F - TECHNOLOGY

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Over the past decade, hospitals across Canada have implemented a wide range of initiatives in an effort to meet the expectations of the public and the respective Ministry of Health for a safer, more efficient and accountable healthcare system. When properly implemented, there is a growing body of evidence that supports the proposition that technologies such as computerized prescriber order entry (CPOE) systems, automated dispensing cabinets, point-of-care barcode systems, and electronic medication reconciliation systems can reduce medication errors and improve the quality of care.[1, 2, 3, 4, 5, 6.] Technology also plays an important role in collecting and managing information, lowering the costs associated with certain labour-intensive activities and increasing the efficiency of a wide range of other activities.

This section of the Hospital Pharmacy in Canada Report provides information on the implementation and use of various types of technology that are now being used as part of the medication systems in many Canadian hospitals.

PHARMACY INFORMATION SYSTEMS: USE OF CLINICAL DECISION SUPPORT SYSTEMS (CDSS)

A "Clinical Decision Support System" (CDSS) was defined in the 2009/10 Survey as:

> *"A computer program feature that provides automatic reminders, advice, or interpretation as data is entered for a specific patient and/or a specific medication order. A clinical decision support system (CDSS) uses patient specific data and evidence based practice guidelines to generate an alert and/or a suggested course of action."*

As reported in this section in prior survey reports, pharmacy information systems with built-in clinical decision support functionality are in place in most Canadian hospitals. However, despite the evidence that these systems improve the quality and safety of the medication management system, the actual level of adoption and use of specific CDSS functionality continues to be less than optimal.[2, 3.] Although there has been an increase in the use of certain CDSS safety features over the last few years, many hospitals continue to report that they do not utilize, or fully utilize, the CDSS functionality that is available in their pharmacy information system. The reasons for this anomaly need to be explored. If the functionality is not well-designed, work needs to be done with the providers of the software to resolve that problem. If the CDSS is well-designed, but is not being used by pharmacy staff, pharmacy managers should explore the reasons why and attempt to maximize the patient safety benefits that the CDSS was intended to provide.

Several CDSS functionalities have not been fully implemented.

- Almost all respondents (99%, 158/160) across all sectors and all sizes of hospitals reported that they have a pharmacy information system (PIS). (Table F-1) Eighty percent (125/156) reported that the pharmacy information system includes clinical decision support functionality, vs. 91% (150/164) of respondents in the 2007/08 report, 83% (118/142) in the 2005/06 report and 40% (58/144) in the 2003/04 report. Caution should be exercised in trying to compare these responses since "clinical decision support systems" were defined differently in the earlier surveys. The reported availability of a pharmacy information system with clinical decision support functionality was similar across most provinces and hospitals, with the exception of the Prairie region, and small hospitals with 50-200 beds, where the availability of such systems was lower.

In the 2009/10 survey we again attempted to determine if hospital pharmacy staff were using the clinical decision support functionality that was available in their pharmacy information system. Among the 125 respondents that reported having clinical decision support within their pharmacy information system:

- All respondents indicated that their pharmacy information system includes both drug allergy and drug interaction alerts, and that they are using that functionality. In previous surveys, respondents had reported similar results with respect to the widespread use of these two clinical decision support functionalities.

- Although 85% of respondents reported that their pharmacy information system included maximum dose alert functionality, only 54% of respondents reported that they were using that functionality. Differences in usage of this functionality were reported in different parts of the country. Quebec hospitals were most likely to report that they were using this functionality (78%, 18/23), followed by the Prairies at 60% (6/10), and respondents in the Atlantic Provinces were least likely to use that functionality (33%, 4/12). Note that these results are not comparable to the 2007/08 report as the structure of the survey question was changed in 2009/10,

- Seventy-five percent of respondents reported that their pharmacy information system had dosage modification alert functionality for drugs used in patients with renal or hepatic dysfunction. Of these, 64% reported that they used this functionality. Non-teaching hospitals were more likely to report the availability of this functionality than teaching hospitals (83% vs. 54%). Sixty-five percent of non-teaching hospitals reported that they were using this functionality, vs. 58% of teaching facilities. Quebec respondents reported the highest uptake for the use of this particular safety feature. Eighty-nine percent (17/19) of QC respondents with access to the functionality reported that they use it. In contrast, the Atlantic Provinces reported the highest availability of the functionality (92%, 12/13), but only 42% (5/12) reported that they were using it. Note that these results are not comparable to the 2007/08 report as the structure of the survey question was changed in 2009/10,

The availability of pharmacy information systems with clinical decision support functionality, based on evidence-based guidelines or clinical pathways, remains low. Although the percentage of respondents reporting they had access to this functionality has increased somewhat since previous surveys, the percentage of respondents who are actually using the functionality is similar to previous years.

- Thirty percent of respondents reported that their CDSS includes drug therapy guidance alerts based on evidence-based guidelines or clinical pathways. Of those, 43% reported that they are using the functionality. In the 2007/08 survey, 24% (36/148) of respondents reported that this clinical decision support functionality was available in their pharmacy information system and 49% (17/35) of those reported that they were using the functionality. In the 2005/06 survey, 18% (21/118) reported that this functionality was available and 57% (12/21) reported that they were using it. Over the last three surveys the numbers indicate that more respondents have access to this functionality, but only about half of all respondents are using that functionality. More than half (5/7) of respondents from QC who had access to this functionality reported that they were using it, compared with 50% or less in other provinces.

