**Canadian Pharmaceutical Bar Coding Project**

# Medication Bar Code System Implementation Planning

## *Introduction*

August 2013 (Final)

*This resource guide was developed as part of the **Canadian Pharmaceutical Bar Coding Project**, collaboratively led by the Institute for Safe Medication Practices Canada and the Canadian Patient Safety Institute.*

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This publication is available at:  www.ismp-canada.org
Project documents and endorsements are available at:  http://www.ismp-canada.org/barcoding/index.htm
For additional information or to provide feedback please contact: info@ismp-canada.org

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**About the Institute for Safe Medication Practices Canada (ISMP Canada)**

ISMP Canada is an independent national not-for-profit agency committed to the advancement of medication safety in all healthcare settings. ISMP Canada works collaboratively with the healthcare community, regulatory agencies and policy makers, provincial, national, and international patient safety organizations, the pharmaceutical industry, and the public to promote safe medication practices.

ISMP Canada's mandate includes collecting, reviewing, and analyzing medication incident and near-miss reports, identifying contributing factors and causes, and making recommendations for the prevention of harmful medication incidents.

Link to the Institute for Safe Medication (Canada)

**About the Canadian Patient Safety Institute (CPSI)**

CPSI is a not-for-profit corporation, operating collaboratively with health professionals and organizations, regulatory bodies, and governments to build and advance a safer healthcare system for Canada. CPSI performs a coordinating and leadership role across healthcare sectors and systems, promotes leading practices, and raises awareness about patient safety by working in collaboration with partners, patients, their families, and the general public.

Link to the Canadian Patient Safety Institute

*This resource guide is dedicated to the memory of Allan Reynolds, a member of our advisory Implementation Committee, whose enthusiasm and unceasing commitment to improving medication safety for Canadians were guiding beacons.*

# Foreword

This comprehensive resource document has been written for use by senior practice leaders involved with medication management and system development and by their executive leadership colleagues responsible for strategic funding and system acquisition.

The purpose of this document is to review the need for automated identification (e.g., bar coding) of medications within both community-based (e.g., nursing home) and institutional (e.g., hospital and ambulatory) care. It is hoped that a better understanding of relevant issues will accelerate the adoption of innovative and safer medication processes within the Canadian healthcare system thus creating a medication system that protects Canadian patients from preventable and potentially serious harm.

Its release represents the final phase of the Canadian Pharmaceutical Bar Coding Project, co-led by the Institute for Safe Medication Practices Canada and the Canadian Patient Safety Institute. Its development has incorporated input and received support from major Canadian healthcare practice organizations, such as the Canadian Nurses Association and the Canadian Society of Hospital Pharmacists.

This document has four sections:

*A Bar Code Primer for Leaders*
Section I provides an overview of how automated identification works using the GS1 global standard.

*Building the Case for Automated Identification of Medications*
Section II reviews evidence and principles, building a case for the acquisition and implementation of bar coding systems by reviewing current medication error rates, the potential for human error, available effectiveness studies, and important organizational leadership principles.

*Implementation Considerations*
Section III presents a high-level review of system implementation considerations, which may be used as the basis for developing a detailed plan.

*References*
Section IV provides a list of categorized references.

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***Document Navigation***
***Readers are encouraged to begin by reading the "Executive Summary", followed by the summary section entitled "Document Précis". These summaries may be most efficient for executive leadership review, and provide direct links to and from the detailed information and citations, as desired.***

***Additional detail is provided in the remaining document sections which may be most useful to managers who seek to develop a strategic funding argument and/or develop an implementation plan.***

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## Some Words From Leaders …

### From Richard Alvarez …
*President and CEO*
*Canada Health Infoway*
*https://www.infoway-inforoute.ca/*

*Working together is key to reducing the potential for medication errors. Common standards and sharing of best practices can enable more effective use of technology in patient care environments so as to help Canadians and their healthcare providers to achieve safer medication practices. This resource guide reflects the collective input of experts from across Canada committed to using these tools to make care safer in community-based and institutional settings.*

