HIMSS Davies Enterprise Award Submission

Title of Case Study: Medication reconciliation reduces risk of unintended medication discrepancies

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Executive Summary

Since 1968, North York General Hospital (NYGH) has served the culturally diverse communities of North Toronto with the best possible care experience. As one of Canada's leading community academic hospitals, we offer a wide range of acute, ambulatory and long-term care services across our three sites (inclusive of 618 inpatient beds) covering the south central region of Ontario, centered on Toronto (Figures 1 & 2). Our dedicated team of 5,000+ staff, physicians and volunteers are proud to serve our growing population of over 400,000 people. Our Patients Come First in Everything We Do.

NYGH has a history of adopting innovative technology to promote the ideal patient experience. Beginning in 2007, we embarked on a multi-year clinical transformation project to bring our electronic health record system (EHR) into the future, from HIMSS Stage 2 to a goal of HIMSS Stage 7. This project, called eCare, has a primary focus of improving the quality and safety of care that we provide to our patients every day. One of eCare’s most significant achievements to date is how NYGH established a culture of evidence-based care to measurably improve the number of lives saved. In fact, over the past 6 years, the NYGH eCare project has won seven national awards for improving quality and safety of patient care.
The eCare project includes the implementation of evidence-based order sets with computerized provider order entry (CPOE), clinical documentation, closed loop medication administration with barcode scanning, and clinical decision support tools. These electronic tools make it easier for clinicians to do the right things to provide high quality, safe care to patients.

One specific best practice that is enabled with advanced clinical systems is medication reconciliation. The Institute for Healthcare Improvement defines medication reconciliation as “the process of creating the most accurate list possible of all medications a patient is taking — including drug name, dosage, frequency, and route — and comparing that list against the physician’s admission, transfer, and/or discharge orders, with the goal of providing correct medications to the patient at all transition points within the hospital.”¹ Reconciling medications at these transition points of care is intended to eliminate errors related to medications being omitted, duplicated or incorrectly ordered. Electronic tools for medication reconciliation streamline the process by eliminating duplicate entry, and pulling forward documented home medications to align them with inpatient medication orders, facilitating clinical review, reconciliation and order processes.

Prior to eCare, clinicians recorded a patient’s best possible medication history (BPMH) on paper. Using this BPMH, physicians were expected to review and document which medications to stop, continue or change for each inpatient stay. The paper process was cumbersome and did not allow physicians to easily review and reconcile home and new medications. This led to poor adoption, with only 7 percent of medical inpatients having their medications reconciled at admission, and only 9 percent at discharge. This performance was significantly below national Canadian averages. For comparison, Accreditation Canada reported that the national average for admission medication reconciliation in 2010 was 47%.² NYGH saw a key opportunity to leverage health information technology to improve its organizational performance in this key quality and safety measure, by integrating efficient electronic medication reconciliation processes into clinician workflow.

Since implementing eCare, clinicians now complete all steps of medication reconciliation electronically. Because the process became integrated into the ordering workflow, compliance immediately improved. Within the first month after go live, an average of 70 percent of medical inpatients had their medications reconciled at discharge, and 45 percent at admission. This was surprising, because during the initial implementation phase of CPOE, physicians were encouraged to focus primarily on the new practice of electronic order entry. Medication reconciliation was taught in training, but was not made mandatory. Because the medication reconciliation process was easy to do and clinicians understood the importance of avoiding adverse medication events, they appreciated that technology was making it easy for them to do the right thing. Later, once physicians were more comfortable with CPOE, further system improvements were made, further education was delivered, and medication reconciliation compliance for medical patients continuously increased to what it is today: 85% at admission and 87% at discharge.

Local Problem

In 2005, the US Joint Commission and the Canadian Council on Health Services Accreditation (CCHSA) identified medication reconciliation as a National Patient Safety goal. The evidence and criticality of avoiding medication errors were so clear that a statement was made on a national scale. In 2008,

http://www.ihi.org/topics/adesmedicationreconciliation/Pages/default.aspx
Accreditation Canada included medication reconciliation as a Required Organizational Practice (ROP), and mandated that all acute care facilities have it implemented in at least one inpatient unit. This ROP will be further strengthened in 2018, when Accreditation Canada will require medication reconciliation to be active on all inpatient units of acute care facilities.

