent of important medication variances before any patient was harmed (92). In summary, there is substantial evidence regarding the effectiveness of Med Rec approaches in reducing the rate of ADEs and improving quality of patient care.

My review of the literature revealed a historical inattention to standardization of Med Rec that has hampered the ability to make organizational and jurisdictional comparisons of its effectiveness. In 2005, the MRQA Med Rec was developed in an effort to standardize Med Rec implementation processes and to permit comparisons across healthcare settings and jurisdictions.
1.2.7.7.2 International scope of MRQA Med Rec

Since 2006, Institute for Safe Medication Practices (ISMP) Canada has been the protocol lead for the WHO’s High 5s Med Rec Program - 'Assuring Medication Accuracy at Transitions in Care'. (93) The project is focused on continuing major concerns about patient safety around the world. The High 5s name originates from the Project's initial aims to significantly reduce the frequency of 5 challenging common patient safety problems: (1) managing concentrated injectable medicines (concentrated injectable); 2) assuring medication accuracy at transitions of care (medication reconciliation); 3) perform the correct procedure at the correct body sites (correct site surgery); 4) communicate during patient care handovers; and 5) improve hand hygiene to prevent health care-associated infections) in 5 countries over 5 years. Alongside WHO Collaborating Centre for Patient Safety, current list of participating countries includes: Australia, France, Germany, Netherlands, Singapore, Trinidad & Tobago and United States of America. (93)

High 5’s aims to enable implementation and evaluation of standardized patient safety interventions within a global community to attain measurable, substantial and sustainable reductions in patient safety problems. (93) The High 5s Project is patient safety collaboration among a group of countries and the WHO Collaborating Centre for Patient Safety in support of the WHO Patient Safety Programme. High 5s Project includes the development and application of problem-specific Standardized Operating Protocols (SOPs). SOPs entail: 1) creation of a comprehensive Impact Evaluation Strategy; 2) collection of data, reporting and analysis; and 3) the establishment of an electronic collaborative international learning community.(93) The High 5s project developed, tested, implemented and evaluated Standard Operating Protocols including this Med Rec SOP.(93) The High 5s project is currently supported by the U.S. Agency for
Healthcare Research and Quality and is coordinated by the WHO Collaborating Centre for Patient Safety, which is led by The Joint Commission and Joint Commission International. (93)

1.2.7.7.3 National scope of MRQA Med Rec

MRQA Med Rec has been a national patient safety initiative that is co-led by Canadian Patient Safety Institute (CPSI) and The Institute for Safe Medication Practices Canada (ISMP Canada), ten national organizations: 1) Accreditation Canada; 2) Canada Health Infoway; 3) Canadian Medical Association; 4) Canadian Nurses Association; 5) Canadian Patient Safety Institute; 6) Canadian Pharmacists Association; 7) Canadian Society of Hospital Pharmacists; 8) College of Family Physicians of Canada; 9) Institute for Safe Medication Practices Canada and 10) Royal College of Physicians and Surgeons of Canada created an advisory group for a National Med Rec Strategy to assist with moving forward. (94)

MRQA Med Rec was introduced into the Accreditation Canada program in 2005 as a required organizational practice (ROP), based on the recommendations of the Accreditation Canada Patient Safety Advisory Committee. (78) It arose as the resolution to patient safety problem of unintentionally initiating changes in patients' medication routines as a result of incomplete or inaccurate medication information at transitions in care. Designed as a partnership among healthcare professionals, the MRQA Med Rec intervention entails a systematic process for obtaining a medication history that is subsequently compared to medication orders at/upon transitions to identify and resolve discrepancies to prevent ADEs. (95) It ensures that upon transfers between healthcare settings, the patient medication history and medication list are revised, appropriately altered, updated and that changes are documented and properly communicated between care providers. The objective of MRQA Med Rec is to ensure that communication about medications at all transitions of care is accurate and effective.
In most Canadian provinces, the MRQA Med Rec is considered a key strategic priority for improving safety and quality of patient care related to medication. (96) National compliance with the MRQA Med Rec is met when a healthcare organization implements the intervention in two hospital client service areas: 1) at hospital admission and 2) during transfer and discharge. National healthcare organizations’ compliance with the MRQA Med Rec requirement (seen in Figure 1.7) – had a 21 percent upsurge from 61 percent (2010) to 82 percent (2012). (97) MRQA Med Rec at admission national compliance rates improved from 47 percent (2010) to 71 percent (2012). Med Rec at Transfer or Discharge compliance rates improved from 36 percent (2010) to 62 percent (2012). This indicated that national compliance rates for the MRQA Med Rec at admission, transfer and discharge improved over several years.

Recently ISMP Canada, healthcare provider organizations, and Canadian Patient Group (organization) jointly developed an interactive iPhone and iPad app, MyMedRec. (97) The app is available worldwide to support people in managing their medications safely and appropriately. It prompts patients and caregivers to have their medication and immunization records at their fingertips. It assists patients and caregivers to: compile a full list of their medications (including prescriptions, over the counter or natural health products) and to share this information with their healthcare team. The app includes features such as refill and dosage reminders, medication histories, multiple patient profiles, email and picture capabilities and contact information of
prescribers and pharmacies. (97)

Figure 1-7: Adapted from National compliance rates with the Accreditation Canada Med Rec ROPs.

1.2.7.7.4 Foundation of MRQA Med Rec - Best Possible Medication History (BPMH)

Essentially, all Med Rec interventions aim to reconcile patient medications to mitigate medication discrepancies and ADEs. The Medication Reconciliation in Alberta (MRQA) Med Rec operates under the same principles, yet it is very different from other Med Rec interventions
in several ways: 1) it is implemented across the healthcare system in Alberta including several (different) healthcare setting (acute care hospitals; long term care facilities and home care settings) whereas other Med Rec interventions have been implemented and evaluated in a ‘single’ care setting (such as several hospitals or a single hospital ward); 2) the MRQA intervention targets vulnerable moments that occur during care transitions (i.e. transfer between settings, or transfers within setting); 3) unlike other Med Rec interventions, MRQA Med Rec is not a ‘single’ provider intervention. Rather it is predicated upon a partnership among providers and caregivers, and it recognizes patients as active participants in the reconciliation process.

Past studies provided evidence that patient safety may be compromised during care transitions phases (49, 53) due to: 1) high medication error rates (98); 2) incomplete information transfer (99); and 3) lack of coordination with the next provider of care. (100) MRQA Med Rec aims to improve communication during vulnerable moments across the care continuum and has the potential to address medication discrepancies and thus reduce the rate of ADEs.

Effective communication is assured through completion of Best Possible Medication History (BPMH), the foundation of MRQA Med Rec. It entails a detailed and complete history of all regular medication use (prescribed and non-prescribed) with the following elements: 1) drug name; 2) dose; 3) frequency; and 4) route of administration for each medication that the patient is currently taking. BPMH is more comprehensive than primary medication history as it includes a systematic patient interview and verification of information with more than one source such as: 1) contacting community pharmacies; 2) review of medication vials and/or patient medication lists; 3) government medication databases, and 4) previous patient health records. (95)
The MRQA Med Rec intervention has been implemented in hospitals and LTC facilities in Canada. At each of these settings, many healthcare professionals may participate in patient medication management, which adds to the complexity, risk and exponential number of potential interfaces. (95) Following sections describe in greater detail care settings in which MRQA Med Rec intervention currently takes place.

1.2.8 MRQA Med Rec Intervention Implementation Settings

1.2.8.1.1 Acute care hospitals

Hospital care, also referred to as "acute care", is an essential part of the health care system. Hospital-based acute inpatient care is a vital component of the continuum of health services. (101) It offers critical treatment for a variety of disease or severe episodes of illness for a short period of time. The goal of acute inpatient care is to: stabilize urgent/emergency conditions, injuries and symptoms.(102) Acute care services are typically delivered by teams of health care professionals from a range of medical and surgical specialties. It may require a stay in a hospital emergency department, ambulatory surgery center, urgent care centre or other short-term stay facility, along with the assistance of diagnostic services, surgery, or follow-up outpatient care in the community. Acute care settings include but are not limited to: emergency department, intensive care, coronary care, cardiology, neonatal intensive care, and many general areas where the patient could become acutely unwell and require stabilization and transfer to another higher dependency unit for further treatment. Acute care services can be delivered in teaching (‘university’ hospital that provides clinical education and training to health professionals) and non-teaching hospitals, while the facilities where care is delivered often vary in size. (101)
The Canada Health Act warrants public funding for all medically necessary services in acute care hospitals. (103) Therefore, hospital care in Alberta remains in the quasi-public domain as hospitals are directly owned or operated by health regions, governments or large-scale non-profit societies. (101)

1.2.8.1.2 Continuing care facilities

Continuing care encompasses both long-term care and designated supportive living. (104) Presently there are a total of 24,947 continuing care beds in Alberta including: 14,768 LTC beds; 9,936 designated supportive living (DSL) beds; and 243 palliative care or hospice beds. Of the 24,947 continuing care beds: 5,258 (21%) are operated by Alberta Health System (AHS) or a regional health authority, 10,808 (43%) are run by for-profit corporations, and 8,881 (36%) are run by non-profits. (105) As per government’s definition LTC facilities include nursing homes and auxiliary hospitals, thus encompassing both residential LTC and assisted living LTC facilities.

Residential LTC facilities employ registered nurses, licensed practical nurses, and health care aides on site 24 hours a day and are regulated by Nursing Homes Act (Hospital Act) providing a range of services to significantly disabled individuals. (105, 106) Assisted-living facilities are less regulated and provide a limited number of support services to seniors with fewer disabilities.

Supportive living is meant for residents whose needs are best met living in a facility, yet who do not require the level of care available in LTC facilities. SL facilities are subject to vague standards of care that do not include minimum staffing requirements. (106) SL is subdivided into 5 categories based on the level of care required by residents, and the three most intensive are referred to as “designated supportive living.” DSL facilities are governed by a contract between
Alberta Health Services and the building operator. At these facilities, registered nurses are available on an on-call basis, and only health care aides (Level 3) or health care aides and licensed practical nurses (Level 4 and Dementia) are staffed on-site. (106)

Facility-based LTC is not an insured service under the Canada Health Act and it encompasses different services in each province and territory. (107) All provinces and territories have legislation concerning facility–based LTC. (107) LTC is considered an “extended” service, and therefore government is not obliged to provide a standard range of services. (107)

1.2.9 MRQA Med Rec in acute care settings and in the community

The following sections describe a brief overview of MRQA Med Rec intervention in acute care settings and in the community. The Figure 1.8 illustrates the MRQA Med Rec process in acute care and community. (95)

1.2.9.1 Overview of MRQA Med Rec steps in acute care and in the community

Figure 1-8: Adapted from Fernandes OA – MRQA Med Rec in acute care and in the community
1.2.9.2 **MRQA Med Rec in acute care settings**

In general, MRQA Med Rec in acute care setting is a 3 Step process (95):

*Step 1*: Create a complete and accurate Best Possible Medication History (*BPMH*) of the patients’ medication: name, dosage, route and frequency.

*Step 2*: Reconcile Medication.

*Step 3*: Document and communicate any resulting changes to medication orders to the patient, family/caregiver and to the next provider of care.

MRQA Med Rec in acute care setting should take place at admission, at internal hospital transfer and at hospital discharge.

1.2.9.2.1 **Reconciliation process at admission**

The purpose of reconciliation on admission is to ensure that there is a concise communication regarding prescriber’s decisions to change (i.e. to continue, discontinue, or modify) patient’s medication regimen upon admission. (95) The admission MRQA Med Rec processes are either: 1) proactive process 2) retroactive process.

1.2.9.2.2 **Reconciliation process at internal hospital transfer**

Internal hospital transfers are often associated with change in patient status. For instance, transfers from ward to intensive Care Unit (ICU) would signal deterioration while transfers from ICU to a ward indicate improvement. Evidence indicates that care transfers represent vulnerable moments during which patients are at an increased risk for medication errors as a result of poor communication between care teams. Past evidence suggests that: 21 percent of patients required at least one change in their transfer medication orders as a result of errors detected through the use of MRQA Med Rec tool (108); as a result of failure to review chronic medication upon transfer from ICU, 33 percent of patients ultimately had one or more of their chronic medications omitted at discharge from hospital (109).
1.2.9.2.3 Reconciliation at hospital discharge

Patients are at an increased risk for medication discrepancies during hospital discharge. At discharge it is important to reconcile the medications that the patient has been taking prior to admission, and those initiated during hospital stay, with the medications patient will be taking post-discharge. MRQA Med Rec clarifies the medication patient should be on post-discharge by reviewing: 1) patient’s BMPH; 2) alongside patient’s most current MAR (medication administration record)/medication profile and 3) new medications planned to start upon discharge. (95) A discharge MRQA Med Rec may be developed similar to the admission Med Rec form and should result in Best Possible Medication Discharge Plan (BPMDP).

For a detailed description of MRQA Med Rec steps in acute care, please refer to Appendix B.

1.2.9.3 MRQA Med Rec in the community

In contrast to the acute care setting, the community setting is a much more heterogeneous care environment. (110) For instance, patient medication management may vary, and range from patient self-management to the administration of medications on the part of nurses or by staff to whom the task has been delegated. Also, patients may shift between these environments, and regularly visit primary care providers, ambulatory clinics, or have frequent acute care admissions. Although LTC and home care are considered community care as both are outside of hospital, there is a distinctive difference in how these institutions operate, differences in their missions, differences in levels of care, and degree of autonomy with which care is administered.

As patients often have several prescribers that influence their medication management, a patient’s medication regimen in the community can be constantly changing without one distinct healthcare provider overseeing and supporting the patient through these processes. (110) Thus, every healthcare visit is a potential risk point for medication discrepancies. MRQA Med Rec
may assist health care providers in reducing the rates of medication discrepancies and aid patients to safely navigate changes to their medication schedule.

There are two specific instances when MRQA Med Rec should occur in the community (110): 1) major healthcare setting interface transitions (i.e., discharge from an acute care hospital to home) and 2) minor interface transitions (i.e., risk points where medication changes upon transition to/from a primary care physician from/to specialists/from/to LTC home).

1.2.9.3.1 MRQA Med Rec in LTC settings

LTC residents frequently experience transitions between health care settings that could result in adverse patient outcomes. (111) Incomplete and/or inaccurate medication information is a significant problem in LTC homes. Boockvar et al. (2004) noted that medication changes that occur during transfers between hospital and nursing home may be linked to discrepancy-related ADEs. (112) The findings indicated that: for 96 episodes of hospitalization, the mean number of medications altered between nursing home–to–hospital transfer documents and hospital admission orders was 3.1 (SD, 2.3; median, 3; range, 0-11) exclusive of newly prescribed medications; for 99 episodes of hospitalization, the mean number of medications altered between hospital–to–nursing home transfer documents and nursing home readmission orders was 1.4 (SD, 1.7; median, 1; range, 0-9) exclusive of newly prescribed medications. (112) Error!

ookmark not defined. Also, the study noted that ADEs that resulted in hospital readmissions occurred in 20 percent of medication changes. The overall risk of ADE per drug alteration was 4.4 percent (95 percent confidence interval, 2.5-7.4 percent). Even though most medication changes (8/14) implicated in causing ADEs occurred in the hospital, most ADEs (12/14) occurred in the nursing home following nursing home readmission. A pre-post study conducted in a consecutive sample of residents of a 514-bed, urban, not-for-profit New York’s nursing
home who were hospitalized in its primary referral hospital, and returned to the nursing home noted that Med Rec reduced discrepancy-related ADEs. (113) A survey of Alberta’s continuing care nurses and pharmacists indicated that: 75 percent of the time medication information was incomplete; 90 percent of the time information was not available in order to determine whether the prescribed drugs were appropriate for the resident’s diagnosis; and, 40 percent of the time medication information was not available at the time of resident’s admission to LTC home. (114) Further, a study by Bronskill et al. (2012) noted that nine or more drug therapies are dispensed concurrently to 10,007 (15.5 percent) of LTC home residents, which puts them at an increased risk for ADEs. (115)

In general, MRQA Med Rec in LTC setting is a 3 Step Process (110):

**Step 1**: Create a complete and accurate Best Possible Medication History (BPMH) of resident’s medication.

**Step 2**: Reconcile Medication.

**Step 3**: Document and communicate any resulting changes in medication orders to the relevant providers of care and resident or family member whenever possible.

MRQA LTC Med Rec should take place at LTC admission, at internal transfer and at discharge or external transfer.

1.2.9.3.1.1 Reconciliation at LTC admission

Upon admission, it is important to identify which residents should receive an in-depth BPMH, in what timeframe, and how to go about obtaining the BPMH. (95, 110) Safer Healthcare Now recommends for Med Rec to occur within 24 hours of admission, nonetheless each facility should decide what the best practice is for them. Similar to MRQA Med Rec in acute care, LTC Admission MRQA Med Rec processes generally fit into two models: 1) proactive; and 2) retroactive processes. (95)
1.2.9.3.1.2 Reconciliation at internal transfer

The transfer occurs within the facility when there is a change in resident’s level of care or transitions when facility requires medications to be re-ordered. If MRQA Med Rec took place during LTC admission, then the ‘most current medication list’ becomes the BPMH. MRQA Med Rec at internal transfer encompasses comparing the new transfer orders with the most current medication list from the transferring unit and resolving any unintentional or undocumented discrepancies.

1.2.9.3.1.3 Reconciliation at discharge/external transfer

LTC residents may be transferred externally to acute care for medical intervention. External transfer is defined as discharge usually if the length of stay in acute care is more than 21 days or if the resident is not expected to return. Medications should be reconciled upon admission to acute care and again upon return to LTC facility. The list should be concisely communicated to the next provider of care and to the resident/family members. It should be sent in a timely manner and be transferred when possible, along with the resident to the receiving facility.

For a detailed description of MRQA Med Rec steps in LTC, please refer to Appendix C.

Medication discrepancies leading to ADEs occur frequently at care transitions and may result in adverse patient outcomes, such as ADE related ED visits and ADE related hospitalizations. In Canada 20% of patients discharged from hospitals experience an adverse event, and of those, 66% are drug-related. (116) The total cost of preventable, drug-related hospitalizations is close to $2.6 billion per year. (116) Med Rec has been recognised as a major intervention tackling the burden of medication discrepancies and subsequent patient harm at care transitions. It has been proven as a cost-effective intervention of over 60% by a quality-adjusted life year value of $20,000 CAD. (117) Yet, its impact on healthcare utilization in Canadian
context has not been examined. MRQA Med Rec is a required organizational practice in Alberta. Thus, evaluation of MRQA Med Rec impact in Alberta’s acute care hospitals and LTC facilities was a natural starting point. Further, recognizing that resources, infrastructure, and process changes may pose challenges for the successful implementation of MRQA Med Rec, it was important to understand organizational factors that may impact implementation of this intervention.

1.3 Summary

Previous studies have estimated that up to 25 percent of all hospital admissions and emergency department (ED) visits are drug-related. (118, 119) Transitions of care, like hospital admission and discharge, contribute to ADEs through undocumented medication discrepancies and unintentional medication discrepancies. Medication discrepancies are defined as unexplained differences in documented medication regimens across different settings of care. Evidence indicates that such discrepancies are common, occurring in up to 70 percent of patients at hospital admission or discharge. (49, 50, 120) The literature suggests that about one-third of these have the potential to cause patient harm and are associated: 1) with ED visits in the 30 days post-discharge period; 2) may lead to ED visits; 3) may lead to hospital readmissions; and 4) use of other health care resources. (121, 122)

In Alberta, Medication Reconciliation Alberta (MRQA Med Rec) has been concurrently implemented in hospitals and continuing care facilities with the aim of enhancing medication safety. In studies from other jurisdictions, it has been demonstrated that Med Rec interventions similar to the MRQA Med Rec reduced medication discrepancies, thus reducing the probability of ADEs (79). However, these studies were focused on evaluation of Med Rec interventions implemented at a single hospital (ward) (123) or multiple wards (124); and/or for selected (often
described as high risk) patient population (87, 125) limiting the generalizability of their findings. Past literature calls for studies of Med Rec interventions at the system-level to address this research gap. Findings from this study could offer new insights into the extent of variation in MRQA Med Rec across care institutions, and the organizational factors associated with its effectiveness across care settings.

1.3.1 General Thesis Description

The reviewed literature suggests that ADEs have been associated with adverse patient outcomes and increased health system utilization in a variety of health care settings. Research has demonstrated that Med Rec interventions have the potential to improve quality of patient care by: 1) reducing the rate of medication discrepancies and likelihood of ADEs; 2) significantly reducing the rate of medication errors; and 3) flagging important medication variances before any patient is harmed. Yet Med Rec interventions have often been misperceived as a superficial administrative accounting task with a "pre-occupation with completing forms" resulting in the implementation of ineffective processes. (126) Finally, evidence suggests that some organizational factors may impact the implementation of Med Rec interventions and organizational effectiveness in achievement of desired outcomes.

MRQA Med Rec arose as the solution to the well-documented patient safety problem of unintentionally introducing changes in patients’ medication regimens as a result of incomplete or inaccurate medication information. (95) Although MRQA Med Rec operates under the same principles, it is very different from other Med Rec interventions in several ways: 1) it is implemented across healthcare system in Alberta including various healthcare setting (acute care hospitals; LTC facilities and home care settings) whereas other Med Rec interventions have been implemented and evaluated in a ‘single’ healthcare setting (such as 3 hospitals or a single
hospital ward; a single LTC facility); 2) the MRQA intervention targets vulnerable moments that occur during care transitions (i.e. transfer between settings, or transfers within setting); 3) unlike other Med Rec interventions, MRQA Med Rec is not a ‘single’ provider intervention. Rather it is predicated upon a partnership among providers and caregivers, and it recognizes patients as active participants in the reconciliation process.

The MRQA Med Rec at admission process was selected as the focus of this project because: it is the first step of interaction with the patient; it may be considered a ‘phased-in’ approach that could facilitate any subsequent MRQA Med Rec processes as patients’ BPMH has already been created; may avoid the complexities of the discharge process; and finally, as Accreditation Canada’s MRQA Med Rec quality indicator used to evaluate medication reconciliation process has been focused on admission. This means that hospitals evaluate the medication reconciliation process by measuring the total number of patients with medication reconciled as a proportion of the total number of patients admitted to the hospital. Hospitals that reach 100% medication reconciliation at admission are strongly encourage to examine the quality of the reconciliation process and/or move on to the next stage of reconciliation: at transfer or discharge.

This dissertation took a more systemic approach to evaluation of the MRQA Med Rec at it was focused on evaluation of intervention’s impact in acute care hospitals and LTC facilities in Alberta. Typically, Med Rec evaluation studies are performed at a single hospital (ward)(82) or multiple wards(124); and/or for selected (often described as high risk) patient population.(87, 127)

The reason being that MRQA Med Rec may operate on similar principles as other Med Rec interventions, yet its context tailored mechanisms implemented across distinct healthcare settings
make it exceptionally unique. Findings from this study could offer new insights into the extent of variation in MRQA Med Rec across care institutions, and the organizational factors associated with its effectiveness across care settings.

Through the application of Accident Causation Model, the study was designed: to assist in understanding if implementation of MRQA’s Med Rec intervention had any impact on ADEs related health system utilization (ADE related ED visits and hospitalizations) across Alberta’s healthcare settings; to evaluate the potential relationship between organizational factors and MRQA Med Rec effectiveness across care settings; and to assess the consistency of intervention implementation.

1.3.1.1 Thesis Objectives

The primary objective of this thesis was to evaluate the effectiveness of MRQA Med Rec at admission in two care settings in the Province of Alberta: acute care hospitals and LTC facilities. Secondary objectives were to:

1. Characterize Alberta’s healthcare institutions participating in the intervention and compare with non-participating institutions to assess if there are statistically significant differences between two groups.

2. Evaluate the impact of the MRQA Med Rec intervention in acute care hospital units and LTC facilities in Alberta on ADE related ED visits and hospitalizations.

3. Determine the consistency of MRQA Med Rec implementation by assessing the Quality Audit Bundle Compliance at Admission, intervention’s fidelity measure. This measure was utilized to assess whether the intervention has been implemented according to the proposed model and to assure policy-makers that services are being implemented as intended and are reaching the target audience.
4. Determine if there were between and within setting differences regarding the effectiveness of MRQA Med Rec intervention.

5. Identify and examine organizational factors that could potentially explain the relationship between intervention and outcome.

To achieve these research objectives, a retrospective cohort study using generalized linear mixed models was conducted.

1.3.1.2 Thesis project framework

The associations between the intervention and outcomes are described in the Thesis Project Framework in Figure 1.9. The framework linked concepts of Accident Causation Model (ACM). ACM notes that both active and latent failures are responsible for the occurrence of ADE related ED visits and hospitalizations. Active failures, such as not checking name, dose, strength and route of each medication, may be considered directly responsible for ADE. Latent failures, such as hospitals' teaching status, may not be directly responsible for ADE. They are considered contributing factors to active failures and ADEs. The Thesis project framework illustrated that latent failures such as teaching status may impact the implementation of an intervention through a fidelity measure such as Quality Audit Bundle at Admission (fidelity measures) and thus indirectly contribute to an ADE related ED visit.
Chapter 2: Extant Theory and Research of Relevance to Patient Safety

2.1 Accident Causation Model (Swiss cheese Model of System Failure)

2.1.1 Rationale for the Conceptual model

The dominant conceptual model used in health services research in studies of patient safety is the Accident Causation Model, popularly referred to as the “Swiss Cheese Model of System Failure”. The Accident Causation Model originated with J. Reason. (128, 129) Its popularity lies in its broad applicability to patient safety phenomena in an array of care settings; it is an
appropriate model for studying the MRQA Med Rec intervention, since MRQA Med Rec intervention could impact ADE related ED visits and hospitalization by breaking the cycle of active and latent failures.