### From Sam Shortt …
*Director, Quality Initiatives*
*Canadian Medical Association*
*http://www.cma.ca/*

*The Canadian Medical Association (CMA) supports initiatives that increase patient safety and whose implementation is feasible within the fiscal parameters of Canadian healthcare. Adverse drug events, especially those that are preventable through improved healthcare systems, are an ongoing concern to the Association. For that reason, in 2010 the CMA provided written support for the Canadian Pharmaceutical Bar Coding Project, co-led by the Institute for Safe Medication Practices Canada and the Canadian Patient Safety Institute.*

*The current report, entitled Medication Bar Code System Implementation Planning: A Resource Guide, represents the principal deliverable in the final phase of the Bar Coding Project. It makes a compelling case that the introduction of information systems employing the GS1 global standard for Automated Identification of Pharmaceuticals will enhance patient safety. The use of this technology will allow consistent tracking and identification of medications from the process of manufacture to the hands of the patient in a way that human checking methods can not duplicate.*

*We encourage healthcare providers and managers in both community and institutional settings to explore this document and, in particular, to learn from the very practical advice on implementation. The report states that in 2010 bar code verification was employed for only 8% of institutional beds in Canada. In contrast, the figure in the United States is currently almost 50%, suggesting Canadian healthcare should accord greater priority to this important patient safety intervention.*

### From Barb Mildon …
*President*
*Canadian Nurses Association*
*http://www.cna-aiic.ca*

*Patient safety has always been a key driver in the Canadian Nurses Association's efforts to advance excellence in nursing practice, whether in community, home or hospital care settings. The care systems we work in evolve through the interaction of highly developed sciences, human variability and technology. Under these conditions, using technology can be our most effective way of reducing preventable errors and improving the quality of health care. The nursing profession, which is responsible for delivering more care than any other group in the health system, fully supports the widespread adoption of medication bar coding technology. In terms of medication safety systems, bar coding offers a much needed series of checks and balances that will minimize the opportunities for error, cross-referencing several pieces of information as medications move along the supply chain to the nurse at the patient's bedside.*

*In order for bar coding to improve patient safety, nurses and other health-care providers also need a clear understanding of how the technology works and how to use it to support their practice. I think the new Medication Bar Code System Implementation Planning Resource Guide is a valuable tool in achieving this understanding. It presents the key activities to implement bar coding and step-by-step procedures, background information and system requirements, an overview of medication errors and how to design systems to weed them out, and responses to challenges we might meet along the way. This comprehensive guide brings us much closer to ensuring greater patient safety in the future for all patients.*

## From Myrella Roy …

*Executive Director*
*Canadian Society of Hospital Pharmacists*
[http://www.cshp.ca/](http://www.cshp.ca/)

*The Canadian Society of Hospital Pharmacists (CSHP) welcomes the release by the Institute for Safe Medication Practices Canada (ISMP Canada) and the Canadian Patient Safety Institute (CPSI) of the publication Medication Bar Code System Implementation Planning: A Resource Guide.*

*CSHP represents pharmacists who are committed to patient care through the advancement of safe, effective medication use in hospitals and other collaborative healthcare settings. One of our strategic programs is the CSHP 2015 initiative, launched in 2006. As a vision of pharmacy practice excellence by the year 2015, CSHP 2015 strives to improve patients' medication-related outcomes and safety. Two of the CSHP 2015 objectives address the use of bar-code technology:*

- *75% of hospitals will use machine-readable coding to verify medications before dispensing.*
- *75% of hospitals will use machine-readable coding to verify all medications before administration to a patient.*