In 2005, Cornish et al\(^3\) conducted a study to evaluate the number and severity of medication discrepancies on hospital admission. They concluded that 53.6 percent of patients (81 of 151 patients) had at least one medication discrepancy. The discrepancies were reviewed by a medical team who found that 38.6% of the discrepancies had the potential to cause moderate to serious harm. (Figure 3)

So why is it taking so long for healthcare organizations to implement this critical safety goal? The answer is that medication reconciliation is a complex process that requires an inter-professional team, a well-designed workflow with clear accountabilities, and effective tools to complete the work efficiently.

In organizations without advanced electronic clinical systems, providers attempt to complete medication reconciliation on paper (Figures 4 and 5). This process is fraught with challenges, making clinician adoption of this vitally important process near impossible. Not surprisingly, Accreditation Canada reported in 2011 that medication reconciliation processes had the lowest average national compliance rates among all Required Organizational Practices (ROPs)\(^4\).

**Challenges with Paper-Based Medication Reconciliation:**

- Home and Active meds may print separately, therefore are difficult to visually compare
- Medications do not sort according to therapeutic class, making reconciliation inefficient and error-prone

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– Paper forms are difficult to update, therefore accuracy may be low
– Errors may occur when transcribing hand-completed reconciliation sheets to order forms, MAR
– Completion of reconciliation forms is not well integrated into physician workflow, therefore the process may be seen by physicians as additional effort in an already very busy work day

Prior to eCare, NYGH tried to meet these challenges by engaging unit secretaries and two full-time pharmacists on a pilot Cardiology nursing unit to print and help cardiologists complete paper reconciliation forms (Figure 4 and 5). Unfortunately, even with these additional human resources in place, physician adoption of paper-based medication reconciliation was poor. This failed attempt to implement a paper-based workflow served as the impetus for NYGH to design an electronic system to make medication reconciliation efficient and easy for clinicians to adopt.

**Design and Implementation**

Prior to implementing the electronic medication reconciliation process, the project team – including physicians, pharmacists, nursing and informatics – worked together to evaluate the current paper-based workflow and identify potential gaps and improvements.

**Identified Requirements:**

1. BPMH must be completed prior to admission
2. BPMH must be accurate
3. Clear accountability of who will complete BPMH; must also resource the role appropriately
4. Since the reconciliation process is medication ordering, only prescribers can perform
5. System must be built to support the auto-conversion of medications between inpatient and outpatient orders
6. System must generate automatic discharge prescriptions for MD’s to sign and provide to patient

In evaluating what healthcare provider role is best suited to perform the BPMH, NYGH performed accuracy audits and time studies on the BPMH process. It was concluded that pharmacists or pharmacy technicians were best prepared, most accurate and most efficient in completing BPMH. We evaluated
the points of entry for hospital admission, and evaluated staffing needs to sufficiently resource the task of BPMH completion prior to admission. The main points of entry were the Emergency Department (ED) and the Surgery Pre-admit unit. At the time, NYGH did not have pharmacy technicians trained in BPMH, so pharmacists were staffed in these two areas. The ED was already staffed with two pharmacists; however, their shift times were altered to provide coverage from 8am to 8pm. After 8pm, the admitting physician or nurse could enter BPMH, or the pharmacist would prioritize those patients for BPMH the following morning. The ED has a tracking board which serves as a visual overview of all ED patients and their status. When an ED physician sees a patient and determines a medical consult is required, an icon appears on the tracking board. This is the signal for pharmacy to perform the BPMH, knowing that there is a high likelihood of the patient being admitted to hospital. Having the BPMH completed before the decision to admit allows the admitting physician to reconcile home medications at the same time admission orders are entered. This ensures prior therapies are considered at the time the acute admission orders are being placed.

To ensure medications seamlessly auto-convert between outpatient prescriptions and inpatient orders, the informatics team ran audits of common outpatient prescriptions filled in the outpatient pharmacy. Building these outpatient medications in advance ensured an efficient medication reconciliation workflow at eCare go live. The informatics team built over 20,000 order synonyms and over 10,000 outpatient order sentences. Regular audits are run to identify medications which fail auto-conversion, so they can be updated to convert correctly.