- Twenty-six percent of teaching hospital respondents reported that they had access to drug therapy guidance alerts based on evidence-based guidelines or clinical pathways but only three (9%) of those reported that they were using it. In contrast, 32% of non-teaching respondents reported that the functionality was available to them and 46% of those respondents reported that this functionality was being used in their facility. Once again QC reported considerably greater adoption of this functionality compared with other provinces.

- Fifty-four percent of respondents reported they had the ability to input patient-specific variables (e.g. renal function), that can then be used by the pharmacy information system to calculate patient- specific dosages or to enable the provision of patient-specific clinical recommendations. Seventy-three percent of these respondents reported that they were using this functionality.

- Thirty-seven percent of teaching hospitals reported the ability to input patient-specific variables to assess drug therapy, with 8 of these 13 hospitals (62%) reporting that were using that functionality. In comparison, 60% of respondents from non-teaching facilities reported that they had this functionality, and 75% of those reported that they were using it. In the Atlantic Provinces, the availability and use of this particular functionality appears to lag a bit behind that of other regions. Only 21% (3/14) of respondents from the Atlantic Provinces reported that they had access to this functionality and only one of those three respondents reported that they were using it.

As with many automated systems, pharmacy information systems generally allow users to override, or ignore, the alerts that are provided by an automated clinical decision support system. This ability to override an alert is necessary, given that automated alerts are based on imperfect assumptions that may not apply to a particular clinical situation. However, it is incumbent on hospitals to insure that alerts are being critically reviewed

by pharmacy staff and sound clinical judgments are being made when automated clinical decision support alerts are being overridden.

Table F-1. Clinical Decision Support System (CDSS) 2009/10

		All	Bed Size			Teaching Status	
			50 - 200	201- 500	>500	Teach	Non-Teaching
Does your hospital have a Pharmacy Information System (PIS)?	(n=)	(160)	(34)	(94)	(32)	(43)	(117)
		158	33	93	32	42	116
		99%	97%	99%	100%	98%	99%
Base: all repsondents							
The Pharmacy Information System includes a Clinical Decision Support System (CDSS)	(n=)	(156)	(32)	(92)	(32)	(42)	(114)
		125	21	77	27	35	90
		80%	66%	84%	84%	83%	79%
Base: respondents with a PIS							
Clinical Decision Support System's patient-specific alerts and use							
Drug alergy alerts	(n=)	(125)	(21)	(77)	(27)	(35)	(90)
Available		125	21	77	27	35	90
		100%	100%	100%	100%	100%	100%
in use	(n=)	(124)	(21)	(76)	(27)	(35)	(89)
		124	21	76	27	35	89
		100%	100%	100%	100%	100%	100%
Drug interaction alerts	(n=)	(125)	(21)	(77)	(27)	(35)	(90)
Available		125	21	77	27	35	90
		100%	100%	100%	100%	100%	100%
in use	(n=)	(125)	(21)	(77)	(27)	(35)	(90)
		125	21	77	27	35	90
		100%	100%	100%	100%	100%	100%
Maximum dose alerts	(n=)	(124)	(20)	(77)	(27)	(35)	(89)
Available		106	15	69	22	28	78
		85%	75%	90%	81%	80%	88%
in use	(n=)	(105)	(15)	(68)	(22)	(28)	(77)
		57	7	37	13	13	44
		54%	47%	54%	59%	46%	57%
Dosage modification alerts for certain drugs used in patients with renal or hepatic dysfunction…	(n=)	(122)	(21)	(75)	(26)	(35)	(87)
Available		91	14	59	18	19	72
		75%	67%	79%	69%	54%	83%
in use	(n=)	(91)	(14)	(59)	(18)	(19)	(72)
		58	7	39	12	11	47
		64%	50%	66%	67%	58%	65%
Drug therapy guidance alerts based on evidence-based guidelines or clinical pathways …	(n=)	(125)	(21)	(77)	(27)	(35)	(90)
Available		38	4	24	10	9	29
		30%	19%	31%	37%	26%	32%
in use	(n=)	(37)	(3)	(24)	(10)	(9)	(28)
		16	1	13	2	3	13
		43%	33%	54%	20%	33%	46%
Ability to input patient-specific variables for use by the PIS…	(n=)	(125)	(21)	(77)	(27)	(35)	(90)
available		67	11	41	15	13	54
		54%	52%	53%	56%	37%	60%
in use	(n=)	(66)	(10)	(41)	(15)	(13)	(53)
		48	6	33	9	8	40
		73%	60%	80%	60%	62%	75%

Base: respondents with a CDSS

- Twenty-one percent (26/125) of respondents reported that their hospital has a policy dealing with the overriding of clinical decision support alerts that are generated by their pharmacy information system. This is similar to the response to this question in the 2007/08 survey (23%, 35/150). Teaching hospitals were slightly more likely to report having such a policy (26%, 9/35) than non-teaching hospitals

There is little increase in the number of respondents reporting use of an override policy.

(19%, 17/90). Regionally, BC (4%, 1/23) and the Prairies (7%, 1/15) were less likely than other regions to have a policy governing overrides.

- Of those hospitals with override policies, 52% (13/25) reported that their override policy includes identification of specific alerts that do not permit overrides, requiring that the order be changed. In comparison, only twenty-nine percent (8/28) of respondents in the 2007/08 report indicated that their policy included specific alerts that do not permit overrides.