*Medication bar code systems are associated with improved operational efficiencies and reduced preventable medication errors and potential adverse events. Despite a wealth of evidence supporting these systems, adoption of the technology is largely lacking in Canada. According to the CSHP 2015 section of the Hospital Pharmacy in Canada 2011/2012 Report, 20% of the survey respondents indicated that bar-code technology is used in their pharmacy dispensary operations and 4% use it to verify medications at the point of care before administration to a patient. Canadian hospitals are making progress, but most still have a long way to go. CSHP is confident that this Guide from ISMP Canada and CPSI will garner support for implementation of medication bar-code, and help build safer medication system infrastructure.*

*Medication Bar Code System Implementation Planning: A Resource Guide stands on the shoulders of an extensive collection of literature. This comprehensive Guide addresses a variety of topics of interest to pharmacy managers and leaders: how the different types of bar codes differ, how patient care benefits from*

bar-code systems, how to make the case for the strategic need for the system, and how to implement and assess such systems. The Guide is a must read not only for all those who want a medication bar-code system, but also for those who wish to upgrade their existing bar-code system.

CSHP congratulates ISMP Canada and CPSI on publishing this breakthrough guidance document!

## From Elaine Orrbine …

President and CEO, Canadian Association of Paediatric Health Centres
http://www.caphc.org/

The Canadian Association of Paediatric Health Centres (CAPHC) is a recognized leader and advocate for advancing the improvement of healthcare for Canada's children and youth. In this capacity, our Board strongly endorsed the Canadian Pharmaceutical Bar Coding Project and has supported the work of the Institute for Safe Medication Practices Canada, the Canadian Patient Safety Institute, and all the partners behind this project throughout its development process. It is our pleasure to now stand behind the release of this bar coding resource guide, which is the product of many years of work and collaboration between the pharmaceutical industry and national health organizations.  We are especially appreciative of the significance of the guide in helping members of the CAPHC community adopt the principles of automated patient identification and implement the systems needed to ensure safer care at the bedside for the thousands of children and youth who have to be accommodated daily, with countless recalculations of their medication because of the small doses in which they have to be administered.

## From Michael Cohen …

President, Institute for Safe Medication Practices (U.S.)
http://www.ismp.org/default.asp

Bar code scanning is one of the most important technologies to assure patient safety. So completion of the bar code project serves as a seminal event for Canada. It ends a standoff that existed for many years where manufacturers were reluctant to invest in systems to produce bar-coded medication packages if hospitals and pharmacies weren't equipped to scan them. At the same time, hospitals and pharmacies wouldn't invest in scanning systems unless medications were available with bar-codes as repackaging the medications internally would be costly.

## From Mark Neuenschwander …

President, Neuenschwander Company, and co-founder of the TerraPharma Project
Producers of the unSUMMIT Conferences on Medication Bar Coding



http://twitter.com/hospitalrx
http://www.unsummitu.com/unsummit-u/

The Medication Bar Code System Implementation Planning resource guide is brilliant, thorough, and timely. This labor of love from the Canadian Pharmaceutical Bar Coding Project paves the way for hospitals, nursing homes and patients to benefit from state-of-the-art technologies, which have proven effective for industry and consumers across North America and around the world.

*Utilizing bar-coding at all transfer points, Federal Express and UPS have demonstrated efficiency and accuracy in delivering packages to the correct address. Amazon.com fulfillment centers commit less than one error in a thousand transactions by scanning product bar codes against computer-generated orders. Big-box stores and super markets have enough data to trust the accuracy of customers scanning and weighing products at self-checkout kiosks.*

*Common sense suggests that bar-code driven clinical systems would assist caregivers in giving the right medications to the right patient and to prevent one patient's specimen from being confused with another's.*

*Arguably, the life-and-death benefits for healthcare are more important than the economic benefits to business and industry. So what if a blue baby blanket ordered on line arrives in pink? It's critical that heparin ordered by a physician for that little boy does not arrive in an adult dosage.*