The electronic medication reconciliation solution was designed to meet all of the aforementioned requirements, and a future state workflow was mapped and tested. During the testing stage, clinicians identified a seventh requirement, which was the ability to “pause” the reconciliation process and “save for later” in case they are pulled away in an emergency and unable complete all steps in one session.

It was this thoughtful design approach, aimed at streamlining processes and clarifying roles, that allowed the electronic process to be adopted, making it easy for clinicians to do the right thing.

**How Health IT Was Utilized**

When designing the IT solution, we knew we needed the system to be well aligned to the optimal clinical workflow (Figure 6).

“Make it easy to do the right thing!”

![Figure 6](Figure 6)

The first step in the process is the documentation of home medications (BPMH), completed primarily by pharmacists at hospital entry points (e.g. ED and the pre-op clinic). Outpatient order sentences were built in advance to make it faster for clinicians to select and enter the most common prescriptions (Figure 7).
Once the decision is made to admit the patient, the admitting physician will enter admission orders and reconcile home medications that should continue during the course in hospital. The system is intuitive, and was built to automatically convert home medications to inpatient formulary orders without extra steps required of the physician (Figure 8).

**Admission Medication Reconciliation**

When patients are transferred to another level of care or discharged home, the medications are once again reconciled, during which time the discharging physician determines which medications to continue or stop, and which medications require a new prescription (Figure 9).

**Discharge Medication Reconciliation**
Based on requirements defined by our clinicians, the system was also designed so that inpatient orders selected to be continued on discharge automatically convert to an outpatient prescription, which can be printed and provided to the patient (Figure 10). To further increase safety and efficiency, all discharge medication reconciliation decisions are also automatically added to an electronic Discharge Summary, which is printed and provided to the patient so that it is clear which home medications should be stopped, which should be continued, and which new prescriptions should be filled (Figure 11).

Over time, as physicians became more comfortable with CPOE, we began to pay closer attention to our medication reconciliation compliance rates. Perplexed as to why our initial eCare admission medication reconciliation rates were significantly lower than discharge rates (see Value Derived section), we examined the workflow in more detail. It was discovered that many patients are admitted from ED during evening/overnight hours when pharmacists are not available to complete BPMH. Upon speaking to the physician group, it became clear that the admitting physician in the ED expected the receiving (attending) physician on the nursing unit to complete the reconciliation the next morning, after the pharmacy had the opportunity to document the home medications. On the flipside, the attending physician on the nursing unit assumed that admission reconciliation had already been completed by the admitting physician in the ED. The result was that neither physician completed the admission medication reconciliation. In response, the eCare team developed a clinical decision support rule to help correct this communication gap, which is still in use today.

The rule works as follows:

1. If the BPMH is complete AND
2. Admission medication reconciliation is not complete AND
3. The clinician logged into the system is the most responsible (attending) physician, THEN
4. Issue an automated alert to remind the physician to complete Admission medication reconciliation (Figure 12).
Value Derived

It is clear from the literature and position statements made from national quality councils that medication reconciliation is critical in averting serious adverse medication events. We also know that it is difficult to implement, based on the slow progress nationally to adopt this important practice.

NYGH’s journey in adopting this best practice can be directly measured from the data made available by the eCare system, which measures completion rates of medication reconciliation at the required points: admission, transfer and discharge. The graph in Figure 13.1 shows a significant improvement between pre-CPOE compliance rates (where only 7 to 9% of medical patients had paper-based medication reconciliation) to compliance rates immediately post implementation of eCare (45% on admission, and 70% on discharge). We feel that this improvement was particularly significant, given that the focus at go live was for physicians to transition from paper ordering processes to CPOE, and medication reconciliation was not made mandatory.