2.1.1.1 General description of Accident causation model

The model follows the system error approach. The basic premise in the system approach is that humans are fallible and errors are to be expected. Errors are perceived as consequences rather than causes with origins in systemic factors. In an ideal world any system would consist of a series of intact defensive layers. In reality, layers are more like slices of Swiss cheese (seen in Figure 2.1), with many holes that are continually opening, shutting, and shifting their location. (128) For a disastrous event to occur the holes need to align for each step in the process. When layers are set up with all the holes lined up, system becomes inherently flawed and this permits a problem at the beginning to progress all the way through to adversely affect the outcome. (128) The alignment of holes defeats all defenses and results in an ADE. Each slice of cheese is an opportunity to stop an error and the more defenses one puts up, the more likely an error will not occur. Further, the fewer the holes and the smaller the holes, the more likely errors will be prevented. (128)

Generally speaking, there are two broad categories of unsafe acts (active failures): 1) unintended; and 2) (usually) deliberate. Unintended failures take a variety of forms such as: 1) slips; 2) lapses; 3) fumbles; 4) mistakes. (128) Unintended failures may occur when the adequate plan of actions is: 1) executed in the wrong order; 2) executed in relation to the wrong objects; 3) poorly timed; 4) clumsily executed. (128) Deliberate active failures are violations, defined as the intentional deviations from safe operating procedures, recommended practices, rules or standards. Violations can be: 1) routine and 2) necessary (situational). Routine violations,
frequently promoted by indifferent environment, may involve cutting corners in order to take the path of least effort between task related points. Even though routine violations occur at the skill-based level of performance, occasionally they may become a part of one’s repertoire of largely automatic actions. Situational violation is a non-compliance that is committed simply in order to get a particular job done. Active failures (128) are summarized in Table 2.1.

**Table 2-1: Summary of active failures**

<table>
<thead>
<tr>
<th>Forms</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slips</td>
<td>Skill-based errors &amp; Execution Failures during well-practiced tasks</td>
</tr>
<tr>
<td></td>
<td>Breakdowns in the planned execution of an observable action sequence as a result of an interruption/disturbance</td>
</tr>
<tr>
<td>Lapses</td>
<td>Memory failures resulting in the failed implementation of a plan</td>
</tr>
<tr>
<td>Fumbles</td>
<td>Incompetently executed plan of action</td>
</tr>
<tr>
<td>Mistakes</td>
<td>Rule-based</td>
</tr>
<tr>
<td></td>
<td>Rule based mistakes that occur during problem solving when the wrong rule is applied/selected, or applied incorrectly</td>
</tr>
<tr>
<td></td>
<td>Knowledge-based</td>
</tr>
<tr>
<td></td>
<td>Knowledge-based mistakes result from similar processes: incomplete/incorrect knowledge; flawed analytical processes or incorrect application of the knowledge.</td>
</tr>
<tr>
<td>Violations</td>
<td>Routine</td>
</tr>
<tr>
<td></td>
<td>Repetitively avoiding to reconcile patient’s medication after internal hospital transfer to reduce workload.</td>
</tr>
<tr>
<td></td>
<td>Necessary (situational)</td>
</tr>
<tr>
<td></td>
<td>Not reconciling patient’s medications at hospital admission from ED during crowded shifts to speed up the process.</td>
</tr>
</tbody>
</table>

What makes this model particularly useful in investigating ADEs is that investigators are required to address latent failures within the causal sequence of events. The concept of latent failures refers to the contributory factors in the system that may lay dormant for a long time until they finally contribute to the accident. (128) Latent conditions can translate into error provoking
conditions within the local workplace (i.e. understaffing, changes in ownership of facilities) and they can create long-lasting holes or weaknesses in the defenses (unworkable procedures, design and organizational deficiencies). Unlike active failures, whose specific forms are often hard to foresee, latent conditions can be identified and remedied before an adverse event occurs. (128) Even though the layers appear compartmentalized, each layer and level impacts the next. (Seen in Figure 2.1) (128).

**Figure 2-1:** Adapted from Human Factor analysis - Accident Causation framework illustrating Active and Latent Failures

The framework perceives human systems as multiple slices of Swiss cheese, stacked together, side by side. (seen in Figure 2.2) (130) The holes in the Swiss cheese slices represent distinct vulnerabilities in parts of the system, and are continually varying in size and position in all slices. Some holes result from active failures, while others are due to latent conditions.
2.1.1.2 Accident causation model and MRQA Med Rec

The accident causation model indicates that to varying degrees every step in MRQA Med Rec process has the potential for failure. The holes represent opportunities for a process to fail, and each of the slices denote defensive layers in the process. An error may allow a problem to pass through a hole in one layer, but in the next layer Med Rec intervention could rearrange the holes in different places and the errors could be detected. Therefore, subsequent layers are defense against potential error affecting health outcomes. (128)
2.1.1.3 **Active failures**

In the context of MRQA Med Rec, an unintentional discrepancy (medication error) is an example of an unsafe act. The medication error could be a result of a skills based error; rule-based mistake or situational violation. Regardless of the underlying mechanism of action, a medication error may result in an ADE that could impact patient safety and clinical outcomes.

2.1.1.4 **Latent failures**

In the context of MRQA Med Rec *pre-conditions for unsafe acts* could be perceived as conditions such as: 1) mental fatigue of health care professionals due to reduced nurse to patient ratio; 2) lack of communication regarding changes in patient’s medication regimen, between health care professionals in the patient circle of care as well as between health care professionals patient and family; and 3) undocumented care coordination in care settings. Unsafe supervision could be perceived as a trigger responsible for poor communication and breakdown of care coordination. For example, uninformed caregivers might be unfamiliar with changes such as alternations to patient’s list of medication delivery. Also, dosing errors and synergistic drug effects could result from lack of documentation of new and discontinued medication.

Organizational influences can also impact organization’s effectiveness and performance at all levels. (128) For instance, in times of fiscal austerity, funding is often cut and as a result, there may be a reduction in nurse to patient ratios (changes to staffing intensity).

In order for MRQA Med Rec to have an impact on ADEs, active and latent failures need to be identified by health care professionals, patients and their caregivers across the various care transitions points. Organizational factors must be addressed if any prevention system is going to succeed. One needs to know what these system failures or "holes" are to develop mitigating strategies to close the “holes”.
Figure 2.3 (128) illustrates the potential mechanisms by which MRQA Med Rec intervention can break the cycle of active and latent failures such as: when at hospital discharge prescriber obtains patient’s Best Possible Medication Discharge Plan that contains Best possible medication history (BPMH), patient’s most current MAR (medication administration record)/medication profile and new medications planned to start upon discharge; when pharmacist reviews patient Best possible medication discharge (BPMDP) plan that contains patient allergy status; and when nurse prior to administering the drug evaluates patient’s BPMH that clearly illustrates the medication patient is allergic to.

Figure 2-3: Adapted from Patient Safety Quality Improvement

2.2 Organizations and performance

In addition to the theoretical/conceptual work discussed above that focusses exclusively on understanding patient safety phenomena including ADEs, research in the field of organization
theory on organizational effectiveness also stands to enhance our understanding the influence on patient safety of factors at the organizational and extra-organizational levels.

2.2.1 Organizational effectiveness

Organizations are formed to achieve goals that are beyond the capacity of an individual. (131) Healthcare organizations aim to provide acute, rehabilitative, or restorative high quality care in order to assist people in maintaining or improving their health status and quality of life. (131) Generally speaking, goal attainment necessitates the coordination of many highly specialized disciplines that must work together seamlessly. This is particularly true for healthcare organizations such as hospitals and LTC facilities, where the complexity of tasks carried out in the provision of services require the coordination of workers with different skills to deliver care safely and appropriately. (131)

Safety and effectiveness are central to quality of care. As mentioned previously, effective care produces intended results (organization’s goals), such as reduction in rate of ADEs. (132) Safe care has been defined as the reduction and mitigation of unsafe acts within the health care system. (132) One important indicator of patient safety is the rate of ADEs among hospital patients. (53) Thus, one way to measure patient safety is to examine the impact of patient safety initiatives (such as MRQA Med Rec) on safety outcomes, such as ADE related ED visits and ADE related hospitalizations.

Organizational effectiveness, as discussed in the organization theory literature, takes into account a range of variables at the organizational and departmental levels. (133) There are several approaches to measuring organizational effectiveness, with the most widely used being the goal approach. (133) Using the goal approach, I identified organization’s output goals and evaluated how the extent to which the health care organizations on which I focused, have
achieved their stated goals with respect to organizational effectiveness and patient safety. This is the appropriate approach as organizations attempt to attain certain levels of outputs, or quality of care. (133)

In health care organizations, such as hospitals, organizational goals that drive the adoption of initiatives such as MRQA Med Rec will include those focusing on patient safety. (133) In other words, MRQA Med Rec intervention introduces processes that are intended to achieve patient safety goals, hence, e.g. through reducing the number of medication discrepancies and the likelihood of ADEs related ED visits and hospitalization.

2.2.1.1 Factors that impact organization effectiveness

In the context of the MRQA Med Rec intervention, as with any practice change initiative, organizational characteristics, or organizational-contextual factors, can facilitate or impede successful goal attainment. Past research highlights a plethora of contextual factors including: staffing intensity, funding, ownership and delivery of services, facility’s age, teaching status, facility’s size, accreditation status - across an array of healthcare settings that could influence organizational effectiveness.

2.2.1.1.1 Staffing intensity

One of the most common proxy measures of care quality is staffing levels. Higher nursing home and nurse staffing levels in hospitals have been associated with improved patient care and outcomes. (134-138) McHugh and Swain compared reported staffing levels for stroke care within UK in-patient stroke units to stroke strategy staffing guidelines published by the UK Department of Health and the Royal College of Physicians. (139) Authors reported that low staffing levels were associated with suboptimal functional recovery for stroke patients in stroke units. (139) An observational study by Bray et al examined the association between
stroke mortality and weekend working by stroke specialist physicians and registered nurses.(140) The findings indicate that higher nursing ratios – three nurses per ten beds – were associated with a significantly reduced risk of death, and lower nursing ratios – 1.5 nurses per ten beds – with a higher risk of death. Additionally, the findings indicate that below-average nurse/bed ratio was associated with as much as a 35% increased risk of death.(140) An observational cross-sectional study by Tubbs-Cooley et al examined the association between nurse staffing ratios and hospital readmission among children admitted for common conditions.(141) Findings indicated that: each one-patient increase in a hospital's average paediatric staffing ratio increased a medical child's odds of readmission within 15-30 days by a factor of 1.11, or by 11% (95% CI 1.02 to 1.20) and a surgical child's likelihood of readmission within 15-30 days by a factor of 1.48, or by 48% (95% CI 1.27 to 1.73). In summary, children treated in hospitals with paediatric staffing ratios of 1:4 or less were significantly less likely to be readmitted within 15-30 days. Yet, there were no significant effects of nurse staffing ratios on readmissions within 14 days. (141)

In a cross-sectional study of 37 nursing home Bates-Jensen and colleagues evaluated the effect of staffing level on time observed in bed during the daytime in nursing home (NH) residents. In multivariate analyses, staffing level remained the strongest predictor of time observed in bed after controlling for resident functional measures (odds ratio=4.89; P=.042).(135) Collier and Harrington synthesized literature on staffing levels, turnover, and quality of care in nursing homes and concluded that higher staffing levels, less turnover, and higher retention rates are associated with an array of improved resident and facility outcomes.(136) Weech-Maldonado et al. looked at use of physical restraints incidence or worsening of pressure ulcers, cognitive decline, and mood decline and whether these were affected by staffing patterns across nursing homes (n=1200). The authors determined that staffing patterns were found to
affect quality of patient care both directly and indirectly through their positive effect on the processes of delivering care. (136)

Castle and Myers examined the association between caregiver staffing levels and mental health outcomes in 17,000 U.S. nursing homes. (142) The focus was on deficiency citations available in the Center for Medicare and Medicaid Services' Online Survey, Certification, And Recording data. Authors examined nurse aide (NA), licensed practical nurse (LPN), registered nurse, and mental health provider staffing. The results showed that the level of nursing staff matter with respect to mental health outcomes. Whereas greater RN staffing was associated with a lower likelihood of being cited for deficiencies in mental health care, greater LPN and NA staffing were associated with a higher likelihood of being cited for deficiencies. Results indicated no association between mental health provider staffing levels and mental health outcomes. (142) In a retrospective panel data study (1999-2003) of 2 groups of California freestanding nursing homes [Group 1 - 201 nursing homes that consistently met the state's minimum standard for total nurse staffing level over the 5-year period. Group 2 - 210 nursing homes that consistently failed to meet the standard over the period.] Kim et al. examined the relationship between registered nurse (RN) staffing mix and quality of nursing home care measured by regulatory violations. The results indicated that a higher RN mix is positively related to quality of care, but the relationship is affected by overall nurse staffing levels in nursing homes. (143) Tully et colleagues (2009) showed that reductions in staffing intensity have been associated with occurrences of ADEs in hospitalized patients and workload was found to be the strongest predictor of error identification rates, with 40% (33-46%) less errors identified on the busiest days than at other time. (144) In a systematic review Keers and al. (2013) found that increasing staffing workload is an underlying systems factors crucial to the occurrence of
medication errors. (145) In eight studies, heavy staff workload appeared to be an important contributor to ADRs, and included end of shift/patient transfer pressures, patient load and multitasking. In two studies, workload combined with distractions resulted in intravenous administration errors. In four studies, workload combined with patient acuity, inexperience or local working practice led to other ADEs. In six studies, lack of qualified staff and working with inexperienced or new staff members contributed to ADEs. Short staffing was reported by six studies as a cause of ADEs. (145)

Therefore, considering the mix of available evidence which includes some studies suggesting an association between staffing levels and goal attainment relating to care quality in both LTC and hospital settings, it is important to examine the association of staffing intensity with the attainment of goals relating to MRQA Med Rec.

2.2.1.1.2 Funding and delivery of services

Past literature has determined that funding and delivery of services are associated with staffing differences and quality of patient care. Numerous studies have found that publicly funded facilities have higher nurse staffing levels than for-profit facilities and a link between for-profit ownership and inferior quality in LTC facilities.(146-149) In 2005 Berta et al. analyzed Statistics Canada’s Residential Care Facilities Survey (included all residential care facilities every year since 1974 for the period between 1996 and 2002) and reported that privately funded facilities had significantly lower levels of direct-care staff than both non-profit and public facilities.(147) Hillmer et al. (2005) conducted a systematic review and determined that residents of privately funded nursing homes were less likely to be recipients of good quality compared to similar residents in not-for-profit facilities.(148) Quality was measured by assessing: 1) structure quality indicators (measures of staffing) including: nursing aide turnover and number of staff
members; 2) process-based indicators: inappropriate use of restraints, federal audit deficiencies for the use of restraints, rate of catheterization, rate of tube feeding, inappropriate use of psychoactive medications, percentage of residents who are not toileted, and the percentage of residents with advance directives; and 3) outcome quality indicators: mortality, infections, pressure ulcers, hospitalizations, functional ability, incontinence, dehydration, accidents, weight change, and contracture. Authors concluded that publicly funded facilities had a higher staff-skill mix and lower staff turnover compared with for-profit facilities. With respect to process quality measures, the authors reported that, with one exception, all comparisons favoured non-profit care delivery. (148) A review by Comondore et al. (2009) illustrated that non-profit facilities had, on average, significantly higher staffing levels and a lower frequency of pressure ulcers. Authors illustrated a trend among non-profit facilities toward less use of physical restraints and fewer deficiency citations. (149)

2.2.1.1.3 Ownership

Prior research found ownership to be an important factor in predicting quality of care in nursing home facilities. Harrington et al. examined whether investor ownership affects quality of care in nursing home facilities. (150) Results indicate that investor-owned facilities averaged 5.89 deficiencies per home, 46.5 percent higher than non-profit facilities and 43.0 percent higher than public facilities. In multivariate analysis, investor ownership predicted 0.679 additional deficiencies per home; and chain ownership predicted an additional 0.633 deficiencies. Nurse staffing was lower at investor-owned nursing homes. In summary, investor-owned nursing homes provided worse care and less nursing care than do not-for-profit or public homes.

Previous literature implies that the variation in the quality of care between for-profit and non-profit facilities results from lower staffing levels in for-profit facilities. Staffing differences
between for-profit and non-profit facilities are one of the most consistent findings in the literature; numerous studies have found that non-profit and publicly owned facilities have higher nurse staffing levels than for-profit facilities. (151) However, a study conducted in Manitoba reported no apparent differences in nursing staff levels between for-profit and not-for-profit facilities. (152)

In a Pan-Canadian study of institutional LTC homes, Berta et al. observed that LTC’s number of beds varies by institutional type. Thus, some institutional types tend to be bigger than others. Government owned facilities (mean facility size of 77 LTC beds) tend to be significantly larger than for-profit and non-profit facilities. Facilities owned by religious organizations (mean size of 74 beds) are significantly larger than for-profits (mean size of 50 beds) and not-for-profits (mean size of 30 beds). (153)

As noted in 2006 by Berta et al., the government owned about 40 percent of LTC facilities in Alberta. (147) Alberta has seen a 6 percent increase in for-profit LTC beds between 2000 and 2007. (154) Therefore considering the growing trend of for-profit LTC beds, the potential link between quality of care, staffing levels and ownership it is relevant to determine whether ownership status impacts MRQA Med Rec effectiveness.

2.2.1.1.4 Hospitals’ age

Numerous studies (155-157) have linked hospital structure with its performance outcomes. For example, it was noted that there are particular hospital design features that contribute to patient safety such as: 1) hospital wide air filtration system that includes central HEPA filters; 2) airflow systems in which clean air passes the patient and is recycled and filtered again; and 3) a radiant heat panel above or below every patient window to eliminate condensation. Some of these are not available or are not functioning properly in MRQA Med
Rec participating hospitals as it was reported in 2014 that structural problems “plague” Alberta’s hospitals. (158)

Many of Alberta’s hospitals have been experiencing structural breakdowns that put extra pressure on staff (fatigue has been identified as a contributing factor to human error (159)), compromise patient care, and make it difficult to keep the facilities running at full capacity.(158) Report (2014) noted that most of these older buildings (30% of Alberta’s hospitals are over 40 years old, and 75% are 30 years old) have had varying degrees of renovations and upgrades at one time or another.(158) Yet, for many of the key building components: the elevators, boilers, pipes and electrical system — are original. For instance, St. Paul’s hospital (participating in MRQA Med Rec) has had a plastic sheet fastened to the ceiling for over 9 months, due to a leak leading to inadequate drainage — all of which can be breeding grounds for bacteria. Considering the varying degree of structural ‘interruptions’ in MRQA Med Rec participating hospitals, I thought it was relevant to assess if there is any association between hospital structure (assuming that degree of structural ‘interruptions’ is positively associated with building’s age, which is what typically happens with any structure) and implementation of MRQA Med Rec intervention.

2.2.1.1.5 Hospitals’ size

Research has demonstrated that there is an association between the size of the hospital and rate of ADE related hospitalizations, and larger hospital generally experience higher volumes of ADE related hospitalizations.(160) To illustrate variations in number of ADEs based on the size of the hospital, Agency for Healthcare Research and Quality (161) reported that in 2011: small hospitals experienced 2,079,286 ADE related events; medium size hospitals experienced 4,866,452 ADE related events and large size hospitals experienced 13,075,587 ADE
related events.(160) Even premiums for hospital malpractice insurance policies are often based on number of beds, thus reflecting how the number of patients "exposed"(162) varies by the size of the hospital.

Research showed that higher volume is associated with better outcomes for major surgeries and cardiovascular procedures (163); but no relationship between volume and outcomes for chronic obstructive pulmonary disease (COPD) (164); and for hospitals with a high volume of pneumonia patients actually had both worse performances on process measures and worse clinical outcomes than hospitals with a lower volume of pneumonia patients (165). Considering that MRQA Med Rec has concurrently been implemented across small, medium and large hospitals (as defined by number of beds) it was important to determine whether size of the hospital has any impact on outcomes.

2.2.1.6 Hospital’s teaching status

There is a discrepancy in the literature around the impact of teaching hospitals status on rates of preventable ADEs. Some studies of quality of care suggest that quality is higher in teaching hospitals than in non-teaching hospitals(166) including the Harvard Medical Practice study (chart-abstracted data) that found lower rates of ADEs in teaching hospitals(58) while others found inconsistent relationship between teaching status and preventable ADEs(167, 168) or found increased rates of ADEs in teaching hospitals.(168) As a result of inconsistencies in evidence with regards to association between teaching status and rates of ADEs, it was important to evaluate whether hospital’s teaching status has any impact on the implementation of MRQA Med Rec.
2.2.1.1.7 Number of beds in LTC facility

A number of studies found the size of the facility (as defined by number of beds) to be associated with patient outcomes. Aaronson and colleagues (1994) reported significantly higher prevalence rates for pressure ulcers in larger nursing home facilities. (146) To control for potential endogeneity among system variables, authors applied a simultaneous equation model, with model parameters estimated using 3SLS. (146) In a study, Schnelle and colleagues (2004) noted the association between staffing intensity and number of beds, illustrating that smallest LTC facilities experienced the highest staffing intensity. (169) The authors also noted that large LTC facilities had more staff than medium size LTC facilities. (169) Tanuseputro and al. (2015) examined how the size of nursing homes affects rates of death and hospitalization. (170) In assessing residents six months after admission, the authors found that those in homes with at least 150 beds (larger homes) had a 30 per cent lower rate of death but 61 per cent higher rate of hospitalization when compared to facilities with up to 49 beds (smaller beds). (170)

2.2.1.1.8 LTC Accreditation

Accreditation process is undertaken by LTC facilities and awarded to those that demonstrate they meet the standards. The accreditation process is voluntary and the standards are focused on five key elements of service excellence: 1) clinical leadership; 2) people; 3) process; 4) information; and 5) performance. LTC accreditation has been associated with patient safety outcomes and it has been shown that accreditation programs improve the process of care provided by healthcare services. Studies on accreditation in the LTC setting noted more favourable relationships between facility accreditation and patient outcomes such as all cause hospitalization. (171) In a systematic review Alkhenizan et al. found consistent evidence that shows that accreditation programs improve the process of care provided by healthcare
services. Kang et al. (2011) found that residents in non-accredited facilities were more likely to experience hospitalization (odds ratio [OR] = 1.50, 95% confidence interval [CI] = 1.16-1.94). Yet a study by McDonald et al. found accreditation to be associated with some patient outcomes (accreditation was associated with a lower occurrence of falls for LTC residents) but not with others (pressure ulcers, infections, restraints and catheters). The inconsistencies in results between studies and the range of differences that may exist in accreditation programs suggest that impact of accreditation on patient outcomes may be best assessed in region-specific context.

2.2.1.2 Fidelity of implementation

Generally speaking, the fidelity of implementation means that an intervention was being implemented as intended by the researchers, developers or policy makers. The fidelity of implementation consists of key elements: 1) adherence; 2) exposure/duration; and 3) quality of delivery. Appropriate adherence is achieved by following the instructional procedures as intended and by implementing all components of the intervention in the correct order. Exposure/duration means that the intervention was implemented for a pre-specified length of session (e.g., 30 minutes); or pre-specified duration (e.g., 4 weeks); or with a pre-specified frequency (e.g., daily). Lastly, the quality of delivery stands for delivery of the intervention using good teacher practices (e.g., providing time for staff questions and feedback, managing transitions well). Implementing an intervention with fidelity increases the likelihood that the intervention will lead to intended outcomes.
Chapter 3: MRQA Med Rec in Alberta’s healthcare facilities

Abstract

Background: A growing amount of evidence suggests that adverse drug events (ADEs) in Canadian healthcare settings are frequent and result in substantial patient harm. Medication Reconciliation (MRQA Med Rec) was introduced in Alberta’s acute care units and long term care (LTC) facilities through an initiative co-led by Safer Healthcare Now, Canadian Patient Safety Institute (CPSI) and Institute of Safe Medical Practice (ISMP). Implementation of MRQA Med Rec has the potential to reduce ADE-related healthcare utilization by ensuring that all medication changes are accurately documented.

Objective: The objective of the study was to characterize Alberta’s healthcare institutions participating in the MRQA Med Rec at admission and compare with non-participating institutions.

Study population: Cohort included Alberta’s acute care hospital units and LTC facilities, participating in the initiative as of June 2014.

Data collection: Institutional characteristics (administrative data) that were acquired from Guide to Canadian Health facilities database and MRQA Med Rec dataset. Data was linked for the period between June 1st 2013 and March 31st, 2015, using unique facility identifier.

Methods: Continuous variables were described with measures of central tendency and dispersion and categorical variables were described using contingency tables.

Results: Alberta has 328 healthcare facilities, whereas 116 healthcare facilities have implemented the intervention. MRQA Med Rec participating facilities included: hospitals (n=52); hospice (n=1) and LTC facilities (n=63). The ownership categories of 116 facilities included: lay organization (n=1); provincial government (n=2); and regional authority board (n=113). Results illustrated that Alberta’s proprietary LTC facilities are currently not participating in MRQA Med Rec evaluation study.