*In the U.S., we could not scan drugs at the point of care until individual packages arrived from the manufacturer with bar codes. But manufacturers would not bar code product until the government required it. If we had this Resource Guide in the US when we first got serious about bar-coding in hospitals, we'd be ten years ahead of where we are today.*

*I hope and pray your government, drug manufacturers, and healthcare institutions will waste no time in capitalizing on this landmark guide and begin reaping the benefits of bar-coding experienced your neighbors to the south.*

*Oh, and did I mention how the literature[127] finally validated our common sense was correct—that what made business and industry more efficient and accurate would make hospitals less wasteful and, more importantly, safer at the point of care?*

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*127. Poon EG, Keohane CA, Yoon CS, et al. Effect of Bar-Code Technology on the Safety of Medication Administration. N Engl J Med. 2010; 362:1698-707.*

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## Glossary

*The following defined technical terms are italicized throughout this document. Organization names and healthcare terms used repetitively are defined and abbreviated within the document itself.*

### AIDC (Automated Identification and Data Capture) or Automated Identification
Automated Identification refers to the process of automatically reading a *data carrier*, separating and extracting the individual embedded *data elements,* using them to automatically obtain more information about the coded item from a computer database.  The information obtained is then usually recorded (data captured) within a process document, thus indicating that the transaction (or that particular transaction step) has been accurately completed.  Note that a complex process involving several steps may include a series of individual *AIDC* steps before the entire process is deemed to be fully completed.

### Bar Code:
Refers to a specific type of *data carrier*, but performs the same function as other *data carriers*.  There are many types of bar codes, which differ slightly in their ability to carry multiple *data elements* and which will be discussed later in this document.

### Data Carrier:
Refers to any symbol or device capable of holding embedded data characters, and which can be read (extracted) by a reader/scanner.  Examples include bar codes and data chips such as those found on charge cards, staff name badges, etc.

### Data Element
Refers to a piece of information usually in the form of a short numeric, textual or alpha-numeric character string contained within a *bar code* or other *data carrier*.  The characters can often not be interpreted by humans directly, and rely on an aligned *database* to provide additional data fields (information) about the data element.

### DataBar:
Properly called *GS1* DataBar symbology family of bar codes, this term refers to a *GS1*-approved *one-dimensional* bar code family which has several variants.  They generally allow additional characters compared with UPC codes.

### Database or Data Registry:
Refers to a source of information accessible to a reader' software, and which allows the *data element* to be located within the database.  Once located, the associated data record contains additional information about the coded/scanned item.  The information extracted from the database is more descriptive to a human than the *data element* itself.  The additional information possible is almost limitless, and can be used to assist a human to better identify or understand properties about the product, service or person scanned.

### DataMatrix:

Properly called the *GS1* DataMatrix symbology, this term refers to a *GS1*-approved two-dimensional (2D) bar code.  It has expanded capabilities and features, as outlined in Appendix 1.

### Symbology:

Refers generically to a bar code type, such as UPC, DataMatrix, and others.  Different bar code symbologies have different capabilities and, therefore, potential uses.

### UPC Code:

UPC refers to a specific symbology: a *one-dimensional* (*1D* or *linear*) bar code known as a Universal Product Code (UPC), of several sub-types.  The UPC code has a long history both within Europe and North America, particularly within the retail sector for point-of-sale transactions.  It may be used within healthcare settings for a transitional period, but has some technical limitations which may limit its future usefulness.

# About the *Canadian Pharmaceutical Bar Coding Project*

The following resource guide reviews bar coding and its value to community and institutional medication management. It was developed in partnership by the Institute for Safe Medication Practices Canada (ISMP Canada) and the Canadian Patient Safety Institute (CPSI), as the *Canadian Pharmaceutical Bar Coding Project*, under the direction of a national advisory group, the *Implementation Committee* (*IC*). The document has been reviewed by a panel of front-line healthcare leaders and executives, some of whom also sit on the project's *IC* and/or *Technical Task Force*.