The remarkable improvement in medication reconciliation at eCare go-live demonstrates that physicians embraced medication reconciliation as part of their new electronic workflow. We feel this is for 3 reasons:

1. Physicians clearly understood the safety imperative of medication reconciliation

2. The system was designed to make it “easy to do the right thing”. Physicians embraced the process of medication reconciliation because it not only improves safety, but also saves time. Two examples of improved physician efficiency include:
   a. When physicians complete discharge medication reconciliation, automatic processes then immediately complete the medication section of the electronic discharge summary, and print all discharge prescriptions. This saves physician time, and also reduces the risk for errors that may occur when transcribing handwritten discharge prescriptions.
   b. High auto-conversion rates. The auto-conversion process automatically copies medication prescription details (such as dose, route, and frequency) between outpatient and inpatient prescriptions during the medication reconciliation process. This significantly increases efficiency and ease of use for physicians, by saving time and clicks. Also, since prescription details don’t need to be manually re-entered by physicians, the risk of error during medication reconciliation is reduced.

NYGH focused closely on medication build during the design phases of eCare, in order to ensure high auto-conversion rates at system go live. Also, the eCare team instituted ongoing auditing of auto-conversion rates over time, to proactively identify targets for improvement. As a result, NYGH has maintained consistently high, industry-leading auto-conversion rates for medications on admission (85%) and at discharge (92%) (Figure 14).
NYGH engaged in continuous quality auditing and improvement processes to further improve medication reconciliation rates over time. One important effort was the introduction of electronic clinical decision support. The previously described custom automated alert (Figure 12) was designed as an intervention to improve rates of admission medication reconciliation. In 2011, within only two months of introducing this alert, admission medication reconciliation increased from 45% to 70% of medical admissions (Figure 15).

Between 2011 and 2015, following the introduction of the admission reconciliation alert, ongoing quality audits and iterative improvements were made to medication reconciliation system design, clinician education, and workflow. These included the introduction of saved “favourite” discharge medications for physicians, improvements to handling of non-formulary medications, and targeted education. The physician education was delivered at physician rounds sessions. Departmental compliance statistics were presented with emphasis on the importance of medication reconciliation. A patient story was incorporated into the sessions that described an adverse event when a patient took a duplicate therapy of a medication as a result of miscommunication of reconciliation. When medication reconciliation is completed, patient specific instructions are printed in the Depart Summary which clearly describes which meds to fill, continue, and stop. As a result, both admission and discharge reconciliation rates continued to improve. By 2015, medication reconciliation rates for medical inpatients at NYGH were 85% on admission, and 87% on discharge (Figure 15).

Change requests can be generated from a variety of sources:

- Directly from clinicians via link embedded within EHR
- Result of quality improvement initiative
Result of reported incident

All requests are reviewed and vetted according to the change approval process as outlined in Figure 13.2. Once a decision is made to proceed with a requested change, the system is designed, approved, tested and an education plan established prior to implementation. For clinical decision support rules, they system supports validation of rules logic by designing rule in the production environment while activating in “stealth” mode to fully understand frequency and scenarios of alerting in order to tweak rule to prevent alert fatigue.

For the sake of comparison, according to the Accreditation Canada Required Organization Practices (ROP) report issued in 2014\(^5\), the national Canadian average for medication reconciliation was 70\% on admission, and 61\% on discharge. While the national average admission medication reconciliation rate had increased by only 23\% between 2010 and 2014, NYGH’s compliance rate had increased by **78\%** on admission and **78\%** at discharge between 2010 and 2015 (Figures 13 and 15). Clearly, NYGH catapulted

itself from distinctly below-average performance in medication reconciliation to industry-leading results through the implementation of eCare. In fact, NYGH’s successes in improving medication reconciliation processes have been recognized nationwide by ISMP Canada and CPSI as follows (Figure 16)\(^6\):

- MedRec All-Star Facilities and Practice Leaders
- MedRec Information Technology All-Star Facilities

Delivering high quality and safe patient care has always been part of the NYGH strategic plan. With the implementation of eCare, NYGH took advantage of its newly available source of discrete electronic clinical data by implementing a business intelligence system. The BI framework integrates clinical and financial data with tools to build out corporate and departmental dashboards. This system allows NYGH to automatically monitor eCare data and report on key performance indicators (such as medication reconciliation rates) using an electronic Quality Dashboard (Figure 17). Regular access to this data allows departments, and the organization as a whole, to identify opportunities for improvement and implement action plans accordingly. This automated reporting, built into the fabric of eCare, has been key to continuous improvement of the medication reconciliation rates shared in this case study.

\(^6\) [http://www.ismp-canada.org/medrec/map/](http://www.ismp-canada.org/medrec/map/)
Prior to implementing electronic medication reconciliation, NYGH had experienced the implementation of a paper process. This experience offered learnings about the process, and highlighted challenges inherent in this complex workflow. With this knowledge, the team set forth to design and implement an electronic process with a vision to improve patient safety and in doing so, make it easy for clinicians to do the right thing.

**Project Success Factors:**

1. **Education – MedRec is the “right thing to do”**
   It is critical to educate clinicians on why medication reconciliation is the “right thing” to do. Education and communication must be delivered in a manner that tunes into the motivation of clinicians – which is high quality, safe patient care. While national groups such as Safer Healthcare Now and Accreditation Canada advocate for implementation of medication reconciliation, when driven by senior leadership in alignment to these bodies, the message sometimes gets misinterpreted as driven by an administrative mandate.

2. **Ease – Make it easy to “do the right thing”**
Design the system so that everyone knows their part, and there are no barriers to completing their part. Clinicians are very busy, and while their intent is always to “do the right thing”, barriers to efficiency will prevent sustainability of best practice.

3. Integration – Build MedRec into MD workflow
Design medication reconciliation into the admission and discharge workflow of physicians, so that it doesn’t seem like “extra work”.

4. Value Added Processes – Printed prescriptions, Discharge summary
Consider introducing some value-added processes to physician workflow. For example, during discharge medication reconciliation, new medication orders can be designed to automatically print discharge prescriptions, and reconciliation decisions can automatically be copied into a discharge summary to communicate instructions to patients and family.

5. Define Roles and Responsibilities
During the implementation of medication reconciliation on paper, it was communicated that many provider roles – including physicians, nurses and pharmacists – could chart the BPMH. Unfortunately, the outcome was that no one completed it consistently, since everyone assumed that other clinicians would do the work. With the electronic process, roles and responsibilities were made clear. Pharmacists were responsible to complete BPMH during resourced hours, and others were trained to fill in during times when they were not available.

6. Incorporate medication reconciliation compliance into Quality improvement dashboards
To ensure that the benefits of medication reconciliation are sustained, it is essential to design transparent reporting systems that share status and ensure accountability and alignment to best practices.

Challenges:

1. Inputs to Best Possible Medication History (BPMH):
Sometimes it is difficult to obtain a medication history, which makes this step laborious. Pharmacists are often not available 24x7, and provincial drug databases such as Drug Profile Viewer (DPV) contain a limited subset of medication data.

2. Short-stay areas present time constraints:
Some clinical areas, like day surgery and short stay nursing units, have an average length of stay that is under 24 to 48 hours. It is challenging to complete all processes including BPMH, admission and discharge reconciliation within these time constraints.

3. Subspecialist scope of practice:
In some clinical areas, the most responsible physician is a specialist who may not be comfortable reconciling all medications on a patient’s profile, e.g. Surgery or Psychiatry. Assistance from a colleague, such as an Internal Medicine consultant, may be required.

4. MD Training and Re-education:
It is sometimes difficult to secure time with physicians for education or follow up assistance. This is necessary to communicate best practices and tips.

5. No ePrescription on discharge:
It would be more efficient to directly route discharge prescriptions to outpatient pharmacies in digital format, rather print paper copies, sign, and give to the patient. Currently, industry constraints limit implementation of this functionality in Canada.

Financial Considerations

The total cost of the multi-year eCare investment since 2010 is $36.9 million CDN; it consists of $13.9 million in capital and $4.6 million in annual operational costs. A more thorough breakdown of our total cost of ownership for eCare, inclusive of planned costs, is detailed in Figure 18.