Conclusions: Alberta contains various categories of health care facilities, yet not all have implemented the MRQA Med Rec intervention. Generalizability of results relating to implementation would be enhanced were more facilities to participate in the intervention.
3.1 Introduction

Medication discrepancies leading to adverse drug events (ADEs) occur frequently at care transitions may result in adverse patient outcomes, such as ADE related hospitalizations. MRQA Med Rec was introduced in Alberta through an initiative co-led by Safer Healthcare Now, Canadian Patient Safety Institute (CPSI) and Institute of Safe Medical Practice (ISMP) to alleviate the impact of ADEs. (78, 95, 96) It involves a systematic and comprehensive review of all the medications a patient is taking to guarantee that medications being added, changed or discontinued are carefully assessed and documented. MRQA Med Rec ensures health care providers collaborate with patients, families and care providers to ensure accurate and comprehensive medication information is communicated consistently across transitions of care. Based on evidence for its positive impact, MRQA Med Rec has been considered as required organizational practice (ROP) by hospital accreditation authorities across Canada. (78, 95, 96)

MRQA Med Rec was introduced in Alberta’s acute care and in the community setting, more specifically in LTC facilities. In contrast to the acute care setting, the community setting is a much more heterogeneous care environment: 1) patient medication management may vary, and range from patient self-management to the administration of medications on the part of nurses or by staff to whom the task has been delegated; 2) patients may shift between these environments, and regularly visit primary care providers, ambulatory clinics, or have frequent acute care admissions; and 3) a patient’s medication regimen in the community can be constantly changing without one distinct healthcare provider overseeing and supporting the patient through these processes. Evidently, there is a distinctive difference in how these healthcare facilities operate as related to their organizational factors; differences in their missions; differences in levels of care; and degree of autonomy with which care is administered.
3.2 Rationale

MRQA Med Rec intervention has been implemented in hospitals and LTC facilities. At each of these settings, various healthcare professionals may participate in patient medication management, which adds to the complexity, risk and exponential number of potential interfaces. In the context of the MRQA Med Rec intervention, as with any practice change initiative, organizational-contextual factors such as ownership status can impact the quality of patient care in acute care hospitals and LTC facilities. Therefore, it was of utmost importance to portray the present situation of MRQA Med Rec in Alberta in terms of healthcare settings in which it has been implemented. Further, recognizing that resources, infrastructure, and process changes may pose challenges for the successful implementation of MRQA Med Rec, it was important to understand relevant organizational factors within each implementation setting as these may impact implementation of this intervention. These insights contributed to knowledge of current intervention implementation status and offered information about aspects of intervention that interests other evaluators and policy makers.

3.3 Objectives

The overall objective of this study was to characterize Alberta’s healthcare institutions participating in the intervention and compare with non-participating institutions to assess if there are significant differences between two organizational groups with regards to their designation status.
3.4 Methodology

3.4.1 Study population

The study population consisted of Alberta’s MRQA Med Rec participating healthcare institutions (including acute care hospital units; and long term care facilities) that have submitted anonymized patients’ Med Rec reports (Seen in Appendix D) as of June 1st 2014. This study was approved by the institutional review board of University of Toronto.

3.4.2 Data Sources


3.4.3 Analysis

Descriptive analysis provided organizational summary statistics of MRQA Med Rec participating organizations and organizational summary statistics of all of Alberta’s healthcare facilities. Chi-square test assessed whether organizations participating in MRQA Med Rec are significantly different in comparison with Alberta’s healthcare organizations.

3.5 Results

Table 3.1 described overall designation categories of Alberta’s healthcare facilities and presented designation categories among MRQA Med Rec participating facilities. Findings demonstrated that Alberta has a diverse assortment of health care facilities including: 1) acute
care (general/special) hospitals (n=63); 2) head or administrative office (n=6); 3) home care (n=37); 4) LTC facilities (n=204); 5) Regional health authority (n=1); and 6) retirement homes (n=17). Findings showed that as of June 2014, 116 healthcare organizations have implemented MRQA Med Rec including: hospitals (n=52); hospice (n=1) and LTC facilities (n=63).
Table 3-1: Distinction in Designation Status of MRQA Med Rec participating and non-participating facilities

<table>
<thead>
<tr>
<th>Designation</th>
<th>MRQA Med Rec participating facilities</th>
<th>Alberta’s healthcare facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Frequency</td>
</tr>
<tr>
<td>Acute Care (General/Special Hospital)</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Hospice</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Long-Term Care</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Head or Administrative Office</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Home care</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>Regional Health Authority</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Retirement homes</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>116 facilities</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2 presented ownership categories among MRQA Med Rec participating facilities and the ownership categories among Alberta’s healthcare facilities. The ownership categories of 116 facilities where MRQA has been implemented included: lay organization (n=1); provincial government (n=2); and regional authority board (n=113). Findings demonstrated that healthcare facilities in Alberta are owned by: 1) lay organizations (n=42); 2) privately (n=74); 3) provincial government (n=6); 4) regional authority board (n=152); 5) religious organizations (n=58) and 6) undeclared facility (n=1).
Table 3-2: Distinction in *Ownership categories* of MRQA Med Rec participating and non-participating facilities

<table>
<thead>
<tr>
<th>Ownership</th>
<th>MRQA Med Rec participating facilities</th>
<th>Alberta’s healthcare facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Frequency</td>
</tr>
<tr>
<td>Lay</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Provincial Government</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Regional Authority Board</td>
<td>113</td>
<td>113</td>
</tr>
<tr>
<td>Proprietary</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>Religious</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>Undeclared (Y)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>116</td>
<td>116</td>
</tr>
</tbody>
</table>

Table 3.3 described facility types among MRQA Med Rec participating facilities and facility types of Alberta’s healthcare facilities.

Findings in Table 3.3 demonstrated that facilities/departments that implemented MRQA Med Rec intervention included: 1) cancer (n=1); 2) cardiology (n=1); 3) extended care (n=1); 4) general (n=45); 5) hospice (n=1); 6) nursing home (n=63); 7) paediatric (n=1); 8) psychiatric (n=2); and 9) rehabilitation (n=1). Further, results (Table 3.3) illustrated that Alberta has a heterogeneous group of facilities including: 1) adult group (n=1); 2) auxiliary hospital (n=3); 3) cancer (n=2); 4) cardiology (n=1); 5) chronic care (n=1); 6) continuing care centre and facility (n=3); 6) extended care (n=5); 7) general (n=50); 8) home care (37); 9) hospice (n=11); 10) LTC facility (n=2); 11) N (undeclared) (n=1); 12) nursing home (n=195); 13) paediatric (n=1); 14) psychiatric (n=2); 15) rehabilitation (n=1) and 16) retirement home (n=17).
Table 3-3: Distinction in Facility Types categories of MRQA Med Rec participating and non-participating facilities

<table>
<thead>
<tr>
<th>Facility Types</th>
<th>MRQA Med Rec participating facilities</th>
<th>Alberta’s healthcare facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Frequency</td>
</tr>
<tr>
<td>Adult group home</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Auxiliary hospital</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Cancer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cardiology</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chronic care</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Continuing care centre</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Continuing care facility</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Extended care</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>General</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Home care</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>Hospice</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Long term care</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>N* (undetermined)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Nursing home</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Paediatric</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Psychiatric</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Retirement home</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>116 facilities</strong></td>
<td><strong>377 facilities</strong></td>
</tr>
</tbody>
</table>

Note*: Guide to Canadian healthcare facilities administrator was contacted to clarify the meaning of N category, but no explanation was received.
Table 3.4 illustrated frequencies of operation categories among MRQA Med Rec participating facilities and operation categories of Alberta’s healthcare facilities. Findings showed that facilities that have implemented MRQA Med Rec interventions have been operated by: 1) lay organization (n=2); and 2) regional authority boards (n=114). Results showed that in Alberta healthcare facilities have been operated by: 1) lay organizations (n=46); 2) undeclared (N) (n=1); 3) private entities (n=75); 4) provincial government (n=1); 5) regional authority board (n=152); and 6) religious organizations (n=58).

Table 3-4: Distinction in Operation categories of MRQA Med Rec participating and non-participating facilities

<table>
<thead>
<tr>
<th>Operation categories</th>
<th>MRQA Med Rec participating facilities</th>
<th>Alberta’s healthcare facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Frequency</td>
</tr>
<tr>
<td>Lay</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Proprietary</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Provincial Government</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Regional Authority Board</td>
<td>114</td>
<td>114</td>
</tr>
<tr>
<td>Religious</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>116 facilities</td>
<td></td>
</tr>
</tbody>
</table>
Designation status is a variable that contains information on the number of acute care facilities and LTC facilities in a province. Based on Designation status variable - in Alberta, although there are 63 acute care facilities and 204 LTC facilities, based on the available data only 52 acute care facilities and 63 LTC facilities are involved in MRQA Med Rec. This finding was further confirmed by the chi-square test. The chi-square test for equal proportions tested whether the differences in Designation status among MRQA Med Rec participating facilities and those that are not participating are indeed statistically significant. Results indicated that designation status of MRQA Med Rec participating facilities are significantly different (p value <.0001) in comparison with rest of Alberta’s healthcare facilities thus results cannot be generalized elsewhere.

3.6 Discussion

MRQA Med Rec is a systematic process to review all the medications a patient is taking to ensure all medications’ changes are carefully assessed and documented. (97) The purpose of MRQA Med Rec is to ensure accurate communication at care transition points, for example, when patients enter a hospital (MRQA Med Rec at admission), transition to another service or provider or are discharged home. (97)

In most Canadian provinces, MRQA Med Rec has been considered a key strategic priority for improving safety and quality of patient care related to medication. (78) Mitchell and al. (2013) noted that since 2008, there has been a gradual improvement in organizational performance on medication reconciliation ROPs across the continuum of care (97) and that national compliance had a 21% increase from 61% in 2010 to 82% in 2012. (97) This is not consistent with the findings from this study. Results indicated that out of Alberta’s diverse assortment of health care facilities only 43% of publicly owned Alberta’s healthcare facilities
participate in the MRQA Med Rec intervention; including 52 out of 63 acute care hospitals (83%) and 63 out of 204 LTC facilities (30%).

Findings illustrated that there is a diverse group of organizational departments participating in the MRQA Med Rec intervention and noted an even greater diversity when taking into account entire population of Alberta’s healthcare facilities. Past report noted the ADE rates may be impacted by some organizational characteristics such as the size of the facility (as defined by number of beds). To illustrate variations in number of ADEs based on the size of the hospital, Agency for Healthcare Research and Quality (161) reported that in 2011: small facilities experienced 2,079,286 ADE related events; medium size facilities experienced 4,866,452 ADE related events and large size facilities experienced 13,075,587 ADE related events. (160) Alberta’s healthcare facilities entail a wide range of types, from small facilities to large teaching hospitals. All of these should participate in future MRQA Med Rec evaluation studies to assess for whom the intervention conveys the most benefits.

Based on descriptive study findings, it appeared that none of Alberta’s proprietary LTC facilities have implemented MRQA Med Rec. This is of particular concern as past evidence suggested ownership to be an important organizational factor in predicting organizational effectiveness and quality of care in nursing home facilities. Numerous studies have found that publicly funded facilities have higher nurse staffing levels than for-profit facilities and a link between for-profit ownership and inferior quality in LTC facilities.(134-137) As reported by Berta et al.(147) proprietary LTC facilities had significantly lower levels of direct-care staff than both non-profit and public facilities; while Hillmer and al.(148) concluded that publicly funded LTC facilities had a higher staff-skill mix and lower staff turnover compared with for-profit facilities. Comondore et al. (149) illustrated that non-profit LTC facilities had significantly
higher staffing levels and a lower frequency of pressure ulcers with a general a trend among non-profit facilities toward less use of physical restraints and fewer deficiency citations.

It was not possible to compare the findings from this study with some of those found in other Med Rec evaluation studies. Typically, Med Rec evaluation studies are performed at a single hospital (ward) (123) or multiple wards (124); and/or for selected (often described as high risk) patient population (87, 125) whereas this study was positioned from an organizational (system) level, with an attempt to evaluate MRQA Med Rec participating sites at the provincial level. However, one can suggest that previous evaluation studies may appear ‘narrow’ in their evaluative approach as a recent Cochrane systematic review (2016) (176) indicated that it is not known in which form or for which patients’ medication reconciliation are the most effective, further justifying the need for a system level approach. This approach was deemed important as hospitals and LTC facilities contain specific organizational characteristics, or organizational-contextual factors that can facilitate or impede successful MRQA Med Rec implementation and subsequent goal attainment.

3.7 Conclusion

Medication Reconciliation (MRQA Med Rec) was introduced into the Accreditation Canada based on the recommendations of the Accreditation Canada Patient Safety Advisory Committee. (78) It has been developed as a strategy to reduce medication discrepancies and subsequent potential ADEs by comparing patient medications at key transfer points such as admission and discharge.

Descriptive study provided insights into present situation of MRQA Med Rec in Alberta in terms of healthcare settings in which it has been implemented. Key findings illustrated that Alberta’s MRQA Med Rec organizational compliance has remained low. Based on the findings,
it appeared as if though the intervention has not been implemented in any of the proprietary LTC facilities.

Considering impact of ownership status on organizational effectiveness and quality of patient care, propriety LTC facilities should be more involved with the implementation and evaluation of MRQA Med Rec intervention. Subsequent evaluation studies would provide more information on organizations in which the intervention is being implemented and may improve generalizability of results.

Reflecting on the diversity of Alberta’s healthcare institutions, further studies should focus on understating the organizational adherence to MRQA Med Rec protocols that may be a key factor associated with its effectiveness. Successive studies should focus not only on understanding the adherences to protocol but on assessment of consistency of MRQA Med Rec implementation. This could be achieved by evaluating the intervention’s fidelity measure.
Chapter 4: Evaluation of MRQA Med Rec implementation in Alberta’s acute care units

Abstract

**Background:** Adverse drug events (ADEs) pose a significant public health problem. Medication Reconciliation (MRQA Med Rec) was introduced in Alberta’s hospitals with an intent to reduce ADE-related healthcare utilization by warranting that all medication changes are adequately documented.

**Objectives:** The primary objective of this study was to evaluate the effectiveness of MRQA Med Rec at admission implemented in Alberta’s hospitals and to assess the impact of organizational factors on the effectiveness of the intervention. A secondary objective of this study was to determine the consistency of MRQA Med Rec implementation by assessing the Quality Audit Bundle Compliance at Admission, intervention’s fidelity measure.

**Study population:** Cohort consisted of Alberta’s hospitals, participating in the initiative as of June 2014.

**Data collection:** Administrative data was linked by facility identifier for period between June 1st 2013 and March 31st, 2015.

**Methods:** Outcomes associated with ADE related healthcare utilization (ADE related ED visits and ADE related hospitalizations) were analyzed using repeated measures with the generalized linear mixed model procedures in SAS. For all parameter tests, α level was set to 0.05.

**Results:** In acute care cohort (N=42), implementation was not associated with changes in number of ADE related ED visits (p-value = .1090) yet organizational factor analysis found the intervention may have a more pronounced impact in small hospitals (p-value <.0001). Implementation may be associated with changes in number of ADE related hospitalizations (p-value <.0001). Organizational factor analysis noted that hospitals’ age could not be associated with changes in number of ADE related hospitalizations (p-value =.1418); yet larger and teaching hospitals (p-value <.0001 and p-value = .0047) were likely to experience higher volumes of ADE related hospitalizations. Over 10 months, average values of fidelity measure ranged from 2.50 to 3.19, indicating that the intervention was not implemented with fidelity.

**Conclusion:** There was no significant decline in ADE related events detected in this study consequent to the implementation of MRQA Med Rec. Subsequent evaluations should assess impact of other organizational factors such as staffing intensity. Additional research is required to assess impact of intervention in hospitals on all cause ED visits and all cause hospitalizations.
4.1 Introduction

Effective communication allows for identification and resolution of medication discrepancies, thus reducing the potential for the occurrence of adverse drug events (ADEs) within health care organizations. (78, 95, 96) Medication discrepancies have been prevalent for patients admitted to hospitals. (95) Medication reconciliation processes, such as MRQA Med Rec (Medication Reconciliation Alberta) have been considered as a solution to the well-documented problem of un-intentionally changes to patients’ medication regimen. (95-97) MRQA Med Rec was introduced in Alberta’s acute care units through an initiative co-led by Safer Healthcare Now, Canadian Patient Safety Institute (CPSI) and Institute of Safe Medical Practice (ISMP). (78, 95, 96)

MRQA Med Rec entails a systematic and comprehensive review of all the medications a patient is taking to ensure that medications being added, changed or discontinued are carefully assessed and documented. MRQA Med Rec ensures health care providers formally work together with patients, families and care providers to ensure accurate and comprehensive medication information is communicated consistently across transitions of care. (78, 95, 97) Based on its positive impact, such as detection of medication discrepancies (96), MRQA Med Rec has been considered as required organizational practice by hospital accreditation authorities across Canada. (78, 95, 96)

4.2 Rationale

Organizations pursue goals, and the achievement of organizational goals is one aspect of performance known as effectiveness. Healthcare organizations such as hospitals seek to attain patient safety goals. MRQA Med Rec intervention should be regarded as one means of facilitating the achievement of an organization’s patient safety goals. Besides MRQA Med Rec
implementation, other organization level factors may influence effectiveness/the achievement of patient safety goals.

Past research highlights a plethora of contextual acute care organizational factors including: staffing intensity, facility’s age; facility’s size, teaching status –that could influence organizational effectiveness. [Note: Data was available for facility’s size; age; and teaching status. (175)] There are other factors that have been recognized by implementation scientists as potentially important to the effectiveness of an intervention such as the fidelity of intervention’s implementation. Therefore, in addition to examining relationships between MQRA Med Rec implementation and organizational performance, the study also examined the relationships of these factors to performance. Findings from this study could offered new insights into the extent of variation in MRQA Med Rec within acute care institutions with regards to health system utilization, and the organizational factors associated with its effectiveness.

4.3 Objectives

Objectives of this study were to:

1. Evaluate the impact of the MRQA Med Rec intervention in acute care hospital units in Alberta on ADE related ED visits and hospitalizations.

2. Determine the consistency of MRQA Med Rec implementation by assessing the Quality Audit Bundle Compliance, intervention’s fidelity measure. This measure was utilized to assess whether the intervention has been implemented according to the proposed model and to assure policy-makers that services are being implemented as intended and are reaching the target audience.

3. Determine if there were within setting differences regarding the effectiveness of MRQA Med Rec intervention.
4. Identify and examine organizational factors in MRQA Med Rec participating hospitals that could potentially explain the relationship between intervention and outcome.

4.4 Methodology

4.4.1 Study population

Cohort consisted of Alberta’s MRQA Med Rec acute care participating facilities (hospitals) who submitted anonymized patients’ MRQA Med Rec reports (Seen in Appendix D) as of June 1st, 2014.

This study was approved by the institutional review board of University of Toronto.

4.4.2 Explanatory Variable

The explanatory variable of interest was the MRQA Med Rec intervention implemented at acute care hospital facilities across Alberta as of June 2014.

4.4.3 Organizational Factors

Administrative sources that are discussed in the later section were utilized to examine organizational factors that could affect institutional performance measures such as: number of hospital beds; age of hospital; hospital’s teaching status. Organizational factors (seen in Figure 4.1) known to impact the quality of care in acute care facilities, were added to the model thereby helping to explain the mechanisms by which MRQA Med Rec ties in with the rest of organizational factors and influences health system utilization.

<table>
<thead>
<tr>
<th>Hospitals</th>
<th>Number of beds (Size) (0-50; 50-70; &gt;70 beds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age of hospital (&lt;1920; 1920&gt; and &lt;1970; &gt;1970)</td>
</tr>
<tr>
<td></td>
<td>Teaching status (Yes; No)</td>
</tr>
</tbody>
</table>

**Figure 4-1**: Summary of factors known to impact the quality of care in hospitals
4.4.4 Outcomes

Outcomes were: 1) number of ADE-related ED visits and 2) number of ADE-related hospitalizations. Primary outcomes were identified administratively using a list of ADE ICD-10 codes (for a list of suggested ICD-10 ADE codes, please see Appendix E), for 1 year before MRQA Med Rec intervention (pre period June 1st 2013- May 31st 2014) and 1-year post MRQA Med Rec intervention (post period June 1st 2014 to March 31st, 2015). (seen in Figure 4.2)

![Accrual Window Diagram](image)

**Figure 4-2:** Study timelines

4.4.5 Fidelity measure

As discussed previously, every intervention should have an ‘associated’ fidelity measure. In this study, Quality Audit Bundle Compliance at Admission was used as a fidelity measure to and account for negative or ambiguous findings (174) since without documentation and measurement of intervention’s adherence to the intended model, it was difficult to determine whether unsuccessful outcomes reflected a failure of an intervention or failure to implement the intervention as intended. (174)

The Quality Audit Bundle Compliance at Admission was used as a fidelity measure for MRQA Med Rec. It was a composite measure that was collected through the Med Rec Audit tool (seen in Appendix D), that consists of 5 elements:
1) BPMH > 1 source – indicating that best possible medication patient history was created using more than 1 source of information;

2) Actual Med use is verified by Patient/Caregiver source meaning that patient and/or caregiver confirmed the actual drugs that are used;

3) Each med has drug name, dose, strength, route, frequency on BPMH and Admission Orders – confirming the comprehensiveness of the list;

4) Every med in BPMH is accounted for in Admission Orders; and

5) Prescriber has documented rationale for ‘Holds” and “Discontinued” meds.

MRQA Med Rec is implemented properly when a fidelity measure receives a score of 5, all other scores (0,1,2,3, or 4) of fidelity measure indicate that MRQA Med Rec has not been properly implemented. Fidelity measure mean values were used to determine if the intervention has been implemented with fidelity.

Outcomes and fidelity measure are summarized in Figure 4.3

<table>
<thead>
<tr>
<th>Outcomes</th>
<th></th>
</tr>
</thead>
</table>
| **Quality Audit Bundle Compliance at Admission** (Fidelity measure) | 1. BPMH > 1 source;  
| MRQA Med Rec is implemented with fidelity=5 | 2. Actual Med use is verified by Patient/Caregiver source;  
| Otherwise = 0 | 3. Each med has drug name, dose, strength, route, frequency on BPMH and Admission Orders;  
|            | 4. Every med in BPMH is accounted for in Admission Orders;  
|            | 5. Prescriber has documented rationale for ‘Holds” and “Discontinued” meds. |

**Figure 4-3**: Summary of outcomes and fidelity measure

The outcomes (number of ADE related ED visits and number of ADE related hospitalizations) were used as proxy measures for organizational goals related to patient safety, and utilized as
measures of organization’s effectiveness. In this study, an organization was considered effective if there were significant reductions in ADEs related ED visits and hospitalization.

4.4.6 Data Sources

Data was collected administratively and linked using institution ID. Administrative sources include: 1) CIHI Discharge Abstract Database (ADE related hospitalizations); 2) CIHI National Ambulatory Care Reporting System (ADE related ED visits); 3) Guide to Canadian Healthcare Facilities database (Organizational factors related to hospitals). CIHI DAD contains administrative, clinical and demographic information on hospital admissions (including deaths, sign-outs and transfers) (177) for the 2014–2015 period (up to August 5th, 2015). CIHI NACRS contains data for all hospital-based and community-based ambulatory care: day surgery; outpatient clinics and emergency departments. (178) NACRS data was available for 2014–2015 (up to August 5th, 2015). The 2014 Guide to Canadian Healthcare Facilities, Vol. 21 contains updated listings for hospitals, long-term care centres, regional health authorities and other health related facilities across the country. (175) Data for Quality Audit Bundle Compliance at Admission was obtained from Med Rec Alberta Patient Safety Metrics database.

4.4.7 Analysis

4.4.7.1 Study variables/measures

Study variables were collected retrospectively from administrative sources. Outcomes: number of ADE related ED visits and hospitalizations were collected from CIHI administrative data sources (Discharge Abstract Database (DAD) and National Ambulatory Care Reporting System (NACRS) that were discussed previously. Data related to Fidelity measure were collected form Med Rec Alberta Patient Safety Metrics database and information related to organizational factors was collected from Guide to Canadian Healthcare Facilities database.
4.4.7.2 Repeated Measures analysis

Repeated measures analysis with the generalized linear mixed model was conducted to evaluate the impact of MRQA Med Rec as well as to assess whether organizational factors can explain intervention-outcome relationship.

Objectives were addressed using the repeated measures analysis that is appropriate for the study considering the objectives, and the timeline.

Figure 4-4: Pre and Post study timelines

The outcomes consistently measured over a fixed time period were analyzed using repeated measures with the GLM (generalized linear) effects model. Repeated measures analysis was appropriate as this study investigates changes in outcomes over time. This approach allowed for development a time-course for the MRQA Med Rec intervention. Measurements were performed at fixed intervals rather than continuous thus it allowed for a generalized mixed models approach. To fit generalized linear mixed models, I used the GLIMMIX procedure in SAS (proc glimix procedure and Poisson distribution (dist = poisson). Proc glimmix can be used to directly maximize an approximate integrated likelihood, where the integration over the random effects is obtained using numerical quadrature. METHOD =QUAD option was used to increase the accuracy of the numerical approximation by specifying the number of quadrature points used during evaluation of integrals for the marginal likelihood. The RANDOM statement
was used to specify the structure of the covariance matrix for the random effects (G). The structure of G is specified using the TYPE=option. For analysis, it was assumed that random effects are correlated (TYPE=UN).(179)

ED visit and hospitalizations resulting from an ADE are considered somewhat of a rare event and not all health care settings will experience outcomes at all times. This skews the outcome distribution away from a normal distribution. Outcomes were discrete counts of events, thus it was not appropriate to perform a log transformation that would be necessary to ‘normalize’ the distribution. Considering the data, Poisson distribution was a more appropriate option. Differences in outcomes over time were to be considered statistically significant if p-value was less than 0.05.