The need to adopt standards for processes related to *Automated Identification* of medications can be traced through the medical literature, which shows an overreliance on human checking methods. These legacy processes are now known to carry unacceptable error rates.

The purpose of the *Canadian Pharmaceutical Bar Coding Project* was to establish a national consensus on *Automated Identification* for pharmaceuticals. The specific project objectives were published in September 2008. The project continues to be supported by funding from both not-for-profit and for-profit organizations committed to improving medication safety for all Canadian patients, while optimizing system efficiencies within the healthcare supply chain.

The project has been widely endorsed by major Canadian healthcare practice organizations. Endorsements and other project documents are available at the following web page:
http://www.ismp-canada.org/barcoding/

The following is a synopsis of the four project phases:

### Phase I: National Stakeholder Roundtable (January 2008)
The need for a pan-Canadian standard for bar coding of medications was affirmed by the National Stakeholder Roundtable, held in early 2008 under the sponsorship of ISMP Canada and the CPSI and subsequently documented in the roundtable proceedings (published in July 2008), which incorporated broad input from the healthcare industry.
http://www.ismp-canada.org/download/BarCoding_Roundtable_Proceedings.pdf

### Phase II: Project Charter and Adoption of the GS1 global Automated Identification Standard
The IC approved the project charter and a national process to review and adopt a pan-Canadian bar coding standard for pharmaceuticals. It was envisioned that such a standard would provide a common basis for Automated Identification of medications at each stage of the medication-use process.

In April 2009, ISMP Canada and the CPSI issued a joint statement endorsing adoption of the GS1 global standard for *Automated Identification* of pharmaceuticals in Canada. In doing so, they recognized the importance of international integration of identification standards for pharmaceuticals, represented by the global collaboration established by GS1. The GS1 global standard has already been adopted by many Canadian and global manufacturers and by other healthcare-related organizations.

GS1's Canadian arm, GS1 Canada, a not-for-profit organization, has been working with the Canadian Pharmaceutical Bar Coding Project and the project's Technical Task Force to identify the requirements of users in each healthcare sector and thus to ensure that existing or planned GS1 global standards will meet identified needs for efficiency of the supply chain and patient safety.

Reporting to the IC and with technical support from GS1 Canada experts, a 34-member national Technical Task Force was formed. The Technical Task Force consisted of members from six Canadian healthcare sectors: pharmaceutical manufacturers, supply chain and group purchasing organizations, retail pharmacy professionals, institutional pharmacy professionals, integrated providers of healthcare information technology, and professional practice and healthcare quality organizations.

A technical statement entitled Joint Technical Statement on Pharmaceutical Automated Identification and Product Database Requirements (JTS) was originally released in January 2010 and was updated as Version II: 2012 in February 2012. The document describes the pan-Canadian integration of Automated Identification of pharmaceutical products and provides a basis for the coordinated transfer of each medication from the manufacturer to the patient-dose level with a single product bar code (identifier). The JTS (Version II: 2012) and its supplements are available for viewing or downloading at the following link: http://www.ismp-canada.org/barcoding/index.htm

The adoption of a global Automated Identification standard in Canada, with the availability of bar code reader technology connected to intelligent software, will allow the country's healthcare system to advance patient safety practices. In particular, *Automated Identification* of medications, as described in the JTS, will allow healthcare solution providers to meet public expectations for safer healthcare practice, through the development of automated software for identifying products and checking their safety. Such innovations will, in turn, also support busy healthcare providers by ensuring that medications are identified accurately, providing reliable access to standardized product descriptions from a common product data registry, and enhancing the quality of documentation in the patient electronic health record, thus making the Canadian healthcare system safer and more efficient.

### Phases III and IV: Promotion of Improved Understanding and Adoption of Automated Identification
During Phase III of this project, the updated 2012 JTS was disseminated across all Canadian healthcare sectors, to encourage development of appropriate safety software and automated practice systems using a common *AIDC* standard and to promulgate a broad understanding of the safety benefits of bar coding among pharmaceutical manufacturers and technology providers.

During Phase IV, improved end-user and leadership knowledge and acceptance of bar coding methods are being pursued. The purpose of Phase IV activities is to accelerate the adoption into practice of Automated Identification strategies for medications. The current resource guide, which is a defined Phase IV objective, is directed to front-line healthcare providers and executive leaders, in both community and institutional practices.

# Executive Summary

This medication bar code resource guide is part of the *Canadian Pharmaceutical Bar Coding Project,* a project co-led by the Institute for Safe Medication Practices Canada (ISMP Canada) and the Canadian Patient Safety Institute (CPSI). This multiyear project, which has received input from many individuals representing six Canadian healthcare sectors, has also generated a series of technical statements related to the use of a common bar coding standard for pharmaceuticals used in Canada.

The project has been endorsed by major Canadian healthcare practice organizations, for its objectives to create a pan-Canadian standard for pharmaceutical bar coding practices usable within all Canadian healthcare sectors and to increase patient safety through the avoidance of preventable medication errors by automated (bar code) verification methods. All project information, including downloadable documents, can be found at the ISMP Canada website: http://www.ismp-canada.org/barcoding/index.htm

Specifically, this medication bar code resource guide provides direction to end-user organizations within both community-based (e.g., nursing home) and institutional (e.g., hospital and ambulatory) care environments. It provides executives and practice leaders with simple yet important knowledge about bar code systems, develops strategic arguments for the acquisition and funding of such systems, and offers implementation guidance for the successful acquisition and adoption of the technology.

All of the organizations that have supported the project or endorsed its objectives hope that the project as a whole and this guide in particular will stimulate Canadian governmental and healthcare leaders to align behind this national initiative and more rapidly acquire and implement this critical medication-related patient safety technology.

### Section I: A Bar Code Primer for Leaders

Section I introduces bar coding to leaders, showing in a simplified manner how bar codes work along the medication chain  to ensure accuracy of medication verification and documentation, thereby significantly reducing the incidence of preventable medication errors.

Human error is a major cause of preventable medication errors. These errors constitute a major factor in elevated adverse drug event rates in healthcare, which in turn lead to substantial patient harm and wasted system resources. The introduction of automated verification technologies increases patient safety by reducing medication-related harm.

A global bar code standard for pharmaceuticals, known as the GS1 global Automated Identification and Data Capture (AIDC) application standard, has now been adopted for Canada. This global standard has also been adopted by many international healthcare organizations, including numerous regulatory authorities, and will continue to inform national automated identification practices in Canada. Its application in bar codes at the commercial pharmaceutical packaging level (by December 2012) allows individual units of medication to be safely and efficiently processed, with excellent documentation, along the complete medication chain from manufacturer to the patient's bedside.

Section I explains how these machine-readable bar codes work in front-line medication practices. It outlines, in simple terms, the basic components of the GS1 global standard, the various forms of one- and two-dimensional bar codes, and their inherent capacities for embedding essential *data elements* about drug products. These embedded *data elements* ensure accurate medication verification by bar code readers and improve the documentation accuracy of related the medication process in electronic health records.

### Section II: Building the Case for Automated Identification of Medications:
*The Value of Bar Code Systems in Reducing Preventable Medication Errors*

It is imperative that senior leadership, including chief financial and information officers, understand not only that significant patient harm that is avoidable, but also the secondary cost-related and organizational benefits of automated medication-related processes. They must work closely with nursing and pharmacy practice leaders to create funded, multiyear strategic plans for medication safety. Such a process is found in the Ontario Hospital Association recommended benchmarking process for *Electronic Medical Record Adoption*. Failure to automate medication verification and achieve standard procedures with related processes may increasingly be viewed by external stakeholders as organizational failure.

