

# IMPLEMENTATION OF A BARCODED IV MEDICATION SYSTEM

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## INTRODUCTION

The BC Children's and BC Women's Hospitals introduced a Barcoded Intravenous Medication System in May 2010 to enhance patient safety.

In a highly successful deployment in June 2007, BC Children's and BC Women's introduced the use of Alaris "Smart" intravenous (IV) pumps. These modular IV pumps are designed to reduce medication errors at the bedside through the use of a Dose Error Reduction System (DERS), known as Guardrails, that uses a drug library specifying safe infusion limits. The objectives of safe medication administration are to give the right drug to the right patient by the right route in the right dose at the right time, commonly known as the "Five Rights". The 2007 deployment addressed the right drug and the right dose Rights. The barcoding adds further safety to the right drug objective and adds the right patient safety objective.

While the DERS catches errors that may be due to operator input errors, barcoding information eliminates input errors. The barcoded IV medication system incorporates barcoded patient IDs, clinician IDs and IV medications prepared by the Pharmacy which results in benefits beyond simply eliminating data input errors. At present, only IV drugs manufactured by the Pharmacy are barcoded.

The pump point-of-care hardware required to implement the system includes Alaris Auto-ID barcode scanning modules and hand-held barcode scanners. The Auto-ID module attaches directly onto the Alaris pump system and provides for the confirmation of the patient, clinician and drug information by scanning their respective barcodes to allow for:

- 1) Accurate medication administration: automating steps (i.e. drug selection and concentration) decreases operator error and improves efficiency.
- 2) Positive patient identification: matching the patient wristband MRN (Medical Record Number) to the MRN encoded in the drug label confirms the delivery of the right drug to the right patient.
- 3) Tamper-resistant pumps: using Clinician IDs to unlock the IV pump keypad means that only clinicians can program the pump and administer medications.

The BC Children's and BC Women's Hospital site is the first in Canada to launch all elements of the Alaris Auto-ID Barcoding system and offer all three key patient safety features.

## GENERAL CONSIDERATIONS: BARCODE ENVIRONMENT AND SYMBOLOGIES

The existing environment of barcodes must be considered when introducing a new barcoding system. Are there any existing barcode systems that employ symbologies and encoded data that might be confused with valid data in the new system? Are there any systems where sharing the same barcoded data may make sense? Selecting the numbering system for encoding and restricting the range of acceptable encoded data are important to ensuring the required compatibility or incompatibility with other barcoded data.

The core of any barcoding system is the barcode symbology. Some symbologies only encode numeric data, while others can code alphanumeric data. Some symbologies are more compact than others. 2D barcodes are preferred for encoding larger amounts of data, since 2D barcodes (e.g. Aztec or Datamatrix) can encode far more data per unit area than 1D barcodes and use data redundancy (Figure 1).



Figure 1: Barcodes: Drug (2D Aztec, ~80 char), Patient ID, (2D Aztec, 7char), Clinician ID (1D Code128, 6 char)

The three data types that needed to be barcoded in this system, the IV Medication information, Patient ID and Clinician ID, each have different barcoding system requirements. However, the common factors pertinent to this barcoding implementation are:

- 1) Barcode symbology must be supported by Alaris
- 2) Barcode symbology must be one that can encode the required data and be produced by the data system driving the barcode printer
- 3) Barcode printer must be compatible with data system and able to print the barcode symbology
- 4) Printed barcodes (especially 2D) must be

greater than the minimum scannable size

The barcode-enabled datasets are delivered to the pumps via wireless communication. Pumps are set to receive “Test” (for Pharmacy development purposes), “Train” (for user training on the dataset prior to implementation) or “Live” (clinically active) datasets to provide the functionality needed by different project phases.

#### **IV MEDICATION BARCODING SYSTEM**

The IV medication information is structured with required and optional fields according to the manufacturer's specifications. The medication barcode contains the Patient ID number and the drug information. The Patient ID number is provided to the Pharmacy system by the Cerner Clinical Information System (CIS). After processing by the Pharmacy system, the patient ID number must be encoded in an identical format to that provided on the patient wristband to ensure a positive match when the medication is administered.