4.5 Results

4.5.1 Repeated measures with generalized mixed model

4.5.1.1 ADE in MRQA Med Rec participating hospitals
4.5.1.1.1 Describing organizational factors of MRQA Med Rec hospitals

Table 4.1 presented teaching status distribution among hospitals that have implemented MRQA Med Rec intervention as of June 2014. Although MRQA Med Rec Alberta provided information on 52 hospitals participating in the intervention, CIHI was able to match only 42 hospitals based on name and facility IDs that were provided by MRQA Med Rec Alberta. Results in table 3.1 illustrated that among MRQA Med Rec participating hospitals there were n=34 non-teaching status hospitals and n=8 teaching hospitals, indicating that majority of hospitals were (~about 75 % of hospitals) non-teaching facilities.
Table 4-1: Teaching status among MRQA Med Rec hospitals

<table>
<thead>
<tr>
<th>Teaching status</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>34</td>
<td>80.95</td>
<td>34</td>
<td>80.95</td>
</tr>
<tr>
<td>Y</td>
<td>8</td>
<td>19.05</td>
<td>42</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 4.2 illustrated distribution of facilities based on number of acute beds. Please note that Variable N_Acute_Beds_Total was defined as institutions with <50 beds were categorized as 0; 50-70 beds were assigned a category of 1 and facilities containing more than 70 beds were categorized with 2. This categorization was based on reviewed literature. (147)

Results in Table 4.2 illustrated that among MRQA Med Rec participating hospitals n=28 were small with less than 50 beds; n=1 was a medium with more than 50 but less than 70 beds; and n=13 were large hospitals containing over 70 beds, indicating that the majority of hospitals (~67%) participating in MRQA Med Rec intervention were small.

Table 4-2: Distribution of facilities based on number of hospital beds

<table>
<thead>
<tr>
<th>N_Acute_Beds_Total</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute_Beds_Total &lt; 50</td>
<td>0</td>
<td>28</td>
<td>66.67</td>
<td>28</td>
</tr>
<tr>
<td>50 &lt;= Acute_Beds_Total &lt; 70</td>
<td>1</td>
<td>1</td>
<td>2.38</td>
<td>29</td>
</tr>
<tr>
<td>Acute_Beds_Total &gt;= 70</td>
<td>2</td>
<td>13</td>
<td>30.95</td>
<td>42</td>
</tr>
</tbody>
</table>

Table 4.3 displayed the distribution of facilities based on the year these were built, indicating that among MRQA Med Rec participating hospitals: n=7 were built prior to 1920; n=17 were
built between 1920 and 1970; and n=8 were built after 1970. This information was not available for 10 acute care units that have implemented MRQA Med Rec intervention.

Table 4-3: Distribution of facilities based on the age of the hospital (year hospitals were built)

<table>
<thead>
<tr>
<th>N_Year_Opened</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year_Opened &lt;= 1920</td>
<td>0</td>
<td>7</td>
<td>7</td>
<td>16.67</td>
</tr>
<tr>
<td>1920 &lt; Year_Opened &lt; 1970</td>
<td>1</td>
<td>17</td>
<td>24</td>
<td>57.14</td>
</tr>
<tr>
<td>Year_Opened &gt;= 1970</td>
<td>2</td>
<td>8</td>
<td>42</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 4.4 described the mean number of ADE related ED visits across MRQA Med Rec participating facilities over the period of 24 months. Analysis indicated that variance is larger than its mean, which is known as overdispersion of data. By visual assessment, changes in the mean number of ADE related ED visits could not be associated with the implementation of MRQA Med Rec, indicating that there was not much variation of mean in ADE related ED visits pre and post MRQA Med Rec, yet the maximum reported values seemed to decline during the post-period.

Note: When there are between 1 and 4 counts of an event, CIHI notifies that by assigning a “*” to that field. For MRQA Med Rec about 50% of data fields were labelled with “*” indicating 1-4 counts of an event. For analysis, it was assumed that “*” corresponds to 2.5 (a median value). About quarter of (25%) of data fields had a value of 0 indicating no ADE related ED visits occurred during the month in an institution.
ED arrivals and hospitalizations can be well approximated by a Poisson model because, in the absence of a catastrophic event or infections epidemic, people experience injuries or become ill independently of one another. An individual’s risk of an ED visit/hospitalization is likely to vary over time as a function of specific factors and will also vary among individuals. Essentially, this means that there is little or no association between the number of ED visits in one month and the number in the next. (181)
**Table 4-4:** Mean number of ADE related ED visits in MRQA Med Rec acute care facilities

<table>
<thead>
<tr>
<th>N=42</th>
<th>mth</th>
<th>Mean Number of ADE related ED visits</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 (April 2013)</td>
<td>27.1310</td>
<td>34.4113</td>
<td>0</td>
<td>139.0</td>
</tr>
<tr>
<td></td>
<td>2 (May 2013)</td>
<td>28.7262</td>
<td>41.3696</td>
<td>0</td>
<td>161.0</td>
</tr>
<tr>
<td></td>
<td>3 (June 2013)</td>
<td>27.6548</td>
<td>40.3021</td>
<td>0</td>
<td>170.0</td>
</tr>
<tr>
<td></td>
<td>4 (July 2013)</td>
<td>26.3095</td>
<td>37.9788</td>
<td>0</td>
<td>151.0</td>
</tr>
<tr>
<td></td>
<td>5 (August 2013)</td>
<td>27.1905</td>
<td>36.4765</td>
<td>0</td>
<td>133.0</td>
</tr>
<tr>
<td></td>
<td>6 (September 2013)</td>
<td>27.2619</td>
<td>40.8688</td>
<td>0</td>
<td>170.0</td>
</tr>
<tr>
<td></td>
<td>7 (October 2013)</td>
<td>27.2262</td>
<td>38.7480</td>
<td>0</td>
<td>147.0</td>
</tr>
<tr>
<td></td>
<td>8 (November 2013)</td>
<td>25.5595</td>
<td>36.8405</td>
<td>0</td>
<td>148.0</td>
</tr>
<tr>
<td></td>
<td>9 (December 2013)</td>
<td>23.8690</td>
<td>33.4053</td>
<td>0</td>
<td>119.0</td>
</tr>
<tr>
<td></td>
<td>10 (January 2014)</td>
<td>23.8923</td>
<td>34.2430</td>
<td>0</td>
<td>137.0</td>
</tr>
<tr>
<td></td>
<td>11 (February 2014)</td>
<td>24.5714</td>
<td>34.3274</td>
<td>0</td>
<td>123.0</td>
</tr>
<tr>
<td></td>
<td>12 (March 2014)</td>
<td>25.8452</td>
<td>36.4592</td>
<td>0</td>
<td>159.0</td>
</tr>
<tr>
<td></td>
<td>13 (April 2014)</td>
<td>28.1429</td>
<td>40.8758</td>
<td>0</td>
<td>166.0</td>
</tr>
<tr>
<td>Date</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>14 (May 2014)</td>
<td>26.3571</td>
<td>38.0722</td>
<td>0</td>
<td>146.0</td>
<td></td>
</tr>
<tr>
<td>15 (June 2014)</td>
<td>25.2857</td>
<td>34.8572</td>
<td>0</td>
<td>125.0</td>
<td></td>
</tr>
<tr>
<td>16 (July 2014)</td>
<td>26.5714</td>
<td>38.8770</td>
<td>0</td>
<td>139.0</td>
<td></td>
</tr>
<tr>
<td>17 (August 2014)</td>
<td>26.8571</td>
<td>38.3037</td>
<td>0</td>
<td>163.0</td>
<td></td>
</tr>
<tr>
<td>18 (September 2014)</td>
<td>25.0119</td>
<td>34.9464</td>
<td>0</td>
<td>136.0</td>
<td></td>
</tr>
<tr>
<td>19 (October 2014)</td>
<td>27.5595</td>
<td>37.9525</td>
<td>2.5*</td>
<td>138.0</td>
<td></td>
</tr>
<tr>
<td>20 (November 2014)</td>
<td>24.1667</td>
<td>31.9965</td>
<td>0</td>
<td>115.0</td>
<td></td>
</tr>
<tr>
<td>21 (December 2014)</td>
<td>25.8452</td>
<td>36.6778</td>
<td>0</td>
<td>137.0</td>
<td></td>
</tr>
<tr>
<td>22 (January 2015)</td>
<td>25.8095</td>
<td>37.22212</td>
<td>0</td>
<td>125.0</td>
<td></td>
</tr>
<tr>
<td>23 (February 2015)</td>
<td>24.7381</td>
<td>34.7728</td>
<td>0</td>
<td>132.0</td>
<td></td>
</tr>
<tr>
<td>24 (March 2015)</td>
<td>27.6429</td>
<td>37.1968</td>
<td>0</td>
<td>142.0</td>
<td></td>
</tr>
</tbody>
</table>
4.5.1.1.2  ADE related ED visits in MRQA Med Rec participating acute care facilities

To assess the impact of MRQA Med Rec intervention on ADE related ED visits, a dichotomous categorical variable Med Rec was created. The variable assumed a value of 0 pre-MRQA Med Rec implementation and a value of 1 – post-MRQA Med Rec implementation. Variable Month was a continuous variable representing time. Data set was transformed from wide to long as required by Glimmix procedure.

Table 4.5 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results in Table 4.5 demonstrated a p-value = 0.1450 was greater than p-value of 0.05 indicating that implementation of MRQA Med Rec in hospitals could not be associated with changes in the mean number of ADE related ED visits over time.

<table>
<thead>
<tr>
<th>Type III Tests of Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
</tr>
<tr>
<td>MedRec</td>
</tr>
<tr>
<td>Month</td>
</tr>
<tr>
<td>Month*MedRec</td>
</tr>
</tbody>
</table>

Based on reviewed literature the impact of organizational factors (hospitals’ ages (155-157); hospitals’ size (160, 162-165) and hospitals’ teaching status (58, 166-168) on ADE related ED visits was assessed individually.

Table 4.6 illustrates results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results in Table 4.6 indicated that the number of ADE
related ED visits could vary by the size of the hospitals and larger hospital (where 
N_Acute_Beds_Total = 2) experienced higher volumes of ADE related ED visits. Results 
demonstrated that number of ADE related ED visits varied based on hospital size, indicating that 
hospital size is a significant predictor of the event.

Table 4-6: Impact of hospital’s size on ADE related ED visits

<table>
<thead>
<tr>
<th></th>
<th>N_Acute_Beds_Total</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>4.0070</td>
<td>0.2019</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>N_Acute_Beds_Total 0</td>
<td></td>
<td>-2.3358</td>
<td>0.2450</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>N_Acute_Beds_Total 1</td>
<td></td>
<td>-1.3371</td>
<td>0.7567</td>
<td>0.0775</td>
</tr>
<tr>
<td>N_Acute_Beds_Total 2</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7 illustrated results for mixed effects log-linear regression, fitted using adaptive 
quadrature in PROC GLIMMIX in SAS. The p-value is 0.2406 that was greater than 0.05 
indicating that hospitals’ length in operation (age of a hospital) could not be associated with 
changes in the number of ADE related ED visits in MRQA Med Rec participating hospitals.

Table 4-7: Impact of hospitals’ age (length in operation) on ADE related ED visits

<table>
<thead>
<tr>
<th></th>
<th>N_Year_Opened</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.8 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Findings illustrate that p value is less than 0.05 (p < .0001) indicating that hospitals’ teaching status could be associated with changes in the number of ADE related ED visits. Specifically, the results indicated that teaching status hospitals were likely to experience higher volumes of ADE related ED visits. (non-teaching status estimate = -1.9716)

Based on previous analysis, the final analysis was run with organizational factors that previously demonstrated significance. The purpose of the analysis was to assess whether there is any association between these predictors and MRQA Med Rec.

Table 4-8: Impact of teaching status on ADE related ED visits

<table>
<thead>
<tr>
<th>Effects</th>
<th>Teaching status</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>4.0128</td>
<td>0.3696</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Teaching_status</td>
<td>N</td>
<td>-1.9716</td>
<td>0.4110</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Teaching_status</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.9 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results in Table 4.9 indicated that, independently, hospital teaching status and size of the hospital could be associated with changes in the number (volume) of ADE related ED visit. Analysis illustrated that there was no association between teaching status and MRQA MedRec, however there seemed to be an association between size of the hospital and outcome. The association was further explored and analysis revealed that the intervention may have a more pronounced impact in the smaller hospitals. (p-value = 0.0438)

Goodness of model fit was assessed indicating a p-value >0.05, the null hypothesis is rejected, meaning that the model with predictors is a better fit than the null model.

Note that the mean and variance of Poisson distribution should be the same; e.g., $E(X) = Var(X) = \lambda$. Descriptive analysis indicated that variance is larger than its mean (as described in Table 3.9). This is known as overdispersion, which may occur with discrete data. Analyses assuming Poisson distributions may be invalid because of overdispersion. The assumption was that each facility has the same probability of ADE related ED visits per month, but it more realistic to assume that these probabilities will vary by some other factor such as: staffing intensity, crowding, seasonality etc. Then we may observe more variations in the ADE related ED visits than the Poisson model predicts.
Table 4-9: Association between ADE related ED visits and predictors that previously demonstrated significance

<table>
<thead>
<tr>
<th>Type III Tests of Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>MedRec</td>
</tr>
<tr>
<td>Teaching_status</td>
</tr>
<tr>
<td>N_Acute_Beds_Total</td>
</tr>
<tr>
<td>MedRec*Teaching_stat</td>
</tr>
<tr>
<td>MedRec*N_Acute_Beds_Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solutions for Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>MedRec*N_Acute_Beds_Total (0)</td>
</tr>
<tr>
<td>MedRec*N_Acute_Beds_Total (1)</td>
</tr>
<tr>
<td>MedRec*N_Acute_Beds_Total (2)</td>
</tr>
</tbody>
</table>

4.5.1.1.3  ADE related hospitalizations in MRQA Med Rec participating acute care facilities

Table 4.10 described the mean number of ADE related hospitalizations across MRQA Med Rec participating facilities over the period of 24 months. Analysis indicated that variance is larger than its mean, which is known as overdispersion of data. By visual assessment, the changes in the number of ADE related hospitalizations could not be associated with the implementation of MRQA Med Rec among participating hospitals. CIHI was not able to link two hospitals’ facility
IDs provided by MRQA Med Rec Alberta to facility IDs in DAD, thus reducing the sample size from 42 to 40 for the analysis.
Table 4-10: Mean number of ADE related hospitalizations across MRQA Med Rec participating hospitals

<table>
<thead>
<tr>
<th>Mth</th>
<th>Mean number of ADE related hospitalizations</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (April 2013)</td>
<td>19.8500</td>
<td>38.5394</td>
<td>0</td>
<td>178.0</td>
</tr>
<tr>
<td>2 (May 2013)</td>
<td>20.4375</td>
<td>39.4879</td>
<td>0</td>
<td>177.0</td>
</tr>
<tr>
<td>3 (June 2013)</td>
<td>18.6875</td>
<td>34.9024</td>
<td>0</td>
<td>145.0</td>
</tr>
<tr>
<td>4 (July 2013)</td>
<td>20.9500</td>
<td>38.7099</td>
<td>0</td>
<td>154.0</td>
</tr>
<tr>
<td>5 (August 2013)</td>
<td>20.5250</td>
<td>37.8443</td>
<td>0</td>
<td>148.0</td>
</tr>
<tr>
<td>6 (September 2013)</td>
<td>19.4250</td>
<td>37.8698</td>
<td>0</td>
<td>171.0</td>
</tr>
<tr>
<td>7 (October 2013)</td>
<td>21.3250</td>
<td>41.0680</td>
<td>0</td>
<td>164.0</td>
</tr>
<tr>
<td>8 (November 2013)</td>
<td>18.8250</td>
<td>35.7318</td>
<td>0</td>
<td>152.0</td>
</tr>
<tr>
<td>9 (December 2013)</td>
<td>18.3125</td>
<td>33.7566</td>
<td>0</td>
<td>141.0</td>
</tr>
<tr>
<td>10 (January 2014)</td>
<td>18.8750</td>
<td>36.2874</td>
<td>0</td>
<td>152.0</td>
</tr>
<tr>
<td>11 (February 2014)</td>
<td>15.7500</td>
<td>28.5257</td>
<td>0</td>
<td>119.0</td>
</tr>
<tr>
<td>12 (March 2014)</td>
<td>19.6250</td>
<td>36.3291</td>
<td>0</td>
<td>151.0</td>
</tr>
<tr>
<td>13 (April 2014)</td>
<td>18.1750</td>
<td>32.5725</td>
<td>0</td>
<td>120.0</td>
</tr>
<tr>
<td>Date</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>14 (May 2014)</td>
<td>18.7625</td>
<td>32.1832</td>
<td>0</td>
<td>131.0</td>
</tr>
<tr>
<td>15 (June 2014)</td>
<td>18.7125</td>
<td>31.8538</td>
<td>0</td>
<td>124.0</td>
</tr>
<tr>
<td>16 (July 2014)</td>
<td>19.8375</td>
<td>35.2332</td>
<td>0</td>
<td>155.0</td>
</tr>
<tr>
<td>17 (August 2014)</td>
<td>18.3375</td>
<td>32.7266</td>
<td>0</td>
<td>135.0</td>
</tr>
<tr>
<td>18 (September 2014)</td>
<td>19.4625</td>
<td>35.5458</td>
<td>0</td>
<td>145.0</td>
</tr>
<tr>
<td>19 (October 2014)</td>
<td>20.6500</td>
<td>36.2829</td>
<td>0</td>
<td>144.0</td>
</tr>
<tr>
<td>20 (November 2014)</td>
<td>17.5875</td>
<td>33.0865</td>
<td>0</td>
<td>137.0</td>
</tr>
<tr>
<td>21 (December 2014)</td>
<td>21.1875</td>
<td>37.9630</td>
<td>0</td>
<td>170.0</td>
</tr>
<tr>
<td>22 (January 2015)</td>
<td>19.4250</td>
<td>39.8979</td>
<td>0</td>
<td>195.0</td>
</tr>
<tr>
<td>23 (February 2015)</td>
<td>20.1500</td>
<td>39.0713</td>
<td>0</td>
<td>179.0</td>
</tr>
<tr>
<td>24 (March 2015)</td>
<td>21.1750</td>
<td>41.1863</td>
<td>0</td>
<td>177.0</td>
</tr>
</tbody>
</table>
Table 4.11 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results indicate that p-value < 0.0001 which was less that p-value = 0.05 indicating that number of ADE related hospitalizations could be associated with the MRQA Med Rec implementation. The findings demonstrated that there has been an increase in number of ADE related hospitalizations (pre MRQA Med Rec (0) estimate = -0.0812) following the implementation of MRQA Med Rec intervention.

**Table 4-11:** Impact of MRQA Med Rec on ADE related hospitalizations

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>MedRec</td>
<td>0.0048</td>
</tr>
<tr>
<td>Month</td>
<td>0.6378</td>
</tr>
<tr>
<td>Month*MedRec</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Based on reviewed literature the impact of organizational factors (hospitals’ age (155-159); hospitals’ size (160, 162-165) and hospitals’ teaching status (58, 166-168) on ADE related ED visits was assessed individually. These factors were selected as they were previously associated with changes in patient safety outcomes.
Table 4.12 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results in Table 4.12 indicated that the number of ADE related hospitalizations was impacted by the size of the hospitals and larger hospital (where N_Acute_Beds_Total = 2) experienced higher volumes of ADE related hospitalizations. Overall, the results implied that the number of ADE related hospitalizations varied depending on hospital size, indicating that hospital size was a significant predictor of the event.

**Table 4-12: Impact of hospital’s size on ADE related hospitalizations**

<table>
<thead>
<tr>
<th>Effect</th>
<th>N_Acute_Beds_Total</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>3.5056</td>
<td>0.2417</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>N_Acute_Beds_Total 0</td>
<td></td>
<td>-3.1009</td>
<td>0.3001</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>N_Acute_Beds_Total 1</td>
<td></td>
<td>-1.1162</td>
<td>0.6631</td>
<td>0.0926</td>
</tr>
<tr>
<td>N_Acute_Beds_Total 2</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type III Tests of Fixed Effects**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_Acute_Beds_Total</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Table 4.13 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results in Table 4.13 indicated the p-value is 0.1418 which is greater than 0.05, indicating that hospitals’ length in operation did not significantly impact number of ADE related hospitalizations.

**Table 4-13: Impact of hospitals’ (age) length in operation on ADE related hospitalizations**
Table 4.14 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Findings in Table 4.14 illustrated that p value is less than 0.05 ($p < .0001$) indicating that hospitals’ teaching status could impact the number of ADE related hospitalizations. Results indicated that teaching status hospitals were likely to experience higher volumes of ADE related hospitalizations.

Based on previous analysis, the final analysis was run with factors that previously indicated significance and to assess whether there is any association between these predictors and relevant outcome.

Table 4-14: Impact of teaching status on ADE related hospitalizations
Table 4.15 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. The association between hospital’s teaching status and outcome was further explored and analysis revealed that the intervention’s effect may be more pronounced in non-teaching hospitals, which tend to be smaller hospitals. (p-value = 0.0047 < then p-value=0.05)

**Table 4-15**: Estimating the relationship between ADE related hospitalizations and predictors that previously demonstrated significance
Solutions for Fixed Effects

<table>
<thead>
<tr>
<th>Intercept</th>
<th>Estimate</th>
<th>Standard error</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MedRec*Teaching_stat (N)</td>
<td>-0.1060</td>
<td>0.03740</td>
<td>0.0047</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MedRec*Teaching_stat (Y)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.16 presented the average value of Quality audit bundle at admission (fidelity measure) over the 10 months MRQA Med Rec at admission implementation was being assessed. The MRQA Med Rec at admission has been implemented with fidelity, if the measure receives a score of 5, all other scores (0,1,2,3, or 4) of measure indicate that MRQA Med Rec has not been implemented with fidelity. Average values of fidelity measure across MRQA Med Rec participating acute care hospitals ranged from 2.50 (min) to 3.19 (25). Thus, it seemed that intervention was not implemented with fidelity in Alberta’s acute care facilities.

**Table 4-16**: Mean value of Fidelity measure across MRQA Med Rec participating hospitals

<table>
<thead>
<tr>
<th>Months</th>
<th>MRQA Med Rec participating Hospitals</th>
<th>N</th>
<th>Fidelity measure (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 (June ’14)</td>
<td>1190</td>
<td>2.62</td>
<td></td>
</tr>
<tr>
<td>M2 (July ’14)</td>
<td>1323</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>M3 (August ’14)</td>
<td>1129</td>
<td>2.65</td>
<td></td>
</tr>
<tr>
<td>M4 (September ’14)</td>
<td>1165</td>
<td>3.08</td>
<td></td>
</tr>
<tr>
<td>M5 (October ’14)</td>
<td>1791</td>
<td>2.74</td>
<td></td>
</tr>
<tr>
<td>M6 (November ’14)</td>
<td>1043</td>
<td>3.04</td>
<td></td>
</tr>
<tr>
<td>M7 (December ’14)</td>
<td>2434</td>
<td>2.80</td>
<td></td>
</tr>
<tr>
<td>M8 (January ’15)</td>
<td>1171</td>
<td>2.91</td>
<td></td>
</tr>
<tr>
<td>M9 (February ’15)</td>
<td>2114</td>
<td>2.85</td>
<td></td>
</tr>
</tbody>
</table>
4.6 Discussion

Literature indicates that medication discrepancies have been prevalent for patients admitted to hospitals. (95) Medication reconciliation processes, such as MRQA Med Rec arose as the resolution to the well-documented patient safety problem of un-intentionally introducing changes in patients’ drug regimen as a result of inadequate or inaccurate medication information during care transitions. (126) MRQA Med Rec remains a complex and challenging component of patient safety for health care organizations across Canada. (161)

This was the first cohort study that retrospectively evaluated the impact of MRQA Med Rec across Alberta’s participating hospitals at the provincial level.

4.6.1 Impact of MRQA Med Rec on ADE related ED visits

Descriptive analysis revealed diverse hospitals (with respect to teaching status; size and age) have been participating in the intervention. Yet, it did not indicate that there was an association between the changes in the mean number of ADE related ED visits and implementation of MRQA Med Rec. The maximum reported values seemed to decline pre and post-intervention. This could be due to differences in how these occurrences have been reported with the advent of MRQA Med Rec. Also, DAD and NACRS data’s fiscal year runs from March 2014 to April 2015. MRQA Med Rec was introduced in June 2014 and at time of data request administrative data (DAD and NACRS) was not available beyond June 2015. Inconsistencies in timelines may have been responsible for the decline in pre and post- maximum reported outcome values.
Results indicated that implementation of MRQA Med Rec in hospitals could not be associated with changes in the number of ADE related ED visits over time. This finding is in line with previous research by Cornish et al. (2005) (50); Kwan et al. (2007) (52) and Fernandes et Shojania (2012) (126) that found that reconciliation at admission alone (not combined with reconciliation at transition and discharge) was unlikely to impact the rate of ADEs related events. Yet, others found the positive impact of Med Rec at admission on ADE related ED visits. Dedhia et al. (2009) (182) examined the impact of Med Rec in general medicine wards at an academic medical center; a community teaching hospital; and a community-based non-teaching hospital for elderly patients. Results indicated that the highest reduction in ADE related ED visits was at the hospital that had been performing substantially worse than the other two during the ‘pre’ period. (182)

The absence of association between the intervention and number of ADE related ED visits could be explained by focusing on the intervention’s fidelity measure. Based on the average values of fidelity measure, it appeared that the intervention was not implemented with fidelity; and that fidelity of implementation varied close to 20% over month-to-month on average.

Organizational factors such as hospitals’ teaching status and hospital size have been previously associated with higher volume of ADE related ED visits and hospitalizations (183) as one expected that large teaching hospitals typically have higher volume of ADE related ED visits alongside more complex and acute patients compared to non-teaching hospitals. Findings from this study aligned with the past evidence as they demonstrated that organizational factors (teaching status and larger hospital size) were associated with an increased volume of ADE related ED visits in MRQA Med Rec participating hospitals; indicating that large teaching
hospitals participating in the MRQA Med Rec are comparable to large teaching hospitals elsewhere in Canada.

Successive organizational factor analysis found that the intervention’s effect may be more pronounced in small hospitals with fewer than 50 beds. This was in line with findings from Vira and colleagues(51) who found positive impact of Med Rec intervention at admission in a small hospital ED. Authors noted that the intervention detected that 60% of the patients had at least one unintended variance (discrepancy) between their admission orders and the medications they were taking at home and 18% had at least one clinically important variance. (51) Authors noted that while some variances were intended therapeutic changes, others variances were unintended and were thus considered medication errors. When these errors have clinical consequences—cause harm they there are to be considered actual adverse drug events (or clinically important variances). (51)

4.6.2 Impact of MRQA Med Rec on ADE related hospitalizations

Assessment of descriptive statistics revealed that the changes in the mean number of ADE related hospitalizations could not be associated with the implementation of MRQA Med Rec in acute care units. It is important to note that CIHI was not able to link two hospitals’ facility IDs provided by MRQA Med Rec Alberta to facility IDs in DAD, thus reducing the sample size from 42 to 40 for the analysis.

Results illustrated that implementation of MRQA Med Rec in hospitals may be associated with an increase in the number ADE related hospitalizations. This finding should be interpreted with caution as it could be due to differences in how ADE related hospitalizations have been reported with the advent of MRQA Med Rec. Result is different then the findings by Gillespie and colleagues(87) and Koehler e al.(88) Gillespie et al.(91) found that ADE-related
readmissions at the geriatric ward were reduced by 80% (quotient, 0.06 vs 0.32; estimate, 0.20; 95% CI, 0.10-0.41) following reconciliation in patients 80 years or older. Koehler et al. found that pharmacist assisted Med Rec intervention reduced hospital readmissions (10 percent in the intervention group vs 38.1 percent in the control group, \( P = .04 \)) Inconsistencies in findings in this study and those found by others may be due to several differences such as: population being evaluated (geriatric ward and patients 80 years and older versus cohort of MRQA Med Rec hospitals including all patients that are hospitalized for ADE related event); how ADE related hospitalizations have been reported in administrative data sources; and diversity of healthcare settings in which it was being implemented (a hospital ward versus a group of hospitals that vary in organizational characteristics such as size; teaching status and age).

Results illustrated that larger hospital were more likely to experience higher volumes of ADE related hospitalizations. As with number of ADE related ED visits, this finding was in line with previous findings of Agency for Healthcare Research and Quality (161) from 2011. AHRQ noted that in 2011 – large hospitals experienced over 13 million of preventable ADE hospitalizations; medium hospitals experienced about 4 million preventable ADE hospitalizations; whereas small hospital experienced little over 2 million preventable ADE hospitalizations. (160) The finding that teaching status hospitals were likely to experience higher volumes of ADE related hospitalizations was found in Canadian Adverse Event Study. (53) It may be explained by the fact that teaching hospitals represent the majority of level 1 trauma and transplant centers (meaning most-complex patients and/or higher acuity patients), provide care for urban underserved population, are more often located in high ‘traffic’ urban areas. (53)

Organizational factor analysis revealed that the intervention’s effect may be more pronounced in non-teaching hospitals. Yet, when Dedhia et al. (2009) (182) assessed the impact
of hospital teaching status on ADE related hospitalizations, they noted that following Med Rec fewer patients were readmitted to any hospital, regardless of its teaching status. Further, authors claimed that one of the institutions was largely responsible for the “overall” effect, thus found no impact of the teaching status on the outcome. (182)

The finding in my study may be explained by the differences in medical personnel and degree of patient interaction at teaching and non-teaching hospitals. Medical personnel at non-teaching hospitals are typically independent practitioners with full-time hospital-based practices and outpatient clinic-based practices, while medical personnel at teaching hospitals usually include medical students, interns, residents, and attending physicians. (184, 185) In addition, the complexity of care in teaching hospitals indicates that patients may receive care from numerous different providers, which may increase the risk of ADEs related to miscommunication and coordination of care. (53) Thus, each setting affords a different level of patient interaction and communication. Non-teaching hospitals provide staff with a great opportunity for one-on-one interactions with their patients (giving staff more time and opportunity to discuss ADE related issues). (184, 185)

4.6.3 Assessment of MRQA Med Rec implementation with a Fidelity measure

Low average values of MRQA Med Rec fidelity measure – Quality Audit Bundle at admission denoted that the intervention was not implemented with fidelity. Literature suggests that there is limited empirical information about the process and time required to implement Med Rec. Meguerditchian et al. (2013) examined the workforce and time requirements required to conduct Med Rec at admission in various hospital wards in Canada. Findings indicated that there was a substantial variation in the execution of Med Rec across wards, which could compromise the overall efficiency, quality, and institutional ability to implement the process. (186)
currently available data, it was clear that different hospital departments/units were involved in the MRQA Med Rec implementation, which may have caused a substantial variation in the execution of MRQA Med Rec. Literature found that multi-healthcare professional involvement in an intervention may cause intra and inter-unit inconsistencies (186) resulting in reduced intervention implementation consistency.

4.7 Conclusion

This study examined the association between implementation of MRQA Med Rec intervention in Alberta’s acute care units and changes in ADE related events. Results indicated that implementation of MRQA Med Rec in hospitals was not associated with changes in ADE related ED visits and might have led to an increase in number of ADE related hospitalizations. Organizational factor analysis assessed the impact of organizational factors such as: hospital’s teaching status; size; and age; known to impact hospital performance. Hospital’s teaching status and hospital’s size were associated with an increased volume of ADE related ED visits and ADE related hospitalizations; such that large and teaching hospitals were likely to experience higher volumes of ADE related events. Low average values of MRQA Med Rec fidelity measure – Quality Audit Bundle at admission denoted MRQA Med Rec was not implemented with fidelity in Alberta’s participating acute care units.

Subsequent MRQA Med Rec evaluations should examine the impact of other organizational factors such as staffing intensity, on the intervention implementation. Further research is required to assess the impact of MRQA Med Rec in hospitals on other outcomes such as: all cause ED visits and all cause hospitalizations; to evaluate sustainability of intervention (its impact after 24 and 36 months); and to identify ideal implementation and adoption processes.
Chapter 5: Evaluation of MRQA Med Rec implementation in Alberta’s Long term care facilities

Abstract

Introduction: In Canada, adverse drug events (ADEs) are a significant public health problem. Medication Reconciliation (MRQA Med Rec) was introduced in Alberta’s LTC facilities with an intent to reduce ADE-related healthcare utilization by ensuring that all medication changes are properly noted.

Objectives: Primary objective of this study was to evaluate the effectiveness of MRQA Med Rec implemented in Alberta’s LTC facilities and to assess the impact of organizational factors on intervention’s effectiveness. Secondary objective of this study was to determine the consistency of implementation by assessing the Quality Audit Bundle Compliance at Admission, intervention’s fidelity measure.

Study population: Cohort comprised of Alberta’s LTC facilities, participating in the initiative as of June 2014.

Data collection: Administrative data was linked by facility identifier. Data was acquired for the period between June 1st 2013 and March 31st, 2015.

Methods: Outcomes associated with ADE related healthcare utilization (ADE related ED visits and ADE related hospitalizations) were analyzed using repeated measures with the generalized linear mixed model procedures in SAS. For all parameter tests, \( \alpha \) level was set to 0.05.

Results: In LTC cohort, consisting of 63 publicly funded LTC facilities implementation of MRQA Med Rec could not be associated with changes in number of ADE related ED visits (p-value = .5957) and number of ADE related hospitalizations (p-value = .2039). Organizational factor analysis noted that: facilities size could not be associated with changes in number of ADE related healthcare utilization. Over 10 months, average values of fidelity measure across MRQA Med Rec participating acute care hospitals ranged from 4.06 to 4.57, indicating that the intervention was not implemented with fidelity.

Conclusions: MRQA Med Rec implementation was not associated with changes in ADE related events in publicly funded LTC facilities. Findings indicated that ADE related healthcare utilization in LTC facilities may be underreported in administrative data sources. Subsequent evaluations should include outcomes such as all-cause ED visits and hospitalizations. Further research is required to assess the long-term impact of MRQA Med Rec on LTC facilities on ADE related events and to identify optimal implementation and adoption processes.
5.1 Introduction

Long term care (LTC) facilities represent a heterogeneous care environment. LTC residents may have several providers that influence their medication management, thus one’s medication regimen may be constantly changing without one distinct healthcare provider overseeing and supporting the patient through these processes. (78, 96, 103, 111) And every healthcare visit may be a potential risk point for medication discrepancies. (95)

LTC residents may experience transitions between health care settings that could result in incomplete and/or inaccurate medication information transfers. Boockvar et al. (2004) noted that medication changes that occur during transfers between hospital and nursing home might be linked to discrepancy-related ADEs. Authors noted that ADEs resulting in hospital readmissions occurred in 20 percent of medication changes while the overall risk of ADE per drug alteration was 4.4 percent (95 percent confidence interval, 2.5-7.4 percent). (112) A survey of Alberta’s LTC nurses and pharmacists indicated that: 75 percent of the time medication information was incomplete; 90 percent of the time information was not available in order to determine whether the prescribed drugs were appropriate for the resident’s diagnosis; and, 40 percent of the time medication information was not available at the time of resident’s admission to LTC home. (114) Further, a study by Bronskill et al. (2012) noted that nine or more drug therapies are dispensed concurrently to 10,007 (15.5 percent) of LTC home residents, which puts them at an increased risk for ADEs. (115)

Medication Reconciliation (MRQA Med Rec) was introduced into the Accreditation Canada based on the recommendations of the Accreditation Canada Patient Safety Advisory Committee. (78) In Alberta MRQA Med Rec was adopted through an initiative co-led by Safer Healthcare Now, Canadian Patient Safety Institute (CPSI) and Institute of Safe Medical Practice
It was conceptualized as: 1) an assisting tool for health care providers to reduce the rates of medication discrepancies and 2) as patients’ aid to safely navigate medication changes. There are two specific instances when MRQA Med Rec should occur in the LTC setting: 1) major healthcare setting interface transitions (i.e., admission from a LTC facility to an acute care hospital (MRQA Med Rec at admission) and 2) minor interface transitions (i.e., risk points where medication changes upon transition to/from a primary care physician from/to specialists/from/to LTC home). This study evaluated the impact of MRQA Med Rec at admission as the appropriate implementation of MRQA Med Rec at admission has the potential to reduce ADE-related healthcare utilization by ensuring that all medication changes are properly noted and understood by the patient (LTC resident). Therefore, MRQA Med Rec may be a critical tool to assist in reducing the risk of ADEs by having access to accurate, current and comprehensive medication-use information that follows LTC residents as they move from one care setting to another.

5.2 Rationale

Organizations pursue goals, and the achievement of organizational goals is one aspect of performance known as effectiveness. Healthcare organizations such as LTC facilities aspire to achieve patient safety goals. MRQA Med Rec intervention should be regarded as one means of facilitating the achievement of an organization’s patient safety goals. Besides MRQA Med Rec implementation, other organization level factors may influence effectiveness/the achievement of patient safety goals. Past research highlights a plethora of contextual LTC organizational factors including: LTC size (146, 169, 170) (defined by number of beds) and accreditation status. (171-173) Therefore, in addition to examining relationships between MQRA Med Rec implementation and organizational performance, the study also examined the relationships of these factors to
performance. Findings from this study offered new insights into the extent of variation in MRQA Med Rec within LTC facilities with regards to health system utilization, and the organizational factors associated with its effectiveness.

5.3 Objectives

Objectives of this study were to:

1. Evaluate the impact of the participating MRQA Med Rec intervention in LTC facilities in Alberta on ADE related ED visits and hospitalizations.

2. Characterize the fidelity measure – Quality Audit Bundle Compliance at Admission - on MRQA Med Rec effectiveness in LTC facilities in Alberta. This measure was utilized to assess whether the intervention has been implemented according to the proposed model and to assure policy-makers that services are being implemented as intended and are reaching the target audience.

3. Determine if there were within setting differences regarding the effectiveness of MRQA Med Rec intervention.

4. Identify and examine organizational factors in MRQA Med Rec participating LTC facilities that could potentially explain the relationship between intervention and outcome.

5.4 Methodology

5.4.1 Study population

Cohort consisted of Alberta’s MRQA Med Rec participating publicly funded LTC facilities who submitted anonymized patients’ MRQA Med Rec reports (Seen in Appendix D) as of June 1st 2014.

This study was approved by the institutional review board of University of Toronto.
5.4.2 Explanatory Variable

The explanatory variable of interest was the MRQA Med Rec intervention implemented at LTC facilities across Alberta as of June 2014.

5.4.3 Organizational Factors

Administrative sources that are discussed in the later section were utilized to examine organizational factors that could affect institutional performance measures such as: number of beds in a LTC facility and LTC accreditation. Organizational factors (seen in Figure 5.1) known to impact the quality of care in LTC facilities, were added to the model thereby helping to explain the mechanisms by which MRQA Med Rec ties in with the rest of organizational factors and influences health system utilization.

| LTC | • Number of beds in a LTC facility (Size) (0-50; 50-70; >70 beds)  
|     | • LTC Accreditation Status |

Figure 5-1: Summary of factors known to impact the quality of care in LTC facilities

5.4.4 Outcomes

The outcomes were: 1) number of ADE-related ED visits and 2) number of ADE-related hospitalizations. Primary outcomes were identified administratively using a list of ADE ICD-10 codes (for a list of suggested ICD-10 ADE codes, please see Appendix E), for 1-year pre MRQA Med Rec intervention (pre period June 1st 2013- May 31st 2014) and 1-year post MRQA Med Rec intervention (post period June 1st 2014 to March 31st, 2015). (seen in Figure 5.2)
5.4.5 Fidelity measure

Every intervention should have an ‘associated’ fidelity measure. In this study, Quality Audit Bundle Compliance at Admission was used as a fidelity measure to account for negative or ambiguous findings (174) since without documentation and measurement of intervention’s adherence to the intended model, it was difficult to determine whether unsuccessful outcomes reflect a failure of an intervention or failure to implement the intervention as intended (174). The Quality Audit Bundle Compliance at Admission was used and is a composite measure that was collected through the Med Rec Audit tool (seen in Appendix D), that consists of 5 elements:

1) BMPH > 1 source – indicating that best possible medication patient history was created using more than 1 source of information;

2) Actual Med use is verified by Patient/Caregiver source meaning that patient and/or caregiver confirmed the actual drugs that are used;

3) Each med has drug name, dose, strength, route, frequency on BPMH and Admission Orders – confirming the comprehensiveness of the list;

4) Every med in BPMH is accounted for in Admission Orders; and

5) Prescriber has documented rationale for “Holds” and “Discontinued” meds.
MRQA Med Rec is implemented properly when a fidelity measure receives a score of 5, all other scores (0,1,2,3, or 4) of fidelity measure indicate that MRQA Med Rec has not been properly implemented. Fidelity measure mean values were used to determine if the intervention has been implemented properly.

Outcomes and fidelity measure are summarized below (seen in Figure 5.3).

<table>
<thead>
<tr>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality Audit Bundle Compliance at Admission</strong> (Fidelity measure)</td>
</tr>
<tr>
<td>MRQA Med Rec is implemented with fidelity= 5</td>
</tr>
<tr>
<td>Otherwise = 0</td>
</tr>
<tr>
<td>6. BMPH &gt; 1 source;</td>
</tr>
<tr>
<td>7. Actual Med use is verified by Patient/Caregiver source;</td>
</tr>
<tr>
<td>8. Each med has drug name, dose, strength, route, frequency on BPMH and Admission Orders;</td>
</tr>
<tr>
<td>9. Every med in BPMH is accounted for in Admission Orders;</td>
</tr>
<tr>
<td>10. Prescriber has documented rationale for ‘Holds” and “Discontinued” meds.</td>
</tr>
</tbody>
</table>

**Figure 5-3:** Summary of outcomes and fidelity measure

Study outcomes (ADE related ED visits and ADE related hospitalizations) were used as proxy measures for organizational goals related to successful implementation of MRQA Med Rec, and utilized as measures of organization’s effectiveness. In this study, an organization was considered effective if there were significant reductions in ADEs related ED visits and hospitalization.

### 5.4.6 Data Sources

Data was collected administratively and linked using institution ID. Administrative sources include: 1) CIHI Discharge Abstract Database (ADE related hospitalizations); 2) CIHI National Ambulatory Care Reporting System (ADE related ED visits); 3) Guide to Canadian Healthcare Facilities database (Organizational factors related to LTC facilities). CIHI DAD
contains administrative, clinical and demographic information on hospital admissions (including deaths, sign-outs and transfers) (177) for the 2014–2015 period (up to August 5th, 2015). CIHI NACRS contains data for all hospital-based and community-based ambulatory care: day surgery; outpatient clinics and emergency departments. (178) NACRS data was available for 2014–2015 (up to August 5th, 2015). The 2014 Guide to Canadian Healthcare Facilities, Vol. 21 contains updated listings for hospitals, long-term care centres, regional health authorities and other health related facilities across the country. (175) Data for Quality Audit Bundle Compliance at Admission was obtained from Med Rec Alberta Patient Safety Metrics database.

5.4.7 Analysis

5.4.7.1 Study Variables/Measures

Study variables were collected retrospectively from administrative sources. **Outcomes:** number of ADE related ED visits and hospitalizations were collected from CIHI administrative data sources (Discharge Abstract Database (DAD) and National Ambulatory Care Reporting System (NACRS) that were discussed previously. Data related to Fidelity measure were collected form Med Rec Alberta Patient Safety Metrics database and information related to organizational factors was collected from Guide to Canadian Healthcare Facilities database.

5.4.7.2 Repeated Measures analysis

Repeated measures analysis with the generalized linear mixed model was conducted to evaluate the impact of MRQA Med Rec as well as to assess whether organizational factors can explain intervention-outcome relationship.
Objectives were addressed using the repeated measures analysis that is appropriate for the study considering the objectives, and the timeline. (seen in Figure 5.4)

![Repeated Measures Diagram]

**Figure 5-4:** Pre and Post study timelines

The outcomes consistently measured over a fixed time period were analyzed using repeated measures with the GLM (generalized linear) effects model. Repeated measures analysis was appropriate as this study investigates changes in outcomes over time. This approach allowed for development a time-course for the MRQA Med Rec intervention. Measurements were performed at fixed intervals rather than continuous thus it allowed for a generalized mixed models approach. To fit generalized linear mixed models, I used the GLIMMIX procedure in SAS (*proc glimix* procedure and Poisson distribution (*dist = poisson*). Proc glimmix can be used to directly maximize an approximate integrated likelihood, where the integration over the random effects is obtained using numerical quadrature. METHOD = QUAD option was used to increase the accuracy of the numerical approximation by specifying the number of quadrature points used during evaluation of integrals for the marginal likelihood. The RANDOM statement was used to specify the structure of the covariance matrix for the random effects (G). The structure of G is specified using the TYPE=option. For analysis, it was assumed that random effects are correlated (TYPE=UN). (179)
ED visit and hospitalizations resulting from an ADE are considered somewhat of a rare event and not all health care settings will experience outcomes at all times. This skews the outcome distribution away from a normal distribution. Outcomes were discrete counts of events, thus it was not appropriate to perform a log transformation that would be necessary to ‘normalize’ the distribution. Considering the data, Poisson distribution was a more appropriate option. Differences in primary and secondary outcomes over time were to be considered statistically significant if p-value was less than 0.05.

Past literature has illustrated a relationship between organizational factors (i.e., Size of LTC facility (146, 169, 170) (as defined by number of beds) and LTC accreditation (171-173)) and patient safety outcomes. Organizational factors (LTC accreditation and size of LTC facility (number of beds) ) known to impact the quality of care within LTC setting were added to the model. This assisted in understanding whether these factors alter the intervention-outcome association, thereby helping to explain the mechanisms by which MRQA Med Rec ties in with the rest of institutional elements and influences health system utilization. For this analysis, data from will be linked using the institution ID.

Analysis was performed for all ADE ICD-10 X and Y codes that resulted in ED visits and/or hospitalization in Alberta Med Rec LTC participating institutions between June 2013 and June 2015. All analysis was performed at the institutional level (aggregate level data) using SAS version 9.2

5.4.7.3 Missing values

Missing information was addressed with sequential regression modelling (multiple imputation by chained equations (MICE)) approach.(187) This approach has been used in circumstances where 60 percent of the data was missing.(187) The basic idea of this approach is
to impute missing values in $Y_1$ from a regression of the observed elements of $Y_1$ on $(Y_2, Y_3)$, impute missing values in $Y_2$ from a regression of $Y_2$ on $(Y_1, Y_3)$, and so on. The appropriateness of the imputation model will be assessed using graphical diagnostics that compare the marginal distributions of observed and imputed values.

5.4.7.4 Fit of the Model

To help assess the fit of the model, the goodness-of-fit chi-squared test was used. It assumes the deviance follows a chi-square distribution with degrees of freedom equal to the model residual. We rejected the null model and concluded that the model fits reasonably well if the goodness-of-fit chi-squared test was statistically significant (p-value < 0.05).

5.5 Results

5.5.1 Describing MRQA Med Rec participating LTC facilities

Accreditation Canada's Long-Term Care Services standards are intended for organizations providing high levels of care and 24 hour nursing care. Standards are created based on values of - 1) dignity and respect; 2) Information sharing; 3) partnership and participation; and 4) collaboration. (188)

Table 5.1 describes the distribution of accreditation status among LTC facilities participating in MRQA Med Rec. Results in Table 7.0 indicate that 7 MRQA Med Rec participating LTC facilities are not accredited while 56 participating MRQA Med Rec LTC facilities are accredited.

Table 5-1: Accreditation status of LTC facilities participating in MRQA Med Rec

<table>
<thead>
<tr>
<th>Accreditation</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accreditation</td>
<td>Frequency</td>
<td>Percent</td>
<td>Cumulative Frequency</td>
<td>Cumulative Percent</td>
</tr>
</tbody>
</table>
Table 5.2 described distribution of ownership status among LTC facilities participating in MRQA Med Rec intervention. Findings in Table 4.2 illustrated that there were two ownership categories for MRQA Med Rec participating LTC facilities: 1) lay (n=1) and 2) regional authority board (n=62). This indicated that no privately owned LTC facilities have implemented MRQA Med Rec at this time.

**Table 5-2: Ownership status of LTC facilities participating in MRQA Med Rec**

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lay</td>
<td>1</td>
<td>1.59</td>
<td>1</td>
<td>1.59</td>
</tr>
<tr>
<td><strong>Regional Authority Board</strong></td>
<td>62</td>
<td>98.41</td>
<td>63</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Findings in Table 5.3 illustrated the distribution of size among LTC facilities participating in MRQA Med Rec. In regards to MRQA Med Rec participation there were 33 small LTC facilities (less than 50 beds); 11 medium sized LTC facilities (between 50 and 70 beds) and 19 large facilities (over 70 beds). This division of size was created based on previous research.(147)
Table 5-3: Number of beds in MRQA Med Rec participating LTC facilities

<table>
<thead>
<tr>
<th>N_LTC_Beds</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beds_Total &lt; 50</td>
<td>0</td>
<td>33</td>
<td>52.38</td>
<td>33</td>
</tr>
<tr>
<td>50 &lt;= Beds_Total &lt; 70</td>
<td>1</td>
<td>11</td>
<td>17.46</td>
<td>44</td>
</tr>
<tr>
<td>Beds_Total &gt;= 70</td>
<td>2</td>
<td>19</td>
<td>30.16</td>
<td>63</td>
</tr>
</tbody>
</table>
5.5.2 Repeated measures with generalized mixed model

The administrative rule for CIHI data reported in DAD (source for ADE related hospitalizations) and NACRS (source of ADE related ED visits) denotes that anytime a data count is below 5, it is assigned an asterisk (*). More than 80% of overall data for MRQA Med Rec participating LTC facilities including both ADE related ED visits and ADE related hospitalizations was labelled (*). This may be a result of data reporting problem where an ADE for a LTC resident would result in a fall with a hip fracture. However, at the ED the event would be reported (Main diagnosis) as a hip fracture rather than an ADE. Therefore, for the purpose of analysis, number of ADE related ED visits and number of ADE related hospitalizations in MRQA Med Rec participating LTC facilities were estimated using a combination of published literature. Published literature indicates that about 10% of ADE related ED visits and about 10% ADE related hospitalizations might be attributable to LTC residents (55, 106, 189) as ADE related health system utilization seemed to be underreported/miscoded in administrative data sources (CIHI-NACRS and CIHI-DAD).

ED arrivals and hospitalizations can be well approximated by a Poisson model because, in the absence of a catastrophic event or infections epidemic, people experience injuries or become ill independently of one another. An individual’s risk of an ED visit/hospitalization is likely to vary over time as a function of specific factors and will also vary among individuals. Essentially, this means that there is little or no association between the number of ED visits in one month and the number in the next.
5.5.2.1 ADE related ED visits in participating LTC facilities

Table 5.4 described the mean number of ADE related ED visits across MRQA Med Rec participating facilities over the period of 24 months. Analysis indicated that variance is larger than its mean, which is known as overdispersion of data. By visual assessment, changes in the mean number of ADE related ED visits could not be associated with the implementation of MRQA Med Rec. This indicated that there was not much variation of mean pre and post MRQA Med Rec, yet the maximum reported values seemed to decline during the post-period.