- Seventy three percent of respondents (19/26) with an override policy reported that their policy includes a requirement to document a reason for selected high-risk overrides, vs. 54% (15/28) of respondents in 2007/08 who reported that they had this requirement in place. In addition, 58% (15/26) of respondents reported that their override policy includes a requirement for electronic tracking of overrides, vs. 36% (10/28) who reported this in 2007/08. Finally, 31% (8/26) of respondents reported that their override policy includes a requirement for a regular audit, review and follow up of overrides, usually by a medication safety committee or by a group within pharmacy. This compares to 14% (4/28) of respondents in 2007/08 who reported having this requirement in place. These increases between the two surveys suggest that pharmacy departments are recognizing the need for an enhanced level of accountability with respect to how clinical decision support alerts are dealt with by pharmacists.

Facilities increasingly require documentation of a reason for high-risk overrides and auditing of their use.

- Of the eight respondents that reported their override policy included a requirement for audit and review, six reported that the review of appropriateness of overrides was conducted by pharmacy personnel; five in ON and one in the Atlantic Provinces. Appropriateness of the review was verified by a medication safety committee in three of those hospitals.

- Forty-six percent (Table F-2) of respondents reported they had implemented all of the clinical decision making functionalities that were available in their pharmacy information system. Regionally, respondents from QC were most likely to report the use of all clinical decision support functionality (73%, 22/10), followed by the Prairies at 63%, (10/16).

The survey also attempted to identify the reasons why some organizations had decided not to make use of some of the clinical decision support functionality that was available in their pharmacy information system. Twenty-six respondents provided reasons (Table F-2).

- Forty-six percent (12/26) of respondents reported that the clinical significance of many of the alerts is questionable.

- Thirty-one percent (8/26) of respondents reported that there is insufficient staff time available to deal with all the alerts.

- Twenty-three percent (6/26) reported that the database that drives the alerts is out of date.

- One respondent reported that physicians rarely make changes to the order when contacted regarding the alert, so the cost-benefit is too low.

- Ten respondents provided other reasons why the functionality was not being used, including:
    - insufficient data was available to utilize the functionality (e.g. patient weight, renal function, lab tests, etc)
    - staff were not aware that the functionality was available
    - there was a lack of resources and/or expertise to implement the functionality
    - the functionality was not user friendly (requires manual activation, inappropriate alert level options leading to a choice of either alert fatigue or lack of alerts)
    - use of the functionality was a low priority in relation to other needs,
    - lack of confidence in the quality of alerts

The use of automated, computer-driven alerts can be a useful tool, both for improving patient safety and for enhancing evidence-based care. However, the results of this survey suggest that the full potential of computerized decision support systems is not being realized. The barriers to achieving the full benefits of these systems need to be examined and addressed.

Table F-2. Reasons for not using Functionality of the Pharmacy Information System 2009/10

		All	Bed Size			Teaching Status	
			50 - 200	201- 500	>500	Teach	Non-Teaching
Use of available clinical decision support functionalities listed in Table F.1	(n=)	(127)	(22)	(78)	(27)	(35)	(92)
all functionalities are in use		59 46%	11 50%	35 45%	13 48%	14 40%	45 49%
not all functionalities are in use		68 54%	11 50%	43 55%	14 52%	21 60%	47 51%
Reasons for not using clinical decision support functionalities	(n=)	(26)	(3)	(14)	(9)	(5)	(21)
The clinical significance of many of the alerts is questionable		12 46%	3 100%	5 36%	4 44%	3 60%	9 43%
There is insufficient staff pharmacist time to deal with all the alerts		8 31%	1 33%	4 29%	3 33%	0 0%	8 38%
The database that drives the alerts is out of date		6 23%	0 0%	4 29%	2 22%	1 20%	5 24%
Physicians rarely make changes to the order when contacted re the alert		1 4%	0 0%	1 7%	0 0%	0 0%	1 5%
Other		10 38%	1 33%	7 50%	2 22%	2 40%	8 38%

Base: respondents with a CDSS. Note: multiple mentions permitted

Systems integration: Availability of laboratory test results and other patient information

Failure of clinical laboratory and pharmacy information systems to effectively exchange data through an effective, real-time interface is a problem that continues to plague many hospitals. Overcoming this obstacle has the potential to significantly improve the quality of patient care and clinical outcomes.[1] Where computerized prescriber order-entry systems have been implemented, the failure to establish bi-directional laboratory and pharmacy interfaces represents a lost opportunity for achieving a significant improvement in the communication of health information to those at the front line of patient care.[1] Benefits of establishing such interfaces include the availability of better information to support:

- the selection of the most appropriate drug (laboratory-based indications and contraindications),
- drug dosing (renal or hepatic impairment, blood level–guided adjustments),
- laboratory monitoring for toxicity (both baseline and ongoing monitoring)
- laboratory result interpretation (drug-test interaction)

Table F- 3. Pharmacy Access to Lab Results 2009/10

		All	Bed Size			Teaching Status	
			50 - 200	201- 500	>500	Teach	Non-Teaching
How are pharmacists provided with access to laboratory test results?	(n=)	(160)	(34)	(94)	(32)	(43)	(117)
View-only access available from pharmacy terminals (interface or separate log-in)		87 54%	19 56%	53 56%	15 47%	27 63%	60 51%
Lab system is interfaced with medication order entry system ... alert about need for potential drug therapy changes		68 43%	12 35%	39 41%	17 53%	16 37%	52 44%
Through paper-based medical record only		5 3%	3 9%	2 2%	0 0%	0 0%	5 4%

Base: all respondents

The survey results indicate that some progress has been achieved with respect to pharmacists' ability to access laboratory data at the point of care, which is an important enabler for the provision of high-quality pharmacy services and the avoidance adverse drug events.[1]

- Forty-three percent of respondents reported that their laboratory system is interfaced with the medication order entry system. In the 2007/08 survey 35% (57/165) of respondents had indicated that an interface between these two systems was in place.
- Only three percent of respondents (5/160), all of which were in the Prairies, reported that they relied on paper-based lab data, compared to 5% (8/165) who reported that they relied on paper-based access to lab data in 2007/08.
- Fifty-four percent of respondents reported that they accessed lab data through view-only terminals.
- Respondents with larger bed size, teaching hospital status, and location in ON, or the Atlantic Provinces, were more likely to report having an interfaced lab-pharmacy system.