The drug is identified in the pump and the Pharmacy System with an “alias” which is a unique code required by Alaris. The Pharmacy system required custom programming by the software manufacturer in order to provide a field for the drug alias and add associated functionality. The database issues that needed to be addressed were how to handle many to one mappings of the catalog of drugs in the Pharmacy system to the Alaris drug tables, as well as one to many mappings, especially for intermittent and continuously infused drugs. The Pharmacy system was modified to ensure that the text on the medication label is consistent with the data encoded in the barcode by implementing predefined orders (PDOs) that eliminated free text fields.

A 2D barcode is required to accommodate the 80 characters typically encoded in the IV medication barcode, but several 2D symbologies are supported by Alaris. The requirements for the barcoded IV medication label include:

- 1) Barcode readable on curved surfaces (syringes)
- 2) Small physical barcode size to allow barcode positioning on label with text
- 3) Sufficient durability to be read when it reaches patient
- 4) Adhesive which adheres to syringe plastic and when refrigerated

The Aztec symbology was selected, since it met criteria 1 & 2 and printed on existing label media that met criteria 3 & 4. Intermec printers known to be compatible with the Pharmacy and Alaris systems were selected. The Aztec symbol is square and its size

increases with the amount of data encoded, but produced the smallest readable barcode size. A small size and central target are important for making the barcode readable on curved surfaces. The Aztec barcode could be read on 10 ml and larger syringe sizes, when applied to the curved surface of the syringe. Smaller syringes required flagging the label.

#### **PATIENT ID BARCODING SYSTEM**

The Patient ID system, though recognized as a crucial element, was underestimated in scope and benefits potential. Initially, it was perceived as simply adding a barcode to the patient ID wristbands. However, a significant positive impact resulted from changing the existing (manual) processes in over 20 program inpatient and outpatient units in two hospitals.

The Hospitals' internally generated 7-digit MRN was selected as the unique Patient ID number. The Alaris pumps were set to restrict valid Patient IDs to exactly 7 numeric digits to allow the pump to distinguish between the format of the Patient and Clinician ID numbers. The Aztec barcode symbology was selected to provide a small barcode for problem-free when scanning on curved wristband surfaces.

In choosing the most appropriate ID solution for each of the hospitals' patient populations (i.e., Adult, Children, Infants, Newborns), the team had to research the suitability of wristbands, labels, software and printers and involve clinical and clerical staff in the selection. The team also reviewed the current processes to identify opportunities for future improvements, define technological requirements, create and implement the new system and ensure the new process would be well applied and sustained

The team worked to develop a comprehensive solution that would be cost-effective (initial and ongoing) and also comply with the following criteria:

- 1) Adequacy of resources and compliance with organizational standards (e.g., for printers)
- 2) Quality of the ID band media, in terms of durability, comfort, safety, and cost-effectiveness
- 3) Convenience of the solution, including the process for creating a complete ID band with the ability to support different sizes and colors for allergies
- 4) Quality of the text and barcode output on the ID band (i.e., legibility, clarity and scannability)
- 5) Other benefits associated with the solution (e.g., standardization, automation, error reduction)

The team arrived at two main solutions (Figure 2.):

- 1) Barcoded label for Adult & Pediatric patients
- 2) Barcoded tag for Infants & Newborns

Different CIS reports were created to extract the data and print the ID labels and ID tags. For both, the patient's MRN is encoded into the 2D Aztec barcode symbol for comparison with the MRN encoded in patient-specific medication labels. Other patient identifiers include: last name, first name, Personal Health Number (PHN), gender and date of birth.



Figure 2. Patient IDs with barcoded label for Adult & Pediatric patients and tag for Infants & Newborns

The development and implementation of these solutions exceeded the time initially expected, as new information came to light after planning. The major issues faced were technical printer issues, not business processes and procedures, and involved complexities associated with the CIS and the redeployment of thermal printers previously used in the Pharmacy.

Fortunately, the team was ultimately able to solve the issues, steer the project in the right direction and deliver on the solutions designed in a manner that satisfied the operational requirements.

### CLINICIAN ID BARCODING SYSTEM

The purpose of the barcoded Clinician ID is to provide an easy method for unlocking the pumps, which automatically lock after five minutes of inactivity to increase tamper resistance, and to identify the operators of the pumps. The main tasks for the Clinician ID barcoding system included:

- 1) determining which personnel operate pumps
- 2) selecting a Clinician ID numbering system to assign numbers to all pump operators
- 3) deciding to include or exclude non-pump operators from receiving barcoded IDs
- 4) selecting a 1D or 2D barcode symbology
- 5) developing a system and medium for distributing the barcoded Clinician IDