

# Potential Cost Savings and Reduction of Medication Errors Due to Implementation of Computerized Provider Order Entry and Bar-Coded Medication Administration in the Fraser Health Authority

Kane Larson<sup>1</sup>, Clifford Lo<sup>2</sup>

Citation: UBCMJ. 2019; 10.2 (45-46)

## Abstract

A closed-loop medication management system is an ideal system that seamlessly integrates the distribution of medication from health care providers to the patient. The main areas that the system encompasses are prescribing, transcription, dispensing, and drug administration. This paper examines two main aspects of a closed-loop medication management system: bar-coded medication administration (BCMA) and computerized provider order entry (CPOE). Our review of the literature shows that these systems combined could have prevented up to 72% of medication errors; this equates to 11,234 medication errors and 201 adverse drug events (cost saving of \$1.4 million) in the Fraser Health Authority from 2013-2017.

## Introduction

Medication errors are blunders in the patient treatment process that can lead to significant harm to patients and increase the burden on the health care system.<sup>1</sup> Currently, an estimated 70,000 preventable adverse events occur per year in Canada, and one-quarter of these events are related to medication errors, resulting in 700 deaths per year.<sup>2,3</sup> The cost of these medication errors is estimated to be \$2.6 billion per year.<sup>4</sup> Each preventable adverse drug event in a hospitalized patient costs an estimated \$6750 CAD (inflation adjusted to 2017) and increases the length of stay by 4.6 days.<sup>5</sup>

The most frequently cited method for preventing medication errors is incorporating a closed-loop medication management system (CLMM).<sup>4,5,6</sup> The ideal CLMM system seamlessly integrates information technology from automated dispensing devices (ADD), computerized provider order entry (CPOE), and bedside bar-coded medication administration (BCMA). This integration will enable each stage of the medication management process, including prescribing, transcription, dispensing, and administration, to be consolidated into an efficient and safe structure that optimizes patient health.<sup>6</sup>

Fraser Health is British Columbia's largest health authority and is comprised of 12 acute care hospitals, 7760 residential care beds, and 25,000 staff, with an annual operating budget of over \$3 billion.<sup>7</sup> Presently, Abbotsford Regional, Surrey Memorial, Royal Columbian, and Chilliwack Hospitals have deployed ADDs, and the rest of the Fraser Health hospitals will eventually receive them; however, implementation of CPOE and BCMA is only in the planning stages.<sup>8</sup>

CPOE can produce exceptional safety improvements, reducing 46% to 88% of medical errors within US hospitals.<sup>9-12</sup> Furthermore, BCMA has been shown to reduce medication errors by 49% to 51%, and generate an annual savings of \$2.2 million from time-saving.<sup>13,14</sup> Thus, we believe that if a CLMM system had been deployed in Fraser Health from 2013-2017, a significant number of medication errors would have been prevented, in addition to a potential cost savings. This article examines the potential

benefits of implementing BCMA and CPOE in Fraser Health. The medication errors in the Fraser Health Authority from 2013-2017 are listed in Table 1.

Category	Actual Event
Other	3980
Omitted dose	2890
Incorrect quantity (e.g., dose, strength, or concentration)	1812
Extra dose	1448
Incorrect product	1147
Incorrect time (e.g., given late)	1055
No order	783
Incorrect rate or frequency	646
Incorrect patient	545
Incorrect route or technique (includes use of incorrect IV line or SC butterfly)	267
Adverse reaction	277
Contraindicated	206
Incorrect form or formulation (e.g., tablet instead of liquid)	177
Incorrect storage or location	116
Expired or deteriorated product	93
Incorrect sequence	48
Narcotic count discrepancy	14
<b>Total</b>	<b>15,504</b>

Table 1 | Medication Errors from 2013-2017 in the Fraser Health Authority

## Discussion

Several systematic reviews summarize the effectiveness of BCMA and CPOE. The main benefits include more accurate timing of administration, preventing wrong medication from being given to the patient, ensuring the correct route of administration, improving dosage adjustments, and increasing transcription precision.<sup>12,14</sup> Both CPOE and BCMA can prevent many medication errors, and the effects of these two systems can be multiplied together due to their independent reduction values.<sup>14</sup> Based on conservative estimates from the literature, CPOE and BCMA could reduce medication errors by 46% and 49%, respectively.<sup>9,14</sup> The documented number of medication errors in the Fraser Health Authority from 2013-2017 was 15,504; the number of errors would therefore have been reduced from 15,504 to 8372 with the implementation of CPOE, and further reduced to 4269 with the addition of a BCMA system (Table 2).

Preventable adverse drug events refer to patients having dangerous responses to medications that could have been prevented. If CPOE and BCMA had been implemented from 2013-2017, 201 adverse reactions in

<sup>1</sup>Faculty of Pharmaceutical Sciences, University of British Columbia, 2405 Wesbrook Mall, Vancouver, British Columbia, V6T 1Z3, Canada

<sup>2</sup>Manager, Quality & Medication Safety, LMPS, Provincial Pharmacy Lead, Special Projects & Initiatives, BCPRA, Clinical Instructor, UBC Faculty of Pharmacy

Correspondence to:  
Kane Larson (kanelarson@hotmail.com)

the Fraser Health Authority would have been avoided and would equate to a total savings of \$1.4 million CAD. The proposed savings from a reduction in adverse drug events represents a small portion (13%) of the total savings that can be realised by implementing a closed-loop system.<sup>9</sup>

	Prior to Implementation	CPOE and BCMA Implementation	Total Reduction
Medication Errors	15,504	4269	11,234 (72%)
Adverse Drug Events	277	76	201

**Table 2** | Medication errors and projected potential reduction with CPOE and BCMA implementation

‘Adverse drug events’ was the only category for which we could accurately calculate cost savings. Other medication error groups were excluded in the cost-saving calculations due to insufficient clinical and literature information. This provided a very conservative estimate. The categories not included in the calculation were errors with dose, quantity, product, time, order, frequency, patient, route, storage, expired product, and sequence. Furthermore, additional benefits of CPOE and BCMA were not included in the analysis due to considerable variance between hospital systems and implementation strategies. These ‘other benefits’ include improved nurse time utilisation, specific drug guidance, renal dosing guidance, and laboratory monitoring.<sup>9</sup> ‘Other benefits’ are difficult to quantify and can require an extended period of time to manifest.

Despite the potential for CPOE and BCMA implementation to produce significant patient safety improvements, it is essential to be cautious, as the numbers calculated here are theoretically derived and may be imprecise. Incorrect implementation of the system, for example, could lead to conflicting results, such as what occurred with the implementation of iHealth in Nanaimo Regional General Hospital, Dufferin Place, and Oceanside Healthcare Centre. A survey indicated that more than 50% of the staff felt the new Electronic Health Record system (EHR) was less safe and more inefficient compared to the previous paper-based one.<sup>15</sup> Furthermore, the system went over budget by \$18.9 million CAD in capital funds and an additional \$35.2 million CAD in operating cost.<sup>15</sup> Nevertheless, the leadership at these centres is working tirelessly to improve the usability and functionality of the iHealth system. The principal message is that when examining results, it is critical to be cautious in drawing conclusions about the benefits of these systems, as each location is unique and will have a different experience. Proper implementation of CPOE and BCMA into Fraser Health will require significant stakeholder input, full investigation of all safety concerns with iHealth, assurance that the right leaders are in place, creation of realistic financial plans, secured funding, reviewed governance structure, and readiness plans including sufficient training for all staff.<sup>15</sup> The above recommendations are critical to solving the usability and functionality concerns that may arise if Fraser Health chooses to adopt this system.

## Conclusion

Overall, the potential cost savings associated with a closed-loop system due to preventing medication errors is underestimated. The initial stage of implementing the system is the costliest and is usually the primary barrier to implementation. The cost of implementation is challenging to determine for the Fraser Health Authority and will require an extensive review. Nevertheless, implementing CPOE and BCMA has significant potential to produce improved safety and cost savings if the system is appropriately executed.

## Conflicts of Interest

None to disclose.

## References

1. Ferner RE, Aronson JK. Clarification of terminology in medication errors. *Drug Saf*. 2006 Nov 1;29(11):1011-22.
2. Baker GR, Norton PG, Flintoft V, Blais R, Brown A, Cox J, et al. The Canadian adverse events study: the incidence of adverse events among hospital patients in Canada. *Can Med Assoc J*. 2004 May 25;170(11):1678-86.
3. Institute for Safe Medication Practices Canada [Internet]. ISMP Canada; c2000-2018. Ontario pharmacists can help provide a safer medication use system; 2001 Jan 21 [cited 1 September 2017]. Available from: <https://www.ismp-canada.org/OPA-Article.htm>
4. Hohl CM, Nosyk B, Kuramoto L, Zed PJ, Brubacher JR, Abu-Laban RB, et al. Outcomes of emergency department patients presenting with adverse drug events. *Ann Emerg Med*. 2011 Sep 30;58(3):270-9.
5. Bates DW, Spell N, Cullen DJ, Burdick E, Laird N, Petersen LA, et al. The costs of adverse drug events in hospitalized patients. *JAMA*. 1997 Jan 22;277(4):307-11.
6. Agrawal A. Medication errors: prevention using information technology systems. *Br J Clin Pharmacol*. 2009 Jun 1;67(6):681-6.
7. About Fraser Health [Internet]. Fraser Health Authority; 2018. Our People and Our Services; 2017 [cited 7 September 2017]. Available from: <http://www.fraserhealth.ca/about-us/about-fraser-health/>
8. Letwin S, Millin B, Miyata M, Morris L, Virani A, Vojt A. Automated Unit Dose Drug Distribution System Business Case [Internet]. Fraser Health; 2008 Nov [cited 3 Nov 2018]. 29 p. Available from: [https://www.cshp.ca/sites/default/files/Drug%20Distribution/FraserHealth\\_ADC\\_BusCase.pdf](https://www.cshp.ca/sites/default/files/Drug%20Distribution/FraserHealth_ADC_BusCase.pdf)
9. Kaushal R, Jha AK, Franz C, Glaser J, Shetty KD, Jaggi T, et al. Return on investment for a computerized physician order entry system. *J Am Med Inform Assoc*. 2006 May 1;13(3):261-6.
10. Lwin AK, Shepard DS. Estimating lives and dollars saved from universal adoption of the Leapfrog safety and quality standards: 2008 update. Washington, DC: The Leapfrog Group; 2008 Sep 23. 12 p.
11. Devine EB, Hansen RN, Wilson-Norton JL, Lawless NM, Fisk AW, Blough DK, et al. The impact of computerized provider order entry on medication errors in a multi-specialty group practice. *J Am Med Inform Assoc*. 2010 Jan 1;17(1):78-84.
12. Nuckols TK, Smith-Spangler C, Morton SC, Asch SM, Patel VM, Anderson LJ, et al. The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: a systematic review and meta-analysis. *Systematic reviews*. 2014 Jun 4;3(1):56.
13. Poon EG, Keohane CA, Yoon CS, Dittmore M, Bane A, Levitzion-Korach O, et al. Effect of bar-code technology on the safety of medication administration. *N Engl J Med*. 2010 May 6;362(18):1698-707
14. Shah K, Lo C, Babich M, Tsao NW, Bansback NJ. Bar code medication administration technology: a systematic review of impact on patient safety when used with computerized prescriber order entry and automated dispensing devices. *Can J Hosp Pharm*. 2016 Sep;69(5):394.
15. Ministry of Health. Review of Island Health's iHealth Electronic Health Record system [Internet]. Ministry of Health; 2018 Dec 12 [cited 1 May 2018]. 116 p. Available from: <http://www.health.gov.bc.ca/library/publications/year/2017/review-of-Island-Health-iHealth-electronic-health-record-system.pdf>