COMPUTERIZED PRESCRIBER ORDER ENTRY SYSTEMS (CPOE)

Medication errors can occur at all steps of the medication management process. Common prescribing errors include wrong drug or dosage form, incorrect dose calculation, failure to consider allergies or lab results and failure to adjust dosages in patients with renal or hepatic dysfunction .[2] CPOE is a technology that has the potential to improve the efficiency and quality of care, yet the uptake of this technology has been slow across North America.[3] High cost, implementation resource intensity, and low user satisfaction are all factors that have delayed the adoption of this technology. However, there continues to be a strong belief that CPOE technology has the potential to improve patient safety, improve the quality of care, and ultimately to reduce the cost of care, particularly when CPOE is part of a larger strategy to create a technology-enabled, closed-loop, medication use system. Such a strategy would include CPOE, automated drug packaging, automated drug identification labeling using barcode or similar electronic identification technology, automated drug distribution technologies, bed-side barcoding systems and electronic medication administration records.

- The 2009/10 survey results indicate that there has been some progress in the implementation of CPOE systems. Eight percent (13/160) of respondents reported they had an operational CPOE system in place, compared with 5% (9/165) in 2007/08 and 6% (8/142) in 2005/06. (Table F-4)
- Teaching hospitals were more likely than non-teaching hospitals to report an operational CPOE (23% vs. 3%). Mid-sized facilities (200-500) beds were more likely to report that a CPOE system was in place (12%) than small hospitals with 50 to 200 beds (3%), and large facilities with more than 500 beds (3%). Hospitals in ON were most likely to report a CPOE system in place 16% (8/51). There were no facilities in BC that reported having a CPOE system in operation.

There is slow progress in the implementation of CPOE systems

- Not much change was reported since the last survey in the percentage of hospitals with an approved implementation plan for CPOE. Twenty-four percent of respondents reported they have an approved plan to implement a CPOE system, compared with 22% (37/165) in 2007/08 and 23% (33/142) in 2005/06. Despite the 22% of respondents in the 2007/08 who reported that their facility had an approved plan to implement CPOE, the increase in the percentage of those who have actually implemented a CPOE system in the last two years was actually less than 2%.
- Sixty-eight percent of respondents in the 2009/10 survey reported that they had no approved plan for CPOE, emphasizing that this important patient safety functionality is still not high on the priority list of many Canadian hospitals.
- Of the 13 facilities that reported an operational CPOE, five reported that the CPOE system was not interfaced to the pharmacy information system. This is the same number of facilities that reported the lack of an interface in the 2007/08 survey. Six respondents reported that their facility had a bi-directional interface with the pharmacy information system vs. three respondents who reported having a bi-directional interface in 2007/08. Two respondents reported a unidirectional

Information systems integration has improved

interface from the CPOE system to the pharmacy information system, vs. one respondent who reported this configuration in 2007/08.

- Of the 12 respondents with CPOE systems that completed the CPOE integration section of the survey, seven reported that their CPOE system was integrated with a clinical support system that guides the user through established protocols and clinical pathways, a considerable improvement over the one respondent with this functionality in 2007/08.
- Only four respondents reported that their CPOE system is interfaced with the lab system vs. five respondents who reported this in 2007/08 and three who reported this in 2005-06.
- Most respondents (11/12) reported that their CPOE system alerts prescribers to unsafe orders during order entry and guides the use of formulary drugs
- Nine respondents reported that their CPOE system includes weight-based or surface area based dosing for selected drugs and/or patient populations, while five respondents reported that the CPOE system includes functionality that assists with the dosing of medications in special populations (renal impairment, hepatic impairment, etc.)

Table F-4. Computerized Prescriber Order Entry System (CPOE) 2009/10

		Bed Size			Teaching Status	
	All	50 - 200	201- 500	>500	Teach	Non-Teaching
Existence of CPOE (n=)	(160)	(34)	(94)	(32)	(43)	(117)
No, and no CPOE plan approved	109 68%	27 79%	67 71%	15 47%	16 37%	93 79%
No, but approved plan to implement CPOE	38 24%	6 18%	16 17%	16 50%	17 40%	21 18%
Yes, CPOE operational	13 8%	1 3%	11 12%	1 3%	10 23%	3 3%
CPOE and PIS interface (n=)	(13)	(1)	(11)	(1)	(10)	(3)
CPOE is interfaced to PIS (unidirectional)	2 15%	0 0%	2 18%	0 0%	1 10%	1 33%
CPOE is interfaced to PIS (bidirectional)	6 46%	0 0%	6 55%	0 0%	5 50%	1 33%
CPOE is NOT interfaced to PIS	5 38%	1 100%	3 27%	1 100%	4 40%	1 33%
Integration and use of a CPOE (n=)	(12)	(0)	(11)	(1)	(9)	(3)
Is integrated with a clinical decision support system	7 58%	0 0%	6 55%	1 100%	4 44%	3 100%
Is interfaced with the lab system to alert practitioners	4 33%	0 0%	3 27%	1 100%	3 33%	1 33%
Alerts prescribers to unsafe orders during order entry	11 92%	0 0%	10 91%	1 100%	8 89%	3 100%
Guides the use of formulary drugs	11 92%	0 0%	10 91%	1 100%	9 100%	2 67%
Guides the use of weight-based or surface area based dosing for selected drugs and/or patient populations	9 75%	0 0%	8 73%	1 100%	7 78%	2 67%
Guides the dosing of medications in special populations	5 42%	0 0%	4 36%	1 100%	5 56%	0 0%