<table>
<thead>
<tr>
<th>Initial capital costs</th>
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<tbody>
<tr>
<td>eCare Project costs: $12.8 million</td>
<td></td>
</tr>
<tr>
<td>Hardware/Infrastructure: $1.1 million</td>
<td></td>
</tr>
<tr>
<td>Total: $13.9 million</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>On-going operational costs (per year)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Software/Hardware: $1.9 million</td>
<td></td>
</tr>
<tr>
<td>IT and CI Staff: $2.7 million</td>
<td></td>
</tr>
<tr>
<td>Total: $23 million</td>
<td></td>
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</tbody>
</table>

Total eCare investment from 2010-2015: $36.9 million

This case study describes the success that NYGH was able to achieve in increasing adoption of medication reconciliation by physicians, using health information technology as part of the eCare project. From 2010 to 2015, admission and discharge reconciliation rates for medical inpatients each increased by 78% of total patient volume. This is not only an important achievement for patient safety, but also results in significant healthcare cost avoidance due to averted adverse drug events (ADE). The details below calculate the savings that were achieved.

Assumptions for Calculation of Cost Avoidance from Medication Reconciliation:
- A Canadian healthcare study found that 53.6 percent of medical inpatients have at least one unintended discrepancy between their home medication profile and their inpatient admission orders. Furthermore, this study found that 38.6 percent of these medication discrepancies have the potential to cause moderate to serious patient harm due to adverse drug events (Figure 3)\(^7\).
- Industry studies estimate the average cost attributable to a single adverse drug event is US$2,162 (CAN$4,028)\(^8\).

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**Example Cost Avoidance Calculation:**

Since reporting medication errors or near misses is voluntary, the accuracy of medication error rates is not reliable. For this case study, we looked at compliance and volume of medication reconciliation events per fiscal year and used Cornish et al. 2005 study to estimate the number of potential moderate and severe errors per admission which in identifies errors averted. The example calculation below is for the NYGH fiscal year 2015-2016:

- 53.6% of 9,129 total medical inpatients = 4,893 patients have a medication discrepancy in 2015-16
- 39% of 4,893 = 1,908 discrepancies with potential to cause moderate to severe harm in 2015-16
- 87% of 1,908 = 1,660 harmful discrepancies avoided due to admission med. reconciliation, 2015-16
- 1,660 * $4,028 = $6.69 million in cost averted in fiscal year 2015-16

Calculations for other fiscal years were conducted using the same formula. Results for all post-\textit{eCare} fiscal years are depicted in Figure 19 and Figure 20.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Number of Medicine IP Discharges</th>
<th>Admission Med Rec Compliance %</th>
<th>Number of Harms Avoided</th>
<th>Potential Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-2011</td>
<td>3326</td>
<td>44.7%</td>
<td>310</td>
<td>$1,251,839.43</td>
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<tr>
<td>(post-\textit{eCare}, Nov 1 onward)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011-12</td>
<td>8548</td>
<td>57.5%</td>
<td>1027</td>
<td>$4,138,578.69</td>
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<tr>
<td>2012-13</td>
<td>8672</td>
<td>80.5%</td>
<td>1459</td>
<td>$5,878,059.91</td>
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<tr>
<td>2013-14</td>
<td>8792</td>
<td>86.2%</td>
<td>1584</td>
<td>$6,381,368.20</td>
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<tr>
<td>2014-15</td>
<td>9138</td>
<td>87.4%</td>
<td>1670</td>
<td>$6,724,832.09</td>
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<tr>
<td>2015-16</td>
<td>9129</td>
<td>87.0%</td>
<td>1660</td>
<td>$6,687,461.86</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$31,062,140.18</strong></td>
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</tbody>
</table>

Figure 19
In summary, from 2010-2015, NYGH avoided $31 million in costs from averted adverse drug events, as a result of progressively improving adoption of electronic medication reconciliation via eCare, even though reconciliation was not made mandatory for physicians. This result is specific to ADE’s prevented through medication reconciliation on hospital admission, and does not take into account further potential benefits of medication reconciliation on transfer between levels of care, or on discharge.

In addition to reducing costs by averting ADE’s, the eCare project has realized substantial savings by preventing several other common and costly inpatient adverse events. Examples of these cost savings are outlined in our other three case studies. A comprehensive framework of the total eCare return on investment (ROI) is detailed in the Financial Considerations section of our case study that focuses on reduction of preventable inpatient deaths. Please refer to that case study for more details.

Moving forward, North York General Hospital will continue to use eCare to design and iteratively improve IT-enabled, patient centered solutions that achieve the best clinical and financial outcomes for our patients, families, community and health care system. We will also continue to share our lessons learned with other organizations, so that they can achieve similar benefits.