Table 5-4: Mean number of ADE related ED visits across MRQA Med Rec participating LTC facilities

<table>
<thead>
<tr>
<th>mth</th>
<th>Mean Number ADE related ED visits</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (April 2013)</td>
<td>2.7131</td>
<td>3.4411</td>
<td>0</td>
<td>13.9</td>
</tr>
<tr>
<td>2 (May 2013)</td>
<td>2.8726</td>
<td>4.1369</td>
<td>0</td>
<td>16.1</td>
</tr>
<tr>
<td>3 (June 2013)</td>
<td>2.7654</td>
<td>4.0302</td>
<td>0</td>
<td>17.0</td>
</tr>
<tr>
<td>4 (July 2013)</td>
<td>2.6309</td>
<td>3.7978</td>
<td>0</td>
<td>15.1</td>
</tr>
<tr>
<td>5 (August 2013)</td>
<td>2.7190</td>
<td>3.6476</td>
<td>0</td>
<td>13.3</td>
</tr>
<tr>
<td>6 (September 2013)</td>
<td>2.7261</td>
<td>4.0868</td>
<td>0</td>
<td>17.0</td>
</tr>
<tr>
<td>7 (October 2013)</td>
<td>2.7226</td>
<td>3.8748</td>
<td>0</td>
<td>14.7</td>
</tr>
<tr>
<td>8 (November 2013)</td>
<td>2.5559</td>
<td>3.6840</td>
<td>0</td>
<td>14.8</td>
</tr>
<tr>
<td>9 (December 2013)</td>
<td>2.3869</td>
<td>3.3405</td>
<td>0</td>
<td>11.9</td>
</tr>
<tr>
<td>10 (January 2014)</td>
<td>2.3892</td>
<td>3.4243</td>
<td>0</td>
<td>13.7</td>
</tr>
<tr>
<td>11 (February 2014)</td>
<td>2.4571</td>
<td>3.4327</td>
<td>0</td>
<td>12.3</td>
</tr>
<tr>
<td>12 (March 2014)</td>
<td>2.5845</td>
<td>3.6459</td>
<td>0</td>
<td>15.9</td>
</tr>
<tr>
<td>13 (April 2014)</td>
<td>2.8142</td>
<td>4.0875</td>
<td>0</td>
<td>16.6</td>
</tr>
</tbody>
</table>
Table 5.5 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS using an estimated cohort. Findings in Table 4.5 illustrated that implementation of MRQA Med Rec could not be associated with changes in the mean number of ADE related ED visits in participating LTC facilities.

**Table 5-5:** The impact of MRQA Med Rec on ADE related ED visits in participating LTC facilities

<table>
<thead>
<tr>
<th>Date</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14 (May 2014)</td>
<td>2.6357</td>
<td>3.8072</td>
<td>0</td>
<td>14.6</td>
<td></td>
</tr>
<tr>
<td>15 (June 2014) *MRQA Med Rec</td>
<td>2.5285</td>
<td>3.4857</td>
<td>0</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>16 (July 2014)</td>
<td>2.6571</td>
<td>3.8877</td>
<td>0</td>
<td>13.9</td>
<td></td>
</tr>
<tr>
<td>17 (August 2014)</td>
<td>2.6857</td>
<td>3.8303</td>
<td>0</td>
<td>16.3</td>
<td></td>
</tr>
<tr>
<td>18 (September 2014)</td>
<td>2.5011</td>
<td>3.4946</td>
<td>0</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>19 (October 2014)</td>
<td>2.7559</td>
<td>3.7952</td>
<td>0</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td>20 (November 2014)</td>
<td>2.4166</td>
<td>3.1996</td>
<td>0</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>21 (December 2014)</td>
<td>2.5845</td>
<td>3.6677</td>
<td>0</td>
<td>13.7</td>
<td></td>
</tr>
<tr>
<td>22 (January 2015)</td>
<td>2.5809</td>
<td>3.72221</td>
<td>0</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>23 (February 2015)</td>
<td>2.4738</td>
<td>3.4772</td>
<td>0</td>
<td>13.2</td>
<td></td>
</tr>
<tr>
<td>24 (March 2015)</td>
<td>2.7642</td>
<td>3.7196</td>
<td>0</td>
<td>14.2</td>
<td></td>
</tr>
</tbody>
</table>
Based on reviewed literature the impact of organizational factors (size of LTC facility (based on number of beds) and LTC Accreditation status) on ADE related ED visits was assessed individually. These factors were selected as they were previously associated with changes in patient safety outcomes.

Table 5.6 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results indicated that there was no association between Accreditation of LTC facility and ADE related ED visits.

**Table 5-6: Estimating impact of Accreditation on ADE related ED visits**

<table>
<thead>
<tr>
<th>Effects</th>
<th>Accreditation</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>1.5217</td>
<td>0.7364</td>
<td>0.0738</td>
</tr>
<tr>
<td>Accreditation</td>
<td>N</td>
<td>0.6820</td>
<td>0.5841</td>
<td>0.2648</td>
</tr>
<tr>
<td>Accreditation</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type III Tests of Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
</tr>
</tbody>
</table>

| Month*MedRec | 1   | 0   |
Table 5.7 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results indicated that there was no association between size of LTC facility (number of beds) and changes in the number of ADE related ED visits.

Table 5-7: Estimating impact of Size of LTC (number of beds) on ADE related ED visits

<table>
<thead>
<tr>
<th>Effect</th>
<th>N_LTC_Beds_Total</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>1.5753</td>
<td>0.2321</td>
<td>&lt;.1812</td>
</tr>
<tr>
<td>N_LTC_Beds_Total 0</td>
<td></td>
<td>-3.2209</td>
<td>0.3001</td>
<td>&lt;.1752</td>
</tr>
<tr>
<td>N_LTC_Beds_Total 1</td>
<td></td>
<td>-1.1782</td>
<td>0.6731</td>
<td>0.0937</td>
</tr>
<tr>
<td>N_LTC_Beds_Total 2</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.5.2.2 ADE related hospitalizations in participating LTC facilities

Table 5.8 described the mean number of ADE related hospitalizations across MRQA Med Rec participating LTC facilities over the period of 24 months. Analysis indicated that variance was larger than its mean, which is known as overdispersion of data.

By visual assessment, changes in the mean number of ADE related hospitalizations could not be associated with the implementation of MRQA Med Rec in participating LTC facilities.
Table 5-8: Mean number of ADE related hospitalizations in MRQA Med Rec participating LTC facilities

<table>
<thead>
<tr>
<th>mth</th>
<th>Mean number of ADE related hospitalizations</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (April 2013)</td>
<td>1.9850</td>
<td>3.8539</td>
<td>0</td>
<td>17.8</td>
</tr>
<tr>
<td>2 (May 2013)</td>
<td>2.0437</td>
<td>3.9487</td>
<td>0</td>
<td>17.7</td>
</tr>
<tr>
<td>3 (June 2013)</td>
<td>1.8687</td>
<td>3.4902</td>
<td>0</td>
<td>14.5</td>
</tr>
<tr>
<td>4 (July 2013)</td>
<td>2.0950</td>
<td>3.8709</td>
<td>0</td>
<td>15.4</td>
</tr>
<tr>
<td>5 (August 2013)</td>
<td>2.0525</td>
<td>3.7844</td>
<td>0</td>
<td>14.8</td>
</tr>
<tr>
<td>6 (September 2013)</td>
<td>1.9425</td>
<td>3.7869</td>
<td>0</td>
<td>17.1</td>
</tr>
<tr>
<td>7 (October 2013)</td>
<td>2.1325</td>
<td>4.1068</td>
<td>0</td>
<td>16.4</td>
</tr>
<tr>
<td>8 (November 2013)</td>
<td>1.8825</td>
<td>3.5731</td>
<td>0</td>
<td>15.2</td>
</tr>
<tr>
<td>9 (December 2013)</td>
<td>1.8312</td>
<td>3.3756</td>
<td>0</td>
<td>14.1</td>
</tr>
<tr>
<td>10 (January 2014)</td>
<td>1.8875</td>
<td>3.6287</td>
<td>0</td>
<td>15.2</td>
</tr>
<tr>
<td>11 (February 2014)</td>
<td>1.5750</td>
<td>2.8525</td>
<td>0</td>
<td>11.9</td>
</tr>
<tr>
<td>12 (March 2014)</td>
<td>1.9625</td>
<td>3.6329</td>
<td>0</td>
<td>15.1</td>
</tr>
<tr>
<td>13 (April 2014)</td>
<td>1.8175</td>
<td>3.2572</td>
<td>0</td>
<td>12.0</td>
</tr>
<tr>
<td>14 (May 2014)</td>
<td>1.8762</td>
<td>3.2183</td>
<td>0</td>
<td>13.1</td>
</tr>
<tr>
<td>15 (June 2014)</td>
<td><strong>1.8712</strong></td>
<td><strong>3.1853</strong></td>
<td>0</td>
<td><strong>12.4</strong></td>
</tr>
<tr>
<td>*MRQA Med Rec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 (July 2014)</td>
<td>1.9837</td>
<td>3.5233</td>
<td>0</td>
<td>15.5</td>
</tr>
<tr>
<td>17 (August 2014)</td>
<td>1.8337</td>
<td>3.2726</td>
<td>0</td>
<td>13.5</td>
</tr>
<tr>
<td>18 (September 2014)</td>
<td>1.9462</td>
<td>3.5545</td>
<td>0</td>
<td>14.5</td>
</tr>
<tr>
<td>19 (October 2014)</td>
<td>2.0650</td>
<td>3.6282</td>
<td>0</td>
<td>14.4</td>
</tr>
<tr>
<td>20 (November 2014)</td>
<td>1.7587</td>
<td>33.086</td>
<td>0</td>
<td>13.7</td>
</tr>
</tbody>
</table>
Table 5.9 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS using an estimated cohort. Results in Table 4.9 demonstrated that implementation of MRQA Med Rec could not be associated with changes in the number of ADE related hospitalizations in participating LTC facilities.

Table 5-9: The impact of MRQA Med Rec on ADE related hospitalizations in MRQA Med Rec participating LTC facilities

<table>
<thead>
<tr>
<th>Solutions for Fixed Effects</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>.</td>
</tr>
<tr>
<td>MedRec</td>
<td>0</td>
<td>0.2404</td>
<td>0.3549</td>
</tr>
<tr>
<td>MedRec*Month</td>
<td>0</td>
<td>-0.01910</td>
<td>0.2039</td>
</tr>
</tbody>
</table>

Type III Tests of Fixed Effects

<table>
<thead>
<tr>
<th>Intercept</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>MedRec</td>
<td>0.3549</td>
</tr>
<tr>
<td>MedRec*Month</td>
<td>0.2039</td>
</tr>
</tbody>
</table>

Based on reviewed literature the impact of organizational factors (size of LTC facility (number of beds) and LTC Accreditation status) on ADE related hospitalizations were assessed.
individually. These factors were selected as they were previously associated with changes in patient safety outcomes.

Table 5.10 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results indicated that there is no association between Accreditation of LTC facility and the ADE related hospitalizations.

**Table 5-10**: Estimating impact of Accreditation on ADE related hospitalizations

<table>
<thead>
<tr>
<th>Effects</th>
<th>Accreditation</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>Accreditation</td>
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</tr>
<tr>
<td>Accreditation</td>
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<td>0.6733</td>
<td>0.5563</td>
<td>0.2756</td>
</tr>
<tr>
<td>Accreditation</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type III Tests of Fixed Effects**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accreditation</td>
<td>&lt;0.1981</td>
</tr>
</tbody>
</table>

Table 5.11 illustrated results for mixed effects log-linear regression, fitted using adaptive quadrature in PROC GLIMMIX in SAS. Results indicated that there was no association between size of LTC facility (number of beds) and ADE related hospitalizations.

**Table 5-11**: Estimating impact of Number of LTC beds (measure of size of a facility) on ADE related hospitalizations

<table>
<thead>
<tr>
<th>Effect</th>
<th>N_LTC_Beds_Total</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>3.6755</td>
<td>0.2637</td>
<td>&lt;.0976</td>
</tr>
</tbody>
</table>
5.5.2.3  Fidelity measure across MRQA Med Rec LTC facilities

Table 5.12 presented the average value of Quality audit bundle at admission (fidelity measure) over the 10 months MRQA Med Rec at admission implementation was being assessed. Average values of the measure for MRQA Med Rec participating LTC facilities ranged from 4.06 to 4.57, suggesting that LTC facilities might have been more adherent to MRQA Med Rec implementation process.

**Table 5-12**: Mean value of Fidelity measure across MRQA Med Rec participating hospitals and LTC facilities

<table>
<thead>
<tr>
<th>Months</th>
<th>MRQA Med Rec participating LTC facilities</th>
<th>Fidelity measure (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 (June ‘14)</td>
<td>64</td>
<td>4.16</td>
</tr>
<tr>
<td>M2 (July ‘14)</td>
<td>54</td>
<td>4.28</td>
</tr>
<tr>
<td>M3 (August ‘14)</td>
<td>37</td>
<td>4.54</td>
</tr>
<tr>
<td>M4 (September ‘14)</td>
<td>53</td>
<td>4.57</td>
</tr>
<tr>
<td>M5 (October ‘14)</td>
<td>59</td>
<td>4.36</td>
</tr>
<tr>
<td>M6 (November ’14)</td>
<td>36</td>
<td>4.06</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>M7 (December ’14)</td>
<td>51</td>
<td>4.51</td>
</tr>
<tr>
<td>M8 (January ’15)</td>
<td>57</td>
<td>4.46</td>
</tr>
<tr>
<td>M9 (February ’15)</td>
<td>54</td>
<td>4.15</td>
</tr>
<tr>
<td>M10 (March ’15)</td>
<td>88</td>
<td>4.52</td>
</tr>
</tbody>
</table>

### 5.6 Discussion

In Alberta, LTC residents experience transitions between health care settings that could result in adverse patient outcomes.\(^{(112, 114, 115)}\) Medication reconciliation processes, such as MRQA Med Rec arose as the resolution to the well-documented patient safety problem of unintentionally introducing changes in patients’ drug regimen as a result of inadequate or inaccurate medication information during care transitions.\(^{(126)}\) MRQA Med Rec may be a critical tool to assist in reducing the risk of ADEs by having access to accurate, current and comprehensive medication-use information that follows LTC residents as they move from one care setting to another.

This was the first retrospective cohort study to evaluate the impact of MRQA Med Rec across publicly operated Alberta’s LTC facilities at the provincial level. The ‘provincial-level’ approach was selected as a result of a scoping literature review that revealed that most of the reported studies had small sample sizes and were single-site quality improvement projects, indicating the need for a multisite study to assess the impact of this intervention.

#### 5.6.1 ADE related ED visits in MRQA Med Rec participating LTC facilities

By visual assessment, the mean number of ADE related ED visits appeared not to be different following implementation of MRQA Med Rec, indicating that there was not much
variation of mean pre and post MRQA Med Rec. However, the maximum reported values declined during the post-period. Findings illustrated that implementation of MRQA Med Rec was not associated with changes in the number of ADE related ED visits in publicly funded LTC facilities. These results were not consistent with positive impact of Med Rec in LTC setting found in other studies. For example, in the systematic review Chhabra et al. (2010) noted that in all (4) studies implementation of Med Rec led to reduction in hospital utilization (RR=0.38; 95% CI=0.15-0.22) in patients transferred to and from LTC settings.(80) Yet, authors noted that although improvements in the outcome(s) examined was shown in all the studies, there were study design flaws such as: lack of control for confounding factors, small sample size (1 LTC facility), significant crossover in the other aspect of the intervention (medication management) that could lead to an underestimation of the effect of the intervention.(80) Boockvar et al. (2006) demonstrated that LTC residents (after being transferred from hospital to nursing home) had a lower likelihood of experiencing a discrepancy-related ADE (adjusted OR ¼ 0.11, P ¼ .05) following Med Rec intervention.(112) Finally, findings by Crotty et al. (2004) demonstrated that the Med Rec intervention had a protective effect on hospital usage (the combination of emergency department visits and hospital readmissions) (0.38 [0.15-0.99]; P = 0.035)).(190) The discrepancy in findings may be attributable to the notion that LTC cohort consisted entirely of publicly funded LTC facilities and that outcomes have been estimated using a combination of literature and acute care facilities data.

Based on the reviewed literature the impact of organizational factors: size of LTC (146, 169, 170) (based on number of beds) and LTC Accreditation status (171-173) on ADE related ED visits was assessed. Organizational factor analysis indicated that accreditation of LTC facility and size of LTC facility could not be associated with changes in number of ADE related
ED visits. This result is different that findings in previous studies that demonstrated association between facility size and ADEs (146, 169) such that larger LTC facilities were found to have higher number of ADE related events; and non-accredited LTC facilities have been associated with adverse patient outcomes (171, 172). This discrepancy in findings may be attributable to the notion that LTC cohort’s outcomes were estimated using a combination of published literature and acute care hospital data as ADE related outcomes for LTC residents may have been underreported in administrative databases (CIHI-NACRS and CIHI-DAD). (106, 189)

### 5.6.2 ADE related hospitalizations in MRQA Med Rec participating LTC facilities

Visual assessment indicated that the mean number of ADE related hospitalizations was not impacted after the implementation of MRQA Med Rec. Findings demonstrated that implementation of MRQA Med Rec could not be associated with changes in the number of ADE related hospitalizations in participating LTC facilities. Findings were inconsistent with other studies that demonstrated positive effect of the intervention. Crotty et al. (2004) noted reduction in healthcare utilization following the implementation of Med Rec. (190) Inconsistency in results might be a result of the estimated LTC cohort used in this study. LTC cohort was estimated as upon data acquisition from CIHI, it was determined that ADE related healthcare utilization for Alberta’s LTC residents may be underreported and/or miscoded in administrative data sources. This was based on the fact that following data acquisition from CIHI, LTC cohort demonstrated limited experience of ADE related events as most events were labeled with an asterisk (*). To note, in administrative data, counts less than 5 are labeled with asterisk (*). Therefore, in this study, it was not possible to postulate the true effect of MRQA Med Rec in LTC facilities and to comment whether it contributed to overestimation or underestimation of the risk of ADEs.
Published literature indicates that about 10% of ADE related ED visits and about 10% ADE related hospitalizations might be attributable to LTC residents. (106, 189, 191)

Organizational factor analysis revealed that there was no association between organizational factors (accreditation of LTC facility, size of LTC facility (number of beds)) and ADE related hospitalizations. These results were inconsistent with previous studies that showed association between these organizational factors and adverse outcomes (facility size (146, 169) and accreditation status (171-173)); but this inconsistency in findings may be attributable to estimated LTC cohort’s outcomes. That estimation was discussed previously.

5.6.3 Assessment of MRQA Med Rec implementation with a Fidelity measure

The average values of MRQA Med Rec at admission (fidelity measure) over the 10 months for participating LTC facilities suggested that intervention was not implemented with fidelity, yet that LTC facilities might have been somewhat adherent to MRQA Med Rec implementation process. Literature found that multi-healthcare professional involvement in an intervention may cause intra and inter - unit inconsistencies. (186) Multi-healthcare professional involvement in MRQA Med Rec in publicly funded healthcare facilities may explain the month-to-month variations of intervention implementation that was 10% on average.

5.7 Conclusion

Implementation of MRQA Med Rec in publicly funded LTC facilities could not be associated with changes in the number of ADE related events. Organizational factor analysis noted that organizational factors (size of the LTC facility and its accreditation status) could not be associated with changes in ADE related events. Fidelity measure analysis noted that publicly funded facilities may have been somewhat adherent to intervention implementation protocol.
Findings indicated that ADE related healthcare utilization may be underreported in administrative data sources. This was based on the fact that following data acquisition from CIHI, LTC cohort demonstrated limited experience of ADE related events. Subsequent evaluation of MRQA Med Rec intervention should include other outcomes such as all-cause ED visits and hospitalizations as these events may be more accurately reported in administrative sources. Further research is required to assess the impact of MRQA Med Rec in LTC facilities and to identify optimal implementation and adoption processes.
Chapter 6: Synthesis

6.1 Study overview

In Alberta, Medication Reconciliation Alberta (MRQA Med Rec) has been implemented in hospitals and continuing care facilities with the aim of enhancing medication safety. Past evidence illustrated that medication reconciliation (Med Rec) interventions similar to the MRQA Med Rec reduced medication discrepancies, thus reducing the probability of ADEs. Yet, other Med Rec interventions were implemented in specific settings and among at risk populations, thus limiting generalizability of findings. This was the first study that: 1) undertook a system level evaluation of (MRQA) Med Rec intervention; 2) considered the impact of organizational factors on intervention’s effectiveness; and 3) considered the influence of fidelity of the intervention’s implementation on outcomes.

The primary objective of this thesis was to evaluate the effectiveness of MRQA Med Rec at admission in two care settings in the Province of Alberta: acute care hospitals and LTC facilities. Secondary objectives were to:

1. Characterize Alberta’s healthcare institutions participating in the intervention and compare with non-participating institutions to assess if there are statistically significant differences between two groups.
2. Evaluate the impact of the MRQA Med Rec intervention in acute care hospital units and LTC facilities in Alberta on ADE related ED visits and hospitalizations.
3. Determine the consistency of MRQA Med Rec implementation by assessing the Quality Audit Bundle Compliance at Admission, intervention’s fidelity measure. This measure was utilized to assess whether the intervention has been implemented according to the proposed model and to assure policy-makers that services are being implemented as
intended and are reaching the target audience.

4. Determine if there were between and within setting differences regarding the effectiveness of MRQA Med Rec intervention.

5. Identify and examine organizational factors that could potentially explain the relationship between intervention and outcome.

To achieve these research objectives, we conducted a retrospective cohort study using generalized linear mixed models.

6.2 Main findings

6.2.1 Characteristics of Alberta’s acute care hospitals

Descriptive findings illustrated that as of June 2014, 52 out of 63 Alberta’s acute care units have implemented MRQA Med Rec intervention. MRQA Med Rec Alberta dataset contained information on 52 hospitals participating in the intervention, yet CIHI was able to match only 42 hospitals based on name and facility IDs, provided by MRQA Med Rec Alberta. Acute care cohort consisted of: 1) 34 non-teaching status hospitals and 8 teaching hospitals (75% of participating hospitals were non-teaching facilities); 2) 28 small hospitals (less than 50 beds); 1 medium hospital (more than 50 but less than 70 beds); and 13 large hospitals (over 70 beds) – (67% of participating hospitals had fewer than 50 beds); 3) 7 hospitals that were built prior to 1920; 17 hospitals that were built between 1920 and 1970 and 8 hospitals that were built after 1970. Hospital’s age was not available for 10 acute care units that have implemented MRQA Med Rec intervention.
6.2.2 Impact of the MRQA Med Rec Intervention in Alberta’s hospitals

Analysis indicated that implementation of MRQA Med Rec in hospitals was not associated with changes in number of ADE related ED visits (p-value = 0.1090) yet organizational factor analysis found that the intervention may have a more pronounced impact in hospitals with fewer than 50 beds (p-value < 0.0001).

Analysis noted that implementation of MRQA Med Rec in hospitals may be associated with changes in number of ADE related hospitalizations. (p-value < 0.0001) With regards to ADE related hospitalizations, organizational factor analysis noted that while hospitals’ age could not be associated with changes in number of ADE related hospitalizations (p-value = 0.1418); larger size hospital (p-value < 0.0001) and teaching hospitals (p-value = 0.0047) were likely to experience higher volumes of ADE related hospitalizations.

6.2.3 Characteristics of publicly funded Alberta’s LTC facilities

Findings noted that out of 204 Alberta’s LTC facilities, only 62 publicly funded LTC facilities have implemented MRQA Med Rec intervention. LTC cohort compromised exclusively of publicly funded facilities where: 1) 56 LTC facilities have been accredited and 7 have not been accredited; 2) 33 were small LTC facilities (fewer than 50 beds); 11 were medium sized LTC facilities (more than 50 but less than 70 beds); and 19 were large LTC facilities (over 70 beds).

6.2.4 Impact of the MRQA Med Rec Intervention in publicly funded Alberta’s LTC facilities

Findings noted that implementation of MRQA Med Rec could not be associated with changes in number of ADE related ED visits (p-value = 0.5957) and number of ADE related hospitalizations (p-value = 0.2039) in publicly funded LTC facilities. Organizational factor analysis
noted that: facilities size (p-value <.2371) and accreditation status (p-value .1712) could not be associated with changes in number of ADE related ED visits and that facilities size (p-value <.1347) and accreditation status (p-value .1981) could not be associated with changes in number of ADE related hospitalizations.

To note that findings for MRQA Med Rec participating LTC facilities should be interpreted with caution as LTC facility cohort outcomes were estimated using a combination of published literature and hospital data since information pertaining to LTC facilities ADE related healthcare utilization may be underreported in administrative data sources (CIHI-NACRS and CIHI-DAD).

6.2.5 Assessment of intervention’s implementation (fidelity measure) in the acute care hospitals

The fidelity of intervention implementation indicates that an intervention was being implemented as intended by the researchers, developers or policy makers. (174) The fidelity of implementation consists of key elements: 1) adherence; 2) exposure/duration; and 3) quality of delivery. (174) Appropriate adherence is achieved by following the instructional procedures as intended and by implementing all components of the intervention in the correct order. Findings indicated that MRQA Med Rec was not implemented with fidelity in Alberta’s acute care facilities and LTC facilities, as indicated by Quality Audit Bundle at admission values (Fidelity measure).

6.2.6 Assessment of intervention’s implementation (fidelity measure) in publicly funded LTC facilities

Findings indicated higher values of the fidelity measure in publicly funded LTC facilities
suggesting that LTC facilities might have been more adherent to MRQA Med Rec implementation process that participating hospitals. Findings noted that values of the fidelity measure in publicly funded LTC facilities demonstrated higher consistency with 10% of month-to-month variations whereas month-to-month measure variation in participating hospitals reached 20%. These findings are significant as implementing an intervention with fidelity increases the likelihood that the intervention will lead to intended outcomes.

6.3 Study implications

6.3.1 Clinical/Policy implications

Transitions in care, such as hospital admission, place patients at risk for medication errors due to poor communication and inadvertent information loss. As reported by CADTH (192) Med Rec is a resource-intensive activity developed to address the well-documented problem of unintended medication discrepancies introduced during transitions in care. Med Rec is typically carried out by one health care provider, but the process generally requires input from various members of the healthcare team. Thus is requires a high degree of multidisciplinary cooperation or collaboration to maximize the impact from the effort.

Adhering to a Med Rec process takes time, initially an additional 30 to 60 minutes per admission. If a hospital department has multiple admissions, it can translate to the need for additional full-time staff. For instance, if nurses are responsible for the MRQA Med Rec process, nursing hours per patient day may need to increase. These changes may impact costs associated with intervention implementation and sustainability costs yet few studies have been published that outlined the costs associated with design, implementation and sustainability of Med Rec intervention. Therefore, there is a need for more detailed ‘costing’ data in subsequent
MRQA Med Rec evaluation studies to evaluate the potential cost-effectiveness of the intervention.

6.3.2 Measurement implications

In the absence of data containing factors (variables) previously associated with organizational performance, this study required “augmenting” of data acquired through AHS. The augmentation was done with regards to data on organizational characteristics, e.g., organizational size, that have been associated with organizational performance in studies in the field of organization science. Subsequent studies of MRQA Med Rec should consider including measures shown to be associated with organizational effectiveness (as related to patient safety) and whose impact has been previously demonstrated such as staffing intensity.

In January 2014 Accreditation Canada’s Med Rec Required Organizational Practices (ROP) included a user friendly tool (Quality Audit Bundle at admission – Fidelity measure) to be a measure of Med Rec protocol compliance. (as seen in Appendix 4) At present, Alberta’s MRQA Med Rec participating organizations are required to monitor compliance with their Med Rec process, and make necessary improvements. Descriptive assessment of the tool indicated that neither MRQA Med Rec participating hospitals, nor participating publicly funded LTC facilities demonstrated protocol compliance. Fidelity measure analysis demonstrated need for implementation improvements.

6.3.3 Research implications

This was the first ‘multisite’ study to take on a provincial level evaluation of the MRQA Med Rec intervention and its impact on health system utilization in hospitals and publicly funded LTC facilities in Alberta. This study represents the first attempt to examine intervention implementation at multiple organizational sites. Also, it was the first effort to concurrently
examine intervention implementation in two healthcare sectors, acute care hospitals and LTC facilities. Typically, Med Rec evaluation studies are performed at a single hospital (ward) (82) or multiple wards (124); and/or for selected (often described as high risk) patient population. (87, 127)

Study results call for additional ‘multisite’ studies to be conducted on all aspects of MRQA Med Rec processes (admission; care transitions and discharge). Successive evaluative studies should be conducted in all healthcare settings where the intervention is now being implemented (hospitals, LTC facilities and home care) to provide a comprehensive evidence base of intervention’s impact on ADE related health system utilization and system level impact in a more general sense (all cause hospitalizations). Specifically, additional research is needed to: 1) assess the impact of MRQA Med Rec in LTC facilities (including proprietary LTC facilities); 2) evaluate impact of the MRQA Med Rec on health care utilization outcomes such as all cause ED visits and hospitalizations in acute care hospitals; 3) evaluate the impact of MRQA Med Rec in home care settings (MRQA Med Rec has been expanded to home care clients); and 5) identify optimal intervention’s implementation and adoption processes.

Ensuing studies on MRQA Med Rec effectiveness should include a matched control group not undergoing the intervention. With a control group, it may be more scientifically appropriate to establish the cause and effect relationship between the intervention and outcomes. Further, studies of the sustainability of MRQA Med Rec process should be carried out to illustrate long-term effect of the intervention (changes in outcomes in 24 and 36 months).

Given the underreporting of ADE related health system utilization in administrative data, it may be important for future research to include additional data sources, such as chart-abstracted data, to address questions similar to those addressed by this study.
6.3.4 Theoretical implications

To illustrate the impact of MRQA Med Rec and specific organizational factors, on ADE related health system utilization, the study applied the Accident Causation Model (ACM), popularly referred to as the “Swiss Cheese Model of System Failure”. The basic premise in the system approach is that humans are fallible and errors are to be expected. Errors could result from: active failures (also know as unsafe acts) and latent conditions. In the context of MRQA Med Rec, the medication error (unintentional discrepancy), could be considered an example of an unsafe act, resulting from a skills based error; rule-based mistake or situational violation. Regardless of the underlying mechanism of action, a medication error could result in an ADE that could impact patient safety outcomes. In the context of MRQA Med Rec, latent conditions may include factors such as: pre-conditions for unsafe acts; unsafe supervision and organizational influences. Pre-conditions for unsafe acts –could be perceived as conditions such as: 1) mental fatigue of health care professionals due to reduced nurse to patient ratio; 2) lack of communication regarding changes in patient’s medication regimen, between health care professionals in the patient circle of care as well as between health care professionals, patient and family; and 3) undocumented care coordination in care settings. Unsafe supervision could be perceived as a trigger responsible for poor communication and breakdown of care coordination. For example, uninformed caregivers might be unfamiliar with changes such as alternations to patient’s list of medication delivery. Also, dosing errors and synergistic drug effects could result from lack of documentation of new and discontinued medication. Organizational influences can also impact organization’s effectiveness and performance at all levels. (128) For instance, in times of fiscal austerity, funding may be cut and as a result, there may be a reduction in nurse to patient ratios (changes to staffing intensity).
Further, the ACM model indicates that to varying degrees every step in MRQA Med Rec process had the potential for failure. The holes in the “cheese” represent opportunities for a process to fail, and each of the slices represent defensive layers in the process. An error may allow a problem to pass through a hole in one layer, but in the next layer Med Rec intervention could rearrange the holes in different places and the errors could be detected/prevented. Therefore, subsequent layers were considered as defense mechanisms against potential error affecting health outcomes, more specifically ADE related healthcare utilization. (128) The model was applied based on the premise that in order for MRQA Med Rec to have an impact on ADEs, active and latent failures need to be identified during the reconciliation process by health care professionals, patients and their caregivers across the various care transitions points.

Results of this study affirm previous findings that many interventions although effective in health services research studies fail to translate into meaningful patient care outcomes, such as ADE related health system utilization, across multiple contexts. (193) Further, frameworks such as Accident causation model may be heavily focused on summative outcomes. Subsequent, Med Rec evaluations should focus on evaluation of formative outcomes in order to assess the extent to which implementation is effective in a specific setting. This approach would not only prolong sustainability of the intervention but would also promote its dissemination into other settings. (194) The use of formative evaluation proves would allow us to understand why an intervention can be successfully implemented in one setting but not in another. (194) When considering evaluation focused on formative outcomes, Consolidated framework for advancing implementation science (CFIR) seems like a meaningful option. The framework comprises 39 constructs organized across 5 major domains: intervention characteristics, outer setting, inner setting, characteristics of individuals involved, and the process of implementation. Evidence
suggests that CFIR entails a common language by which determinants of implementation can be articulated, meanwhile providing a comprehensive, standardized list of constructs that would serve as a guide for researchers as they identify variables that are most salient to implementation of Med Rec intervention. (194)

Another framework, that could be used in future evaluations of Med Rec is the one proposed by Chaudoir et al. (2013) (195) This would be a relevant framework (as seen in Figure 6.1) (195) as within its many levels it also includes the organization-level factors. The organizational-level factor entails a number of constructs that represent aspects of the organizational in which an intervention, such as Med Rec, is being implemented and that may determine the success of intervention implementation.

Figure 6-1: Adapted from Chaudoir et al.

Going forward, MRQA Med Rec intervention evaluations might include: 1) measures of organizational protocol compliance/fidelity. More specifically, in subsequent studies evaluating Med Rec effectiveness the fidelity measure, or a measure like it, should be embedded within the theoretical framework and 2) consider/evaluate the extent to which potential or actual harm
associated with unreconciled medications is communicated to providers such that they can respond to this feedback.

MRQA Med Rec is itself an incredibly complex intervention, yet during high-risk periods like admission to hospital, some researchers suggest that MRQA Med Rec is only one component of a larger ‘bundle’ of interrelated critical elements that ideally should be applied. (196) Perhaps then, it is unsurprising that this evaluation of one component of a complex bundle of interventions did not itself significantly impact ADE related health system utilization.

Figure 6-2: Adapted from Canadian Consensus on Clinical Pharmacy Key Performance Indicators

Fernandes and colleagues (197) describe MRQA Med Rec as a one of a “bunch of grapes” (seen in Figure 6-2), where the bunch characterizes a bundle of comprehensive direct patient care activities and corresponds to the evidence that only a bundle of integrated patient care activities can lead to meaningful improvement in patient outcomes. The Figure reinforces
that while MRQA Med Rec is an important element of safe and effective patient care. It represents an incredibly valuable element of the reconciliation process as: 1) it is the first step of interaction with the patient; and 2) it may be considered a ‘phased-in’ approach that could facilitate any subsequent MRQA Med Rec processes as patients’ Best Possible Medication History (BPMH) has already been created. MRQA Med Rec at admission is a component of bundle of interrelated critical elements (seen in Figure 6.2).

Integrating the grape analogy with the Accident causation model (also known as Swiss Cheese Model of System Failure), as seen in Figure 6.3 (197) conceptualizes MRQA Med Rec at admission as a single grape, a first step in medication reconciliation process that is essential but not sufficient on its own to effectively break the cycle of active and latent failures associated with the incidence of ADEs, where other steps in the reconciliation process (depicted here) ideally follow.

![Figure 6-3: Adapted from Agency for Healthcare Research and Quality](image)

To mitigate the impact of ADEs, it is important to acknowledge that such events exist, identify them, and analyse their causes. (198) Considering ADEs impact on patients and health
care system, initiatives such as MRQA Med Rec should remain a major focus of patient safety efforts and a “systems-level” orientation, with active involvement of an array of healthcare facilities. MRQA Med Rec should be perceived as a continuing effort to improve patient safety rather than an approach that finds and attaches blame to individuals and organizations.
6.4 Strengths and Limitations

6.4.1 Strengths of the Study

6.4.1.1 Study Design and analytical approach

This was the first Med Rec evaluative study with a ‘multisite’ system-level evaluative approach with a focus on both acute care hospitals and publicly funded LTC facilities. The ‘provincial-(multisite) system level’ approach was selected as a result of a scoping literature review that revealed that most of the reported studies had small sample sizes and were single-site quality improvement projects, indicating the need for a multisite study to assess the impact of this intervention.

The study employed a repeated measure design allowing for exclusion of the effects of individual differences that could occur if two different “participants” are used instead.(199) Other benefits of repeated measures include: 1) more statistical power; 2) recruitment of fewer subjects; 3) quicker and cheaper to complete; and 4) can assess an effect over time.(197)

Regarding increased statistical power, repeated measures designs can be very powerful because they can control for factors that cause variability between subjects, as discussed above. As a result of greater statistical power, a repeated measures design may require fewer subjects to detect a desired effect size. Further sample size reductions are possible because each subject may be involved with multiple treatments. For example, if an independent groups design requires 30 subjects per experimental group, a repeated measures design may only require 30 in total. Essentially, in repeated measures fewer subjects need to be recruited, trained, and compensated to complete an entire experiment. Finally, repeated measures designs can track an effect over time, such as the learning curve for a task. In such case, it may be more pragmatic to measure the same subject at multiple times rather than different subjects at one point in time for each.(197)
6.4.1.2 Administrative data

CIHI datasets used in the thesis (NACRS and DAD) have been recognized nationally and internationally for their comprehensiveness and high standards. NACRS and DAD contain an administrative data repository – a vast, secure array of linked and encoded health-related data. (177, 178) Data is received directly from acute care facilities or from their respective health/regional authority or ministry/department of health. (177, 178) Facilities in all provinces and territories except Quebec are required to report. Further, use of administrative data provided the flexibility to link records across a large breadth of data. (177, 178) This data has been used to make scientific and policy-relevant discoveries that have helped to inform the delivery of evidence-based health care in across Canada and abroad. (199)

6.4.2 Limitations

6.4.2.1 Study Design

The disadvantage of repeated measures design was the lack of a matched control group not undergoing the intervention. This limited the value of information obtained on the intervention-outcome link. Without a control group, it may be difficult to establish the cause and effect relationship between the intervention and an outcome. (199) The repeated measure design did not take into account temporal changes. These may be changes that are taking place independently of the MRQA Med Rec intervention (i.e. other interventions) that could affect the ADE related events.

Another limitation of the study was that information on the exact date each facility joined the intervention was not available. It would have been beneficial to know the exact date each participating facility joined MRQA Med Rec rather than assuming all facilities joined in June 2014 as that would give a more accurate estimate of the intervention’s effect.
6.4.2.2 Administrative data

Administrative data has not been created for research purposes; lacks standard methods for measuring data quality; and the accuracy of administrative data has been defined an elusive construct and should not be expected. (199)

Further, it was not possible to postulate the true effect of MRQA Med Rec in LTC facilities and to comment whether it contributed to overestimation or underestimation of the risk of ADEs as cohort was estimated using a combination of published literature and hospital data. Published literature indicates that about 10% of ADE related ED visits and about 10% ADE related hospitalizations might be attributable to LTC residents. (54, 106, 189)

Institutional aggregate level data was used for the analysis. Data aggregation can lead to information loss, which may occur in the substitution of aggregate (macro level) data for individual (micro level) data; data initially collected at the organizational level cannot be used for lower levels of aggregation; and aggregate data systems often lack the flexibility to examine relationships among variables. (200)
## Appendix 1: Brief summary of Med Rec interventions

<table>
<thead>
<tr>
<th>Type of Med Rec</th>
<th>Mechanism of action</th>
<th>Settings</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physician led</strong>**(201)**</td>
<td>“One-write” non-carbon prescription form that generated an instant copy. Primary care physician lists all ordered meds in patient chart.</td>
<td>Ambulatory</td>
<td>Changes in prescription documentation</td>
</tr>
<tr>
<td><strong>Educational</strong>(202)</td>
<td>Interventions to provide performance feedback and training to the healthcare team, increase patient awareness and participation in the Med Rec process.</td>
<td>Academic ambulatory primary care internal medicine clinic</td>
<td>Completeness and correctness of medication lists</td>
</tr>
<tr>
<td><strong>Co-led by (Hospital) Pharmacist&amp;Physician</strong>(51)</td>
<td>Comprehensive medication use history obtained from multiple sources (the patient and/or caregiver and examination of medication vials).</td>
<td>Canadian community hospital</td>
<td>Unintended medication variances</td>
</tr>
<tr>
<td><strong>Pharmacist-led</strong>(203)</td>
<td>Review of medical records for discrepancies between patient’s home medications at the time of admission and the admission orders in the ED that had not been resolved within 24 h</td>
<td>Canadian ED</td>
<td>Rate of medication discrepancies</td>
</tr>
</tbody>
</table>
of admission.

<table>
<thead>
<tr>
<th>Intervention Type</th>
<th>Description</th>
<th>Location</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacist-led(204)</td>
<td>Seamless monitoring (RCT)</td>
<td>Canada General ward</td>
<td>Number, type and potential clinical impact of drug-therapy problems</td>
</tr>
<tr>
<td>Pharmacist-led(52)</td>
<td>Combined intervention of pharmacist medication assessments and a postop medication order form. (RCT)</td>
<td>Canada Surgical ward</td>
<td>Rate of medication discrepancies</td>
</tr>
<tr>
<td>Educational(82)</td>
<td>Multimodal intervention involving medication reconciliation with real-time feedback and education</td>
<td>General ward New Zealand</td>
<td>Number of errors made by medical staff</td>
</tr>
<tr>
<td>Pharmacist-led(127)</td>
<td>Systematic medicine reconciliation in the ED before patient transfer and initiated the original inpatient prescription chart.</td>
<td>ED UK</td>
<td>Number of prescribing errors</td>
</tr>
<tr>
<td>Physicians-led(83)</td>
<td>'Limited questions list' for medication history acquisition</td>
<td>ED Belgium</td>
<td>Frequency of drug omissions in medication histories</td>
</tr>
<tr>
<td>Co-led by pharmacist &amp; pharmacologist(123)</td>
<td>Systematic medication review and medication counselling</td>
<td>Acute hospital ward internal medicine Denmark</td>
<td>Length of in-hospital stay Readmissions Mortality</td>
</tr>
<tr>
<td>Study Type</td>
<td>Description</td>
<td>Location</td>
<td>Outcome Measures</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Physicians-led (125)</td>
<td>Clinical pharmacist discharge service</td>
<td>Teaching hospital, Netherlands</td>
<td>Frequency of prescription errors in discharge medication Medication discrepancies after discharge combined</td>
</tr>
<tr>
<td>Co-led by Pharmacist &amp; Physician (205)</td>
<td>Integrated medicines management to ease transition from hospital to primary and community care</td>
<td>Hospital ward, Sweden</td>
<td>Rate of Medication errors</td>
</tr>
<tr>
<td>Standardized medication reconciliation tool (86)</td>
<td>Medication Report</td>
<td>Hospital ward, Sweden</td>
<td>Medication error resulting in: Readmission to hospital and/or Visits to primary and out-patient secondary health care</td>
</tr>
<tr>
<td>Pharmacist-led (206)</td>
<td>Systematic medication reconciliations upon hospital admission and of a medication review while in hospital on the number of inappropriate medications and unscheduled drug-related hospital revisits in elderly patients.</td>
<td>Internal medicine ward, Sweden</td>
<td>Number of inappropriate drugs</td>
</tr>
<tr>
<td>Pharmacist-led (87)</td>
<td>Medication review</td>
<td>Hospital ward, Sweden</td>
<td>Morbidity and ADE related ED visits and hospitalizations.</td>
</tr>
<tr>
<td>Pharmacist-led(207)</td>
<td>Pharmacists eliciting medication histories to prepare medication charts</td>
<td>ED in Community hospital Australia</td>
<td>Frequency and clinical significance of medication errors</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------</td>
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<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Pharmacist-led(208)</td>
<td>Medication histories and supplementary prescribing</td>
<td>Surgical ward</td>
<td>Rate of medication errors</td>
</tr>
<tr>
<td>Multimodal(82)</td>
<td>Multimodal intervention involving medication reconciliation with feedback and education for</td>
<td>Teaching hospital general ward</td>
<td>Medication discrepancy rate</td>
</tr>
<tr>
<td>Pharmacist-led(209)</td>
<td>Patient education counselling informing the patient how to take their drugs; a pharmaceutical discharge letter detailing changes made to drug therapy (this was faxed to the patient's GP and community pharmacist on the day of discharge); provision of a Medicines Helpline.</td>
<td>Community hospital, Northern Ireland</td>
<td>Medication discrepancy rate</td>
</tr>
<tr>
<td>Pharmacist-led(210)</td>
<td>Pharmacist medication review, patient counselling, and telephone follow-up</td>
<td>Teaching hospital general ward</td>
<td>Medication discrepancies</td>
</tr>
<tr>
<td>Multimodal(88)</td>
<td>Targeted care bundle - medication counseling/reconciliation by a clinical pharmacist (CP), condition specific education/enhanced discharge planning by a</td>
<td>Hospital ward</td>
<td>30-day post-discharge ED visits/hospitalizations</td>
</tr>
</tbody>
</table>
care coordinator (CC), and phone follow-up.

<table>
<thead>
<tr>
<th>Pharmacist-led(92)</th>
<th>Medication therapy assessment, medication reconciliation, screening for adherence concerns, patient counselling and education, and post discharge telephone follow-up.</th>
<th>Hospital ward</th>
<th>Medication discrepancies 14-day and 30-day readmission rates ED visits within 72 hours of discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Med Rec(211)</td>
<td>Interactive reminder alert</td>
<td>Acute inpatient care unit</td>
<td>Unintended discrepancy rate</td>
</tr>
<tr>
<td>Multimodal(212)</td>
<td>Complete and comprehensive home medication history interview conducted by a pharmacist or designee (pharmacy student or intern with subsequent verification by a pharmacist) within 24 hours of arrival. All components of the medication history are documented utilizing an integrated electronic medical record (EMR) medication documentation tool.</td>
<td>Acute inpatient care unit</td>
<td>Medication error rate across surgical and general ward</td>
</tr>
<tr>
<td>Electronic(89)</td>
<td>Computerized medication reconciliation tool and process redesign involving physicians, nurses, and pharmacists</td>
<td>General medical inpatient units at 2 academic hospitals from May to</td>
<td>Unintentional discrepancies between preadmission medications; admission or discharge medications that had potential for harm</td>
</tr>
<tr>
<td><strong>Electronic (90)</strong></td>
<td>Standardized electronic discharge instructions document with embedded computerized Med Rec</td>
<td>Acute hospital unit</td>
<td>Composite variable of readmission or Emergency Department (ED) visit within 30 days of discharge. Secondary outcomes were the individual variables of readmissions and ED visits within 30 days.</td>
</tr>
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</tr>
<tr>
<td><strong>Multidisciplinary (84)</strong></td>
<td>Nurses, pharmacists, and physicians used an admission/discharge medication reconciliation form to reconcile patients' home medications on admission/discharge.</td>
<td>Acute hospital unit</td>
<td>Mean number of medication discrepancies at admission and discharge.</td>
</tr>
<tr>
<td><strong>Pharmacist-Nurse co-led (85)</strong></td>
<td>Systematic approach for obtaining a medication history</td>
<td>Surgical ward</td>
<td>Rate of medication error</td>
</tr>
</tbody>
</table>
Appendix 2:  *MRQA Med Rec* steps in acute care hospital

**Best Possible Medication History (BPMH)**

Medication discrepancies between admission medication orders and BPMH can be either: an undocumented intentional discrepancy or unintentional discrepancy. (95) An undocumented intentional discrepancy is one in which the prescriber makes an intentional choice to change or discontinue a drug, but the choice is not clearly documented. An unintentional discrepancy is one in which the prescriber unintentionally changed, added, or omitted a medication that the patient was taking prior to hospital admission. This could turn into a medication error and result in an adverse drug event. To determine whether an unintentional discrepancy has occurred, all inconsistencies in the BPMH information should be confirmed with the prescriber and resolved. It is desirable for reconciliation processes to occur at internal transfers between hospital units and other levels of care. BPMH is 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. (Including both prescribed and non-prescribed). Each organization needs to define what to include in the BPMH as is relevant in their setting. Blood products, medical gases, nutritional supplements, and IV solutions are usually not included in BPMH. BPMH needs to be obtained as soon as possible and the entire Med Rec process should be done within 24 hours from the time of the decision to admit. BPMH should be completed by a qualified healthcare professional such as nurse, nurse practitioner, physician pharmacist or pharmacy technician.

*Reconciliation process at admission*

The purpose of reconciliation on admission is to make sure that there is a concise communication about decisions the prescriber decides to continue, discontinue, or modify the medication
regimen upon admission that the patient has been taking before being admitted. (95) The admission Med Rec processes are either: 1) proactive process (seen in Figure 7.1) or 2) retroactive process (seen in Figure 7.2) (95).

**Figure 7-1:** Adapted from Fernandes OA - Proactive reconciliation process
Although it is beneficial to have a single reliable process, it may be necessary to have a combination of processes based on complexity of patients, organization or staffing. This combination of models is sometimes referred to as a mixed model. (95) For instance, as complexity of patients and number of staffing may vary depending on the day of the week, a proactive model may be used on weekdays but retroactive process may be used on weekends. This is more pragmatic as proactive model may not be easily administered at sites with high admission volumes like during crowded shift in ED.

**Reconciliation at internal hospital transfer**

Internal hospital transfers are often associated with change in patient status. For instance, transfers from ward to intensive Care Unit (ICU) would signal deterioration while transfers from ICU to a ward indicate improvement. Evidence indicates that care transfers represent vulnerable
moments during which patients are at an increased risk for medication errors as a result of poor communication between care teams. Past evidence suggests that: 21 percent of patients required at least one change in their transfer medication orders as a result of errors detected through the use of Med Rec tool as a result of failure to review chronic medication upon transfer from ICU, 33 percent of patients ultimately had one or more of their chronic medications omitted at discharge from hospital. (95) Please see Figure 7.3 (95) for detailed description of MRQA Med Rec at internal patient transfer.

**Process of Med Rec at Internal Transfer**

![Process of Medication Reconciliation at Transfer](image)

**Figure 7-3:** Adapted from Fernandes OA - Process of Med Rec at Transfer
Reconciliation at hospital discharge

Patients are at an increased risk for medication discrepancies during hospital discharge. (95) At discharge it is important to reconcile the medications that the patient has been taking prior to admission, and those initiated during hospital stay, with the medications patient will be taking post-discharge. Med Rec at discharge should reduce the risk of: 1) therapeutic duplications; 2) omissions; 3) unnecessary medications; and 4) confusion. This process will ensure that all drug changes are intentional and that any discrepancies are noted and resolved.

Med Rec clarifies the medication patient should be on post-discharge by reviewing: 1) patient’s BMPH; 2) alongside patient’s most current MAR (medication administration record)/medication profile and 3) new medications planned to start upon discharge. (95) A discharge Med Rec may be developed similar to the admission Med Rec form and should result in Best Possible Medication Discharge Plan (BPMDP). (95) BPMDP contains appropriate and accurate list of medications the patient should be taking after discharge. The plan (Seen in Figure 7.4) needs to account for a number of factors such as: 1) new medications started in hospital or upon discharge; 2) adjusted medications; 3) unchanged home medications that will be continued; 4) medications put “on hold” while the patient was in hospital; 4) formulary adjustments; 5) status of other non-prescription medications (i.e., herbals). The plan needs to be formally communicated to the patient, the patient’s family, and to community clinicians (physicians and pharmacists) as well as alternative care facilities. (95) Obtaining BPMH and/or BPMDP at hospital admission/discharge has the potential to improve patient care by reducing the rate of ADR resulting in health system overuse.
Medication Reconciliation at Discharge

1. **Create the BPMDP**
   - Review the last 24-hour MAR prior to discharge and record medications on the BPMDP that are relevant for discharge;
   - Compare these medications to the BPMH obtained at admission and record any medications on the BPMDP that are not included on the MAR;

2. **Identify** all discrepancies between the BPMH and the last 24-hour MAR or medication profile
   - Omitted medications, dose adjustments, non-formulary/formulary adjustments;
   - Complete documentation for each medication on the BPMDP indicating: continue as prior to admission, adjusted, discontinued or new in hospital.

3. **Resolve and document** any discrepancies with the prescriber.
   - Prescriber reviews and completes the BPMDP, makes adjustments and writes new prescriptions as appropriate.

4. **Communicate** BPMDP to the patient and the next providers of care
   - Conduct a BPMDP patient/caregiver interview using a systematic process and document;
   - Assess patient/caregiver knowledge about medications once education provided; e.g., side effects to look out for, who to call if questions re medication, what to do if a dose is missed
   - Refer patient for community pharmacy medication review program follow-up where applicable;
   - Communicate BPMDP to the community pharmacy, primary care physician, alternative care facility, family health team, ambulatory clinics and home care as applicable.

*Note: Unless specified, each institution and/or individual unit should determine who is primarily responsible for completing each step based on available resources (e.g., RPh, RN, MD)*

*Developed by ISMP Canada with support from the Ontario Ministry of Health and Long-Term Care*

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**Figure 7-4:** Adapted from Fernandes OA - Steps of Best Possible Medication Discharge Plan
Appendix 3:  

MRQA Med Rec steps in LTC facility

Reconciliation at LTC admission

Med Rec in LTC begins with obtaining the BPMH. BPMH consists of the resident’s medication including name, dosage, route and frequency. It is created by combining a systematic process of interviewing the resident/family with a review of at least one other reliable source of information. (110) LTC Admission Med Rec processes generally fit into two models: proactive and retroactive processes.(110) (Seen in Figure 7.1 and Figure 7.2) There are instances when Med Rec is not clearly documented at the previous facility. In these cases, pre-acute care medications must be reviewed. This is necessary, as pre-acute medications may have been deliberately changed in acute care. When LTC practitioner is unable to assess these changes, then acute care physician or pharmacists should be consulted.

The purpose of Med Rec (Seen in Figure 7.5) is to identify and resolve: 1) unintentional discrepancies; and 2) undocumented intentional discrepancies. Examples of UD and UID are seen in Figure 7.5.
It is important to identify which residents should receive an in-depth BMPH, in what timeframe, and how to go about obtaining the BPMH (Seen in Figure 7.6) Safer Healthcare Now recommends for Med Rec to occur within 24 hours of admission, nonetheless each facility should decide what the best practice is for them. (110)
Figure 7-6: Adapted from Healthcare now – Med Rec Process Flow Map Admission to LTC Facility
Reconciliation at internal transfer

The transfer occurs within the facility when there is a change in resident’s level of care or transitions when facility requires medications to be re-ordered. If Med Rec took place during LTC admission, then the ‘most current medication list’ becomes the Best Possible Medication History. Med Rec at internal transfer encompasses comparing the new transfer orders with the most current medication list from the transferring unit and resolving any unintentional or undocumented discrepancies. (Seen in Figure 7.7). (110)

Figure 7-7: Adapted from Healthcare now - Examples of UID and UD at Internal Transfer

Reconciliation at discharge/external transfer

LTC residents may be transferred externally to acute care for medical intervention. The transfer may be: 1) short term (i.e. dialysis) when medications remain the same with some addition of very specific treatment for the acute conditions: 2) admitted to an acute care bed for further assessment and treatment where the length of stay varies. External transfer is defined as discharge usually if the length of stay in acute care is more than 21 days or if the resident is not expected to return. Medications should be reconciled upon admission to acute care and again upon return to LTC facility. If appropriate Med Rec took place during admission, then the most current medication list becomes the Best Possible Medication History. The list should be
concisely communicated to the next provider of care and to the resident/family members. It should be sent in a timely manner and be transferred when possible, along with the resident to the receiving facility. A summary of MRQA Med Rec intervention in LTC facility is illustrated in Figure 7.8. (110)

**Figure 7-8:** Adapted from Healthcare now- Summary of Med Rec in LTC facility
Appendix 4: **MRQA Med Rec submission form**

<table>
<thead>
<tr>
<th>Pt #</th>
<th>A. Admit via</th>
<th>B. MedRec Performed</th>
<th>C. BPMH &gt;1 source</th>
<th>D. Actual Med use verified by Pt/Caregiver source</th>
<th>E. Each med has drug name, dose, strength, frequency on BPMH and Admission Orders</th>
<th>F. Every med in BPMH is accounted for in Admission Orders</th>
<th>G. Prescriber has documented rationale for ‘Holds’ and ‘Discontinued’ meds</th>
<th>H. Discrepancy communicated, resolved, and documented</th>
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Access your data and reports at www.patientssafetymetrics.com or for info contact 416-946-3103 or metrics@saferhealthcarenow.ca. Login 1 hour after faxing your forms to verify the data was received successfully.
Appendix 5: ICD-10 Codes defined as ADEs

Based on previous research an ED visit or hospitalization will be qualified as ADE-related in one of two ways: (1) there was an ICD-10-CA diagnosis for ADR listed in the ‘Main Problem” or “Other Problems” fields or (2) there was an ICD-10-CA code of external cause for ADR listed a “Other Problem”. (191)

Manifestation codes for ADEs in administrative data

D52.1 Drug-induced folate deficiency anaemia
D59.0 Drug-induced autoimmune haemolytic anaemia
D59.2 Drug-induced nonautoimmune haemolytic anaemia
D61.1 Drug-induced aplastic anaemia
D64.2 Secondary sideroblastic anaemia due to drugs and toxins
D68.3 Haemorrhagic disorder due to circulating anticoagulants
D89.3 Immune reconstitution syndrome
E03.2 Hypothyroidism due to medicaments and other exogenous substances
E06.4 Drug-induced thyroiditis
E16.0 Drug-induced hypoglycaemia without coma
E23.1 Drug-induced hypopituitarism
E24.2 Drug-induced Cushing’s syndrome
E27.3 Drug-induced adrenocortical insufficiency
E66.1 Drug-induced obesity
G04.0 Acute disseminated encephalitis
G21.0 Malignant neuroleptic syndrome
G21.1 Other drug-induced secondary parkinsonism
G24.0 Drug-induced dystonia
G25.1 Drug-induced tremor
G25.4 Drug-induced chorea
G25.6 Drug-induced tics and other tics of organic origin
G44.4 Drug-induced headaches, not elsewhere classified
G61.1 Serum neuropathy
G62.0 Drug-induced polyneuropathy
G72.0 Drug-induced myopathy
H40.6 Glaucoma secondary to drugs
H91.0 Ototoxic hearing loss
I42.7 Cardiomyopathy due to drugs and other external agents
I95.2 Hypotension due to drugs
J70.2 Acute drug-induced interstitial lung disorders
J70.3 Chronic drug-induced interstitial lung disorders
J70.4 Drug-induced interstitial lung disorders, unspecified
K85.3 Drug-induced acute pancreatitis
L10.5 Drug-induced pemphigus
L23.3 Allergic contact dermatitis due to drugs in contact with skin
L24.4 Irritant contact dermatitis due to drugs in contact with skin
L25.1 Unspecified contact dermatitis due to drugs in contact with skin
L27.0 Generalized skin eruption due to drugs and medicaments
L43.2 Lichenoid drug reaction
L56.0 Drug phototoxic response
L56.1 Drug photoallergic response
M10.20 Drug-induced gout, multiple sites
M10.22 Drug-induced gout, upper arm
M10.24 Drug-induced gout, hand
M10.25 Drug-induced gout, pelvic region and thigh
M10.26 Drug-induced gout, lower leg
M10.27 Drug-induced gout, ankle and foot
M10.28 Drug-induced gout, other site
M10.29 Drug-induced gout, unspecified site
M32.0 Drug-induced systemic lupus erythematosus
M34.2 Systemic sclerosis induced by drugs and chemicals
M80.40 Drug-induced osteoporosis with pathological fracture, multiple sites
M80.42 Drug-induced osteoporosis with pathological fracture, upper arm
M80.43 Drug-induced osteoporosis with pathological fracture, forearm
M80.45 Drug-induced osteoporosis with pathological fracture, pelvic region and thigh
M80.46 Drug-induced osteoporosis with pathological fracture, lower leg
M80.48 Drug-induced osteoporosis with pathological fracture, other site
M81.4 Drug-induced osteoporosis
M83.5 Other drug-induced osteomalacia in adults
M87.11 Osteonecrosis due to drugs, shoulder region
M87.12 Osteonecrosis due to drugs, upper arm
M87.15 Osteonecrosis due to drugs, pelvic region and thigh
M87.16 Osteonecrosis due to drugs, lower leg
M87.18 Osteonecrosis due to drugs, other site
N14.0 Analgesic nephropathy
N14.1 Nephropathy induced by other drugs, medicaments and biological substances
N14.2 Nephropathy induced by unspecified drug, medicament or biological substance
R50.2 Drug-induced fever
T80.3 ABO incompatibility reaction
T80.4 Rh incompatibility reaction
T80.5 Anaphylactic shock due to serum
T80.6 Other serum reactions
T80.8 Other complications following infusion, transfusion and therapeutic injection
T80.9 Unspecified complication following infusion, transfusion and therapeutic injection
T88.1 Other complications following immunization, not elsewhere classified
T88.2 Shock due to anaesthesia
T88.3 Malignant hyperthermia due to anaesthesia
T88.5 Other complications of anaesthesia
T88.6 Anaphylactic shock due to adverse effect of correct drug or medicament properly administered
T88.7 Unspecified adverse effect of drug or medicament

Reference for ICD-10-CA X and Y codes (213)

External causes ICD-10-CA codes

**X codes – Diagnostic codes for ADEs in administrative data**

X-codes are utilized to identify accidental overdose of a drug or wrong drug given or taken in error.

X40 = Accidental poisoning by and exposure to non-opioid analgesics, antipyretics and antirheumatics
X41 = Accidental poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified
X42 = Accidental poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified
X43 = Accidental poisoning by and exposure to other drugs acting on the autonomic nervous system
X44 = Accidental poisoning by and exposure to other and unspecified drugs, medicaments and biological substances

**Y codes – Diagnostic codes for ADEs in administrative data**

Y-codes are utilized to identify correct drug properly administered in therapeutic or prophylactic dosage.

Y400 = Penicillins causing adverse effect in therapeutic use
Y401 = Cefalosporins and other beta-lactam antibiotics causing adverse effect in therapeutic use
Y402 = Chloramphenicol group causing adverse effect in therapeutic use
Y403 = Macrolides causing adverse effect in therapeutic use
Y404 = Tetracyclines causing adverse effect in therapeutic use
Y405 = Aminoglycosides causing adverse effect in therapeutic use
Y406 = Rifamycins causing adverse effect in therapeutic use
Y407 = Antifungal antibiotics, systemically used, causing adverse effect in therapeutic use
Y408 = Other systemic antibiotics causing adverse effect in therapeutic use
Y409 = Systemic antibiotic, unspecified, causing adverse effect in therapeutic use
Y41 = Other systemic anti-infectives and antiparasitics
Y410 = Sulfonamides causing adverse effect in therapeutic use
Y411 = Antimycobacterial drugs causing adverse effect in therapeutic use
Y412 = Antimalarials and drugs acting on other blood protozoa causing adverse effect in therapeutic use
Y413 = Other antiprotozoal drugs causing adverse effect in therapeutic use
Y414 = Anthelmintics causing adverse effect in therapeutic use
Y415 = Antiviral drugs causing adverse effect in therapeutic use
Y418 = Other specified systemic anti-infectives and antiparasitics causing adverse effect in therapeutic use
Y419 = Systemic anti-infective and antiparasitic, unspecified, causing adverse effect in therapeutic use
Y42 = Hormones and their synthetic substitutes and antagonists, not elsewhere classified
Y420 = Glucocorticoids and synthetic analogues causing adverse effect in therapeutic use
Y421 = Thyroid hormones and substitutes causing adverse effect in therapeutic use
Y422 = Antithyroid drugs causing adverse effect in therapeutic use
Y423 = Insulin and oral hypoglycaemic [antidiabetic] drugs causing adverse effect in therapeutic use
Y424 = Oral contraceptives causing adverse effect in therapeutic use
Y425 = Other estrogens and progestogens causing adverse effect in therapeutic use
Y426 = Antigonadotrophins, antiestrogens, antiandrogens, not elsewhere classified, causing adverse effect in therapeutic use
Y427 = Androgens and anabolic congeners causing adverse effect in therapeutic use
Y428 = Other and unspecified hormones and their synthetic substitutes causing adverse effect in therapeutic use
Y429 = Other and unspecified hormone antagonists causing adverse effect in therapeutic use
Y43 = Primarily systemic agents
Y430 = Antiallergic and antiemetic drugs causing adverse effect in therapeutic use
Y431 = Antineoplastic antimetabolites causing adverse effect in therapeutic use
Y432 = Antineoplastic natural products causing adverse effect in therapeutic use
Y433 = Other antineoplastic drugs causing adverse effect in therapeutic use
Y434 = Immunosuppressive agents causing adverse effect in therapeutic use
Y435 = Acidifying and alkalinizing agents causing adverse effect in therapeutic use
Y436 = Enzymes, not elsewhere classified, causing adverse effect in therapeutic use
Y438 = Other primarily systemic agents, not elsewhere classified, causing adverse effect in therapeutic use
Y439 = Primarily systemic agent, unspecified, causing adverse effect in therapeutic use
Y44 = Agents primarily affecting blood constituents
Y440 = Iron preparations and other anti-hypochromic-anaemia preparations causing adverse effect in therapeutic use
Y441 = Vitamin B12, folic acid and other anti-megaloblastic-anaemia preparations causing adverse effect in therapeutic use
Y442 = Anticoagulants causing adverse effect in therapeutic use
Y443 = Anticoagulant antagonists, vitamin K and other coagulants causing adverse effect in therapeutic use
Y444 = Antithrombotic drugs [platelet-aggregation inhibitors] causing adverse effect in therapeutic use
Y445 = Thrombolytic drugs causing adverse effect in therapeutic use
Y446 = Natural blood and blood products causing adverse effect in therapeutic use
Y447 = Plasma substitutes causing adverse effect in therapeutic use
Y449 = Other and unspecified agents affecting blood constituents causing adverse effect in
therapeutic use
Y45 = Analgesics, antipyretics and anti-inflammatory drugs
Y450 = Opioids and related analgesics causing adverse effect in therapeutic use
Y451 = Salicylates causing adverse effect in therapeutic use
Y452 = Propionic acid derivatives causing adverse effect in therapeutic use
Y453 = Other nonsteroidal anti-inflammatory drugs [NSAID] causing adverse effect in therapeutic use
Y454 = Antirheumatics causing adverse effect in therapeutic use
Y455 = 4-Aminophenol derivatives causing adverse effect in therapeutic use
Y458 = Other analgesics and antipyretics causing adverse effect in therapeutic use
Y459 = Analgesic, antipyretic and anti-inflammatory drug, unspecified, causing adverse effect in therapeutic use
Y46 = Antiepileptics and antiparkinsonism drugs
Y460 = Succinimides causing adverse effect in therapeutic use
Y461 = Oxazolidinediones causing adverse effect in therapeutic use
Y462 = Hydantoin derivatives causing adverse effect in therapeutic use
Y463 = Deoxybarbiturates causing adverse effect in therapeutic use
Y464 = Iminostilbenes causing adverse effect in therapeutic use
Y465 = Valproic acid causing adverse effect in therapeutic use
Y466 = Other and unspecified antiepileptics causing adverse effect in therapeutic use
Y467 = Antiparkinsonism drugs causing adverse effect in therapeutic use
Y468 = Antispasticity drugs causing adverse effect in therapeutic use
Y47 = Sedatives, hypnotics and antianxiety drugs
Y470 = Barbiturates, not elsewhere classified, causing adverse effect in therapeutic use
Y471 = Benzodiazepines causing adverse effect in therapeutic use
Y472 = Cloral derivatives causing adverse effect in therapeutic use
Y473 = Paraldehyde causing adverse effect in therapeutic use
Y474 = Bromine compounds causing adverse effect in therapeutic use
Y475 = Mixed sedatives and hypnotics, not elsewhere classified, causing adverse effect in therapeutic use
Y478 = Other sedatives, hypnotics and antianxiety drugs causing adverse effect in therapeutic use
Y479 = Sedative, hypnotic and antianxiety drug, unspecified, causing adverse effect in therapeutic use
Y48 = Anaesthetics and therapeutic gases
Y480 = Inhaled anaesthetics causing adverse effect in therapeutic use
Y481 = Parenteral anaesthetics causing adverse effect in therapeutic use
Y482 = Other and unspecified general anaesthetics causing adverse effect in therapeutic use
Y483 = Local anaesthetics causing adverse effect in therapeutic use
Y484 = Anaesthetic, unspecified, causing adverse effect in therapeutic use
Y485 = Therapeutic gases causing adverse effect in therapeutic use
Y49 = Psychotropic drugs, not elsewhere classified
Y490 = Tricyclic and tetracyclic antidepressants causing adverse effect in therapeutic use
Y491 = Monoamine-oxidase-inhibitor antidepressants causing adverse effect in therapeutic use
Y492 = Other and unspecified antidepressants causing adverse effect in therapeutic use
Y493 = Phenothiazine antipsychotics and neuroleptics causing adverse effect in therapeutic use
Y494 = Butyrophenone and thioxanthene neuroleptics causing adverse effect in therapeutic use
Y495 = Other antipsychotics and neuroleptics causing adverse effect in therapeutic use
Y496 = Psychodysleptics [hallucinogens] causing adverse effect in therapeutic use
Y497 = Psychostimulants with abuse potential causing adverse effect in therapeutic use
Y498 = Other psychotropic drugs, not elsewhere classified, causing adverse effect in therapeutic use
Y499 = Psychotropic drug, unspecified, causing adverse effect in therapeutic use
Y50 = Central nervous system stimulants, not elsewhere classified
Y500 = Analetics causing adverse effect in therapeutic use
Y501 = Opioid receptor antagonists causing adverse effect in therapeutic use
Y502 = Methylxanthines, not elsewhere classified, causing adverse effect in therapeutic use
Y508 = Other central nervous system stimulants causing adverse effect in therapeutic use
Y509 = Central nervous system stimulant, unspecified, causing adverse effect in therapeutic use
Y51 = Drugs primarily affecting the autonomic nervous system
Y510 = Anticholinesterase agents causing adverse effect in therapeutic use
Y511 = Other parasympathomimetics [cholinergics] causing adverse effect in therapeutic use
Y512 = Ganglionic blocking drugs, not elsewhere classified, causing adverse effect in therapeutic use
Y513 = Other parasympatholytics [anticholinergics and antimuscarinics] and spasmyloytics, not elsewhere classified, causing adverse effect in therapeutic use
Y514 = Predominantly alpha-adrenoreceptor agonists, not elsewhere classified, causing adverse effect in therapeutic use
Y515 = Predominantly beta-adrenoreceptor agonists, not elsewhere classified, causing adverse effect in therapeutic use
Y516 = alpha-Adrenoreceptor antagonists, not elsewhere classified, causing adverse effect in therapeutic use
Y517 = beta-Adrenoreceptor antagonists, not elsewhere classified, causing adverse effect in therapeutic use
Y518 = Centrally acting and adrenergic-neuron-blocking agents, not elsewhere classified, causing adverse effect in therapeutic use
Y519 = Other and unspecified drugs primarily affecting the autonomic nervous system causing adverse effect in therapeutic use
Y52 = Agents primarily affecting the cardiovascular system
Y520 = Cardiac-stimulant glycosides and drugs of similar action causing adverse effect in therapeutic use
Y521 = Calcium-channel blockers causing adverse effect in therapeutic use
Y522 = Other antidysrhythmic drugs, not elsewhere classified, causing adverse effect in therapeutic use
Y523 = Coronary vasodilators, not elsewhere classified, causing adverse effect in therapeutic use
Y524 = Angiotensin-converting-enzyme inhibitors causing adverse effect in therapeutic use
Y525 = Other antihypertensive drugs, not elsewhere classified, causing adverse effect in therapeutic use
Y526 = Antihyperlipidaemic and antiarteriosclerotic drugs causing adverse effect in therapeutic use
Y527 = Peripheral vasodilators causing adverse effect in therapeutic use
Y528 = Antivariocose drugs, including sclerosing agents causing adverse effect in therapeutic use
Y529 = Other and unspecified agents primarily affecting the cardiovascular system causing adverse effect in therapeutic use
Y53 = Agents primarily affecting the gastrointestinal system
Y530 = Histamine H2-receptor antagonists causing adverse effect in therapeutic use
Y531 = Other antacids and anti-gastric-secretion drugs causing adverse effect in therapeutic use
Y532 = Stimulant laxatives causing adverse effect in therapeutic use
Y533 = Saline and osmotic laxatives causing adverse effect in therapeutic use
Y534 = Other laxatives causing adverse effect in therapeutic use
Y535 = Digestants causing adverse effect in therapeutic use
Y536 = Antidiarrhoeal drugs causing adverse effect in therapeutic use
Y537 = Emetics causing adverse effect in therapeutic use
Y538 = Other agents primarily affecting the gastrointestinal system causing adverse effect in therapeutic use
Y539 = Agent primarily affecting the gastrointestinal system, unspecified, causing adverse effect in therapeutic use
Y54 = Agents primarily affecting water-balance and mineral and uric acid metabolism
Y540 = Mineralocorticoids causing adverse effect in therapeutic use
Y541 = Mineralocorticoid antagonists [aldosterone antagonists] causing adverse effect in therapeutic use
Y542 = Carbonic-anhydrase inhibitors causing adverse effect in therapeutic use
Y543 = Benzothiadiazine derivatives causing adverse effect in therapeutic use
Y544 = Loop [high-ceiling] diuretics causing adverse effect in therapeutic use
Y545 = Other diuretics causing adverse effect in therapeutic use
Y546 = Electrolytic, caloric and water-balance agents causing adverse effect in therapeutic use
Y547 = Agents affecting calcification causing adverse effect in therapeutic use
Y548 = Agents affecting uric acid metabolism causing adverse effect in therapeutic use
Y549 = Mineral salts, not elsewhere classified, causing adverse effect in therapeutic use
Y55 = Agents primarily acting on smooth and skeletal muscles and the respiratory system
Y550 = Oxytocic drugs causing adverse effect in therapeutic use
Y551 = Skeletal muscle relaxants [neuromuscular blocking agents] causing adverse effect in therapeutic use
Y552 = Other and unspecified agents primarily acting on muscles causing adverse effect in therapeutic use
Y553 = Antitussives causing adverse effect in therapeutic use
Y554 = Expectorants causing adverse effect in therapeutic use
Y555 = Anti-common-cold drugs causing adverse effect in therapeutic use
Y556 = Antiasthmatics, not elsewhere classified, causing adverse effect in therapeutic use
Y557 = Other and unspecified agents primarily acting on the respiratory system causing adverse effect in therapeutic use
Y56 = Topical agents primarily affecting skin and mucous membrane and ophthalmological, otorhinolaryngological and dental drugs
Y560 = Local antifungal, anti-infective and anti-inflammatory drugs, not elsewhere classified, causing adverse effect in therapeutic use
Y561 = Antipruritics causing adverse effect in therapeutic use
Y562 = Local astringents and local detergents causing adverse effect in therapeutic use
Y563 = Emollients, demulcens and protectants causing adverse effect in therapeutic use
Y564 = Keratolytics, keratoplastics and other hair treatment drugs and preparations causing adverse effect in therapeutic use
Y565 = Ophthalmological drugs and preparations causing adverse effect in therapeutic use
Y566 = Otorhinolaryngological drugs and preparations causing adverse effect in therapeutic use
Y567 = Dental drugs, topically applied causing adverse effect in therapeutic use
Y568 = Other topical agents causing adverse effect in therapeutic use
Y569 = Topical agent, unspecified, causing adverse effect in therapeutic use
Y57 = Other and unspecified drugs and medicaments
Y570 = Appetite depressants [anorectics] causing adverse effect in therapeutic use
Y571 = Lipotropic drugs causing adverse effect in therapeutic use
Y572 = Antidotes and chelating agents, not elsewhere classified, causing adverse effect in therapeutic use
Y573 = Alcohol deterrents causing adverse effect in therapeutic use
Y574 = Pharmaceutical excipients causing adverse effect in therapeutic use
Y575 = X-ray contrast media causing adverse effect in therapeutic use
Y576 = Other diagnostic agents causing adverse effect in therapeutic use
Y577 = Vitamins, not elsewhere classified, causing adverse effect in therapeutic use
Y578 = Other drugs and medicaments causing adverse effect in therapeutic use
Y579 = Drug or medicament, unspecified, causing adverse effect in therapeutic use
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