Base: Facilities with CPOE

COMPUTER ACCESS ON PATIENT CARE UNITS

In the 2009/10 survey, a number of questions were asked in an effort to determine if pharmacy staff had access to computers on patient care units for the purpose of carrying out their patient care responsibilities while working there. (Table F-5)

- The majority of respondents, 89%, reported that pharmacy staff had the ability to access patient care information at the patient care unit level, via either a portable computer or a fixed desktop computer.
- Forty-seven percent of these respondents reported that they used portable wireless computers to access patient information and 99% reported that fixed computers on the patient care units could be used by their staff while they were working in those locations. Ninety-eight percent of respondents with access to

patient information reported that they could access patient drug profiles and electronic data bases from the pharmacy information system while working on patient care units.

- Approximately half the respondents with access to patient information reported that their staff used computers on patient care units for decentralized order entry and 93% can access a drug information database while on the patient care unit. Seventy-seven percent of respondents reported that they can access electronic health records when using computers on patient care units
- The ability to perform clinical documentation/monitoring using computers on the patient care units was reported by 66% of respondents
- Using computers on the patient care unit for medication reconciliation documentation was reported by 44% of respondents

Table F-5. Computer Access on Patient Care Units 2009/10

		Bed Size			Teaching Status	
	All	50 - 200	201- 500	>500	Teach	Non-Teaching
Ability to access patient care information at the patient care unit level via a portable or a fixed location desktop computer (n=)	(160)	(34)	(94)	(32)	(43)	(117)
	143	29	85	29	41	102
	89%	85%	90%	91%	95%	87%
Computer location for accessing patient care information: (n=)	(139)	(28)	(85)	(26)	(38)	(101)
Fixed location (wired)	137	28	83	26	38	99
	99%	100%	98%	100%	100%	98%
Portable location (wireless)	66	9	42	15	24	42
	47%	32%	49%	58%	63%	42%
Computers on patient care units are used for (n=)	(143)	(29)	(85)	(29)	(41)	(102)
decentralized order entry on patient care units	73	10	44	19	26	47
	51%	34%	52%	66%	63%	46%
accessing patient drug profiles from the pharmacy information system	140	27	84	29	41	99
	98%	93%	99%	100%	100%	97%
accessing electronic health records	110	20	69	21	31	79
	77%	69%	81%	72%	76%	77%
accessing Drug information database	133	23	82	28	40	93
	93%	79%	96%	97%	98%	91%
clinical documentation/ monitoring	95	12	66	17	27	68
	66%	41%	78%	59%	66%	67%
medication reconciliation documentation	63	10	38	15	20	43
	44%	34%	45%	52%	49%	42%
Other	9	2	4	3	3	6
	6%	7%	5%	10%	7%	6%

Base: Facilities where patient care units have computer access. Note: multiple mentions permissible

SMART PUMPS

When properly programmed, set up, and used, smart pumps have the potential to significantly reduce the risk of adverse events associated with the administration of medications via the parenteral route. According to the literature, approximately 39% of medication errors occur during drug administration and this is typically the phase of the medication system where errors are least likely to be intercepted before reaching the patient.[2,5] Some of the most serious medication errors on patient care units involve the incorrect programming of infusion pumps. Those types of errors can be reduced through the use of smart pump drug libraries and barcode enabled automated dose/rate programming.

- Sixty-eight percent of respondents in the 2009/10 survey reported that smart pumps were being used in their hospital, vs. 61% (101/165) in 2007/08. (Table F-6) In the 2007/08 survey, teaching hospitals were less likely to have implemented smart pumps than non-teaching hospitals. In t2009/10, a similar percentage of teaching and non-teaching hospitals reported that they were using smart pumps (65% and 68% respectively). There were regional differences in smart pump uss, with BC at 80% (20/25), the Prairies at 72% (23/32), ON at 76% (39/51), the Atlantic Provinces at 53% (9/17) and QC at 49% (17/35).
- Thirty percent (32/108) of respondents using smart pumps reported that they used a wireless network to upload or download data to smart pumps. The Atlantic Provinces reported the highest use of wireless systems for transferring information to and from smart pumps (56% 5/9) while BC reported the lowest

rate of use of wireless networks (10%, 2/20). The reported use of wireless networks to upload or download data to smart pumps represents considerable growth since the 2007/08 survey where only nine percent (9/101) of respondents reported the use of wireless systems for this purpose.

- Sixty-two percent of respondents reported they review and update the pumps' libraries at least annually, an increase from 43% (43/99) in 2007/08.

There is increased use of wireless networks for updating smart pumps.

- Forty-eight percent of respondents reported they download and review quality control data from pumps at least annually, an increase from the 36% (35/98) of respondents in the previous survey who reported doing this. Seventy-six percent of these respondents reported that they had made changes to policies, procedures, or pump programming following the review of the pumps' quality control data, compared with 71% (22/31) in 2007/08.

Table F-6. Smart Pumps 2009/10

			Bed Size			Teaching Status	
		All	50 - 200	201- 500	>500	Teach	Non-Teaching
Hospital uses IV Smart pumps	(n=)	(160)	(34)	(94)	(32)	(43)	(117)
		108	19	69	20	28	80
		68%	56%	73%	63%	65%	68%
Use of a wireless network to upload or download data to smart pumps	(n=)	(108)	(19)	(69)	(20)	(28)	(80)
		32	5	20	7	10	22
		30%	26%	29%	35%	36%	28%
Annual review of smart pumps' libraries	(n=)	(107)	(18)	(69)	(20)	(28)	(79)
		66	10	43	13	19	47
		62%	56%	62%	65%	68%	59%
Annual review of smart pumps' quality control data	(n=)	(106)	(18)	(69)	(19)	(27)	(79)
		51	10	27	14	16	35
		48%	56%	39%	74%	59%	44%
Facility made changes following the review of the pumps' quality control data	(n=)	(51)	(10)	(27)	(14)	(16)	(35)
		39	9	20	10	14	25
		76%	90%	74%	71%	88%	71%

Base: Facilities using smart pumps

BARCODING

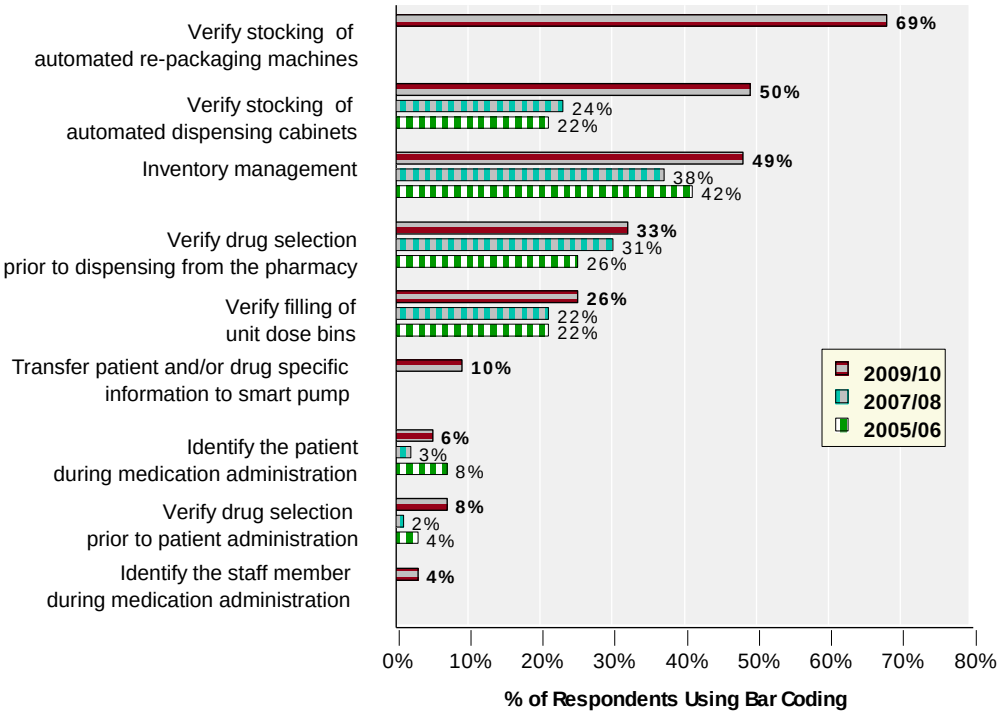
Barcode systems are used in a number of technologies to ensure the correct identification of medications, blood products, lab samples, staff and patients. Within the medication use system barcode technologies have been shown to reduce medication errors.[2,7] Literature reports indicate that the use of barcoding applications within hospital pharmacies can reduce the dispensing error rate by over 30% and the potential rate of adverse events by more than 60%.[8] Other reports indicate that the implementation of bedside medication verification using barcode scanning may reduce medication administration errors by over 40%, the rate of potential adverse drug events by over 50%, and reduce the rate of medication administration timing errors by almost 30%.[6] This represents a significant safety improvement over traditional medication administration processes which are estimated to catch no more than 2% of the errors occurring at the time of medication administration. Typically, approximately 39% of medication related errors occur at the administration phase. The potential to reduce errors at this point in the medication use system therefore represents a major medication safety improvement opportunity.

The use of barcoding continues to slowly increase.

The use of barcode systems in U.S. hospitals is much more common than in Canadian hospitals. However, the implementation of barcode systems presents many challenges, in part because of the lack of a universally accepted barcode standard. The Canadian Pharmaceutical Barcoding Project Team,[9] has recognized this issue as a major obstacle and has joined the Global Barcode Initiative for the adoption of standards for automated identification of medications. This pan- Canadian initiative promotes standardized barcode use in healthcare, using the Global Standard (GS1) for automated identification of pharmaceuticals. This system uses a 14 digit, Global Trade Identification Number (GTIN) linear barcode, or a matrix multidimensional barcode.[10] The Canadian Pharmaceutical Barcode Project[9] was initiated

jointly by the Canadian Patient Safety Institute and the Institute for Safe Medication Practices Canada (ISMP Canada) and is led by a national implementation committee of approximately 40 medication system stakeholders, including pharmaceutical manufacturers, institutional pharmacy, retail pharmacy, professional practice organizations, healthcare solution providers, supply chain organizations and purchasing organizations. The current survey did not solicit information from respondents regarding the barcode standard being used by respondents. Those questions will be introduced in future surveys.