High reliability organizations (HROs) are increasingly cited as models for many healthcare operations. HROs have several common characteristics upon which healthcare planning can be based, including the promotion of standardized processes for routine (but potentially harmful) processes. Such practices would be consistent with automated medication systems.

The medication-use process involves two intersecting chains: a four-step prescription process and a more complex pathway involving a series of product manipulations and transfers. Although study methodologies and definitions of "error" and "adverse drug event" (ADE) vary, current rates of preventable medication error are unacceptably high, in both community-based and institutional care. All practice organizations agree that significant system changes are required; changes that will support healthcare practitioners in routine medication processes known to be associated with inadvertent and significant patient harm.

Patient harm leads to large primary and secondary costs. In the U.S., estimates of direct costs to institutions exceed $6,000 to $8,000 per ADE based solely on a patient's increased length of stay (LOS). Studies in ambulatory care and community settings have shown equivalent error rates and costs probably exceeding $2,000 per ADE. The true costs to the healthcare system, once secondary economic impacts are taken into account, are thought to be much higher than the simple institutional costs. Errors also contribute to the "clogging" of healthcare system services and beds.

Evidence, principally from observational institutional studies, has shown that bar code verification at the patient's bedside reduces preventable errors by at least 50% and by more in pharmacy-based operations such as dispensing. Additional secondary benefits include many critical medication, patient, and dosing safety checks, improved accuracy of documentation, and direct healthcare provider links to secondary medication and procedural information.

Although few formalized return-on-investment (ROI) studies have been conducted, and their methodologies have not been standardized, early evidence from a few studies indicates that medication bar coding systems have a positive ROI, beyond the prevention of needless patient harm. Some studies

have found an ROI (based on 5-year full-system analysis) of 1 to 4 years, based solely on inpatient LOS. When broader advantages related to healthcare system economics and patient throughput within the healthcare system are considered, it is likely that a positive business case can be made for automated identification.

Finally, the cost of medication verification modules are low relative to the costs of other information-based modules such as computerized prescriber order entry and organizational health information systems. Medication bar code systems have good safety and cost ROI.

In 2010, bar code verification was employed for only 8% of institutional beds and 33% of dispensing/compounding practices within hospital pharmacies in Canada. In the United States, the figure is now approximately 50% at the bedside. Furthermore, it is suspected that bedside bar code verification is very low in Canadian community-based practice.

Canadian success stories are provided as case studies in the Section II appendix.

### Section III: Implementation Considerations
High-level implementation considerations are provided looking first at external healthcare system factors influencing planning decisions, and then internal (cultural) factors such as safety-culture education and individual provider practices, touching also on HRO safety principles. Such foundational issues affect the implementation of any new technology, including bar code verification systems.

Experience in health centres has shown that implementation can fail as a consequence of myriad interrelated issues. System "failure modes" may relate to certain issues that are specific to bar coding (e.g., bar code readability, lack of internal facility standards), equipment or network problems, use or over-use of triggered alert warnings, problems with pharmacy support services, or noncompliance by the end user (e.g., low scanning rates or use of workarounds). Healthcare organizations should view new technologies as part of larger collaborative partnerships among care providers and administrative and practice leaders.

To reduce the potential for implementation failure, organizations should consider a number of pre-emptive planning strategies, most of which should be employed during the pre-implementation phase. These include developing implementation teams, applying prudent pre-decision RFP and testing techniques, and performing various other assessments. Failure to perform pre-implementation Usability (Heuristic) Testing of a new system very often results in non-compliance by end users and may even cause new forms of medication errors.

During implementation, a staged training process is recommended. Such an approach allows trainees to gradually increase their comfort with the system under increasingly challenging clinical situations. "Super users" can serve as mentors for newly trained staff members. User satisfaction is highly variable and must be gauged over the long-term, not just immediately after implementation.

A high-level, staged implementation map provided at the end of this section takes the reader through the knowledge, strategic planning, and implementation phases of bar code verification systems.