Figure F-1. Uses of Barcoding 2009/10



Base: Respondents reporting use of bar coding in medication system (50 in 2005/06, 58 in 2007/08, 78 in 2009/10)

- The use of barcode applications in the medication management systems of Canadian hospitals is slowly increasing. Forty-nine percent of respondents in the 2009/10 survey reported that they were using barcoding vs. 37% (60/164) of respondents in the 2007/08 report and 35% (50/142) in the 2005/06 report.
- The reported use of barcode applications in medication systems was higher in teaching hospitals (72%) than in non-teaching hospitals (40%). In teaching hospitals the use of barcode systems has increased from 56% (22/39) of respondents in 2007/08 to 72% of respondents in 2009/10. In non-teaching hospitals, the use of barcode applications increased to 40% of respondents in 2009/10, from 30% (38/125) of respondents in 2007/08. Reported use was higher in larger hospitals with more than 500 beds (63%) and in QC at 63% (22/35), compared with usage by 38% to 51% of respondents in other provinces.
- Of the 78 respondents who reported that they were using barcodes in their medication management systems, the most common use was for verifying the stocking of automated repackaging machines. Sixty-nine percent of those respondents reported that they used barcode systems for this purpose, with an additional 8% of respondents reporting that they had an approved plan to implement barcoding systems for that purpose.
- The next most commonly used purpose was verifying the stocking of automated dispensing cabinets. Fifty-percent of respondents reported that they used barcode systems for this purpose, with an additional 22% of respondents reporting that they had an approved plan to implement barcoding systems for that purpose. This represents a notable increase when compared to the 24% (14/58) of respondents who reported using barcode systems for stocking dispensing cabinets in 2007/08 and the 22% of respondents (11/50) in 2005/06 who reported using this type of barcode system. In 2003/04, only five respondents were using barcode systems for this purpose.

- Use of barcodes for inventory management was reported by 45% of respondents, with a further 10% reporting they had an approved and funded plan to implement this type of barcode system.
- Thirty-three percent of respondents reported they use barcoding to verify drug selection before dispensing from pharmacy, with a further 17% having an approved and funded plan to do so.
- Twenty-six percent of respondents reported the use of barcode technology to verify the stocking of unit dose bins vs. 22% (13/58) in 2007/08 and 22% (11/50) in 2005/06.
- Eight of 78 respondents reported they had implemented barcode scanning to transfer patient and/or drug specific information to smart pumps, compared with only one respondent in 2007/08. Nine respondents reported they had approved and funded plans to implement barcode systems for this purpose.

Table F-7. Barcoding 2009/10

		All	Bed Size			Teaching Status	
			50 - 200	201- 500	>500	Teach	Non-Teaching
Bar Coding is used in the medication system	(n=)	(160)	(34)	(94)	(32)	(43)	(117)
		78	9	49	20	31	47
		49%	26%	52%	63%	72%	40%
Bar Coding is used to							
Verify drug selection prior to dispensing from the pharmacy	(n=)	(78)	(9)	(49)	(20)	(31)	(47)
not used yet, but there is an approved and funded plan to do so		13	1	8	4	7	6
		17%	11%	16%	20%	23%	13%
used for this activity		26	3	16	7	7	19
		33%	33%	33%	35%	23%	40%
Verify drug selection prior to patient administration	(n=)	(78)	(9)	(49)	(20)	(31)	(47)
not used yet, but there is an approved and funded plan to do so		11	0	7	4	6	5
		14%	0%	14%	20%	19%	11%
used for this activity		6	0	6	0	2	4
		8%	0%	12%	0%	6%	9%
Identify the patient during medication administration	(n=)	(78)	(9)	(49)	(20)	(31)	(47)
not used yet, but there is an approved and funded plan to do so		7	0	3	4	3	4
		9%	0%	6%	20%	10%	9%
used for this activity		5	0	5	0	2	3
		6%	0%	10%	0%	6%	6%
Identify the staff member during medication administration	(n=)	(77)	(9)	(48)	(20)	(30)	(47)
not used yet, but there is an approved and funded plan to do so		7	0	3	4	3	4
		9%	0%	6%	20%	10%	9%
used for this activity		3	1	2	0	3	0
		4%	11%	4%	0%	10%	0%
Manage Inventory	(n=)	(78)	(9)	(49)	(20)	(31)	(47)
not used yet, but there is an approved and funded plan to do so		8	0	6	2	4	4
		10%	0%	12%	10%	13%	9%
used for this activity		35	3	20	12	12	23
		45%	33%	41%	60%	39%	49%
Verify filling of unit dose bins	(n=)	(76)	(9)	(49)	(18)	(29)	(47)
not used yet, but there is an approved and funded plan to do so		5	0	3	2	2	3
		7%	0%	6%	11%	7%	6%
used for this activity		20	3	11	6	7	13
		26%	33%	22%	33%	24%	28%
Verify stocking of automated dispensing cabinets	(n=)	(76)	(9)	(48)	(19)	(30)	(46)
not used yet, but there is an approved and funded plan to do so		17	0	12	5	5	12
		22%	0%	25%	26%	17%	26%
used for this activity		(38)	(7)	(22)	(9)	(19)	(19)
		50%	78%	46%	47%	63%	41%
Verify stocking of automated repackaging machines	(n=)	(77)	(9)	(48)	(20)	(31)	(46)
not used yet, but there is an approved and funded plan to do so		6	0	5	1	5	1
		8%	0%	10%	5%	16%	2%
used for this activity		53	7	33	13	21	32
		69%	78%	69%	65%	68%	70%
Transfer patient and/or drug specific information to smart pumps	(n=)	(78)	(9)	(49)	(20)	(31)	(47)
not used yet, but there is an approved and funded plan to do so		9	0	6	3	5	4
		12%	0%	12%	15%	16%	9%
used for this activity		8	1	5	2	7	1
		10%	11%	10%	10%	23%	2%

Base: Facilities using barcoding

- The use of barcode scanning for patient identification during drug administration was reported by 5 respondents in 2009/10, compared with two respondents in 2007/08. In the 2009/10 survey, a further seven respondents reported an approved and funded implementation plan for this use of barcode technology.
- The use of barcode scanning for drug identification verification prior to administration to the patient was reported by six respondents in 2009/10 and a further 11 respondents reported that they had an approved and funded plan to implement such a barcode system.
- Only three respondents in 2009/10 reported that they identify staff using barcodes and a further seven reported an approved and funded plan to do so.

Progress is being made in the reported use of barcode scanning in hospitals. The slow adoption of this technology may be a symptom of the difficulty in both implementing and maintaining these systems. Some of these issues include the financial cost of implementation, the human resources required to maintain the barcode data within the hospital computer system and software incompatibility with Canadian barcodes. A recent study on technology in the U.S reported that over 25% of doses need to be re-packaged in order to apply the necessary, readable barcodes, which represents a considerable workload burden for organizations.[11] However, the Canadian Pharmaceutical Bar Code Project, with its carefully designed stakeholder involvement, intends to minimize this impact.[9]

Differences between data in this chapter and data in the CSHP 2015 chapter

Astute readers may notice that there are a few similar questions in the Technology and CSHP 2015 chapters of this report, and that the responses sometimes appear to be different in the two chapters of the report. There are sometimes differences in the exact wording of the questions in the two chapters that explains the different results. The technology chapter often drills down further than the CSHP 2015 chapter, which leads to the separation of features that remain combined in the CSHP 2015 questions. The respondent base is also different in some of the related questions. For example, in the Technology chapter, 33% (26/78) of respondents who use barcoding use it for identifying the drug before dispensing vs. in the CSHP chapter 17% (27/151) of all respondents use barcoding for identifying the drug before dispensing.

CONCLUSION:

This section of the report indicates that the rate of adoption of certain important technologies, such as CPOE and barcode applications, is slowly increasing. However, the data also suggests that the full patient safety potential of many technologies is not being fully realized. Even when technologies have been adopted, the evidence suggests that the full functionality of the technology is often not being used. The reason for this sometimes appears to be that the design of the software is less than ideal, leading to frustration and a sense that the benefits of the functionality are minimal in comparison to the time and effort that staff have to expend in order to use a particular functionality. In other situations, pharmacy managers and their staff may need to ask themselves if they have done all that they should do in order to realize the full patient safety features of the technology, while ensuring that the system does not create unnecessary additional work for staff.

The results suggest that a small number of respondents are recognizing the need for pharmacy departments and their staff to accept greater accountability for how new technologies are used, or not used. Those respondents reported that they have policies in place that require their staff to document a reason for selected high-risk overrides. In addition, some facilities have audit systems in place to review override records and insure that pharmacy staff are responding appropriately to the automated alerts that are built into the technologies that they are using. However, it appears that most facilities have not implemented these types of review procedures to ensure that the patient safety features of their technology are being appropriately used.

This section also suggests that progress is being made in the area of systems integration. More respondents now report that their pharmacy information system is interfaced with the laboratory information system and with their CPOE system. There has also been an increase in the use of wireless networks to support the updating of drug libraries in smart pumps and to download audit information related to staff overrides of automated smart-pump alerts.

There were a number of additional respondents this year who reported that they now have a functional CPOE system in place. However, the adoption rate of this technology changes very little from survey to survey.

The use of barcoding continues to increase, but at a slow pace from survey to survey. Notable increases were reported this year in the use of barcode systems for verifying the stocking of automated medication distribution cabinets. However, the use of barcode systems for bedside verification of medication identification and patient identification remains very low. Hospitals are encouraged to review the Canadian Pharmaceutical Barcoding Project Technical Statement[9] and to align technology and barcoding activities accordingly. The use of barcodes to identify products, patients and healthcare personnel has the potential to yield significant patient safety benefits. The more consistent we are as a nation in the adoption and use of barcoding and the more aligned we are with the Global Community, the more successful we will be in the improvement of patient care and safety in Canadian hospitals.

The 2010 survey asked respondents to indicate if they have approved plans to implement a number of barcode applications. A significant percentage reported affirmatively in all areas. It will be of interest to review future surveys to determine if this projected growth in the use of barcode systems is realized.

The implementation and use of technology still represents a major challenge for Canadian hospitals. Specifically, the level of funding required to enhance existing medication systems for patient safety far exceeds historical funding patterns for this area of practice. On the positive side, the standard for new hospitals and newly developed pharmacy departments generally includes a comprehensive suite of medication systems technology. There is also encouraging growth in adoption and use of technology, particularly in the areas of systems integration and barcode applications, Hopefully this growth in the use of these and other technologies will accelerate, supported by national initiatives, global standards and a commitment to patient safety and continuity of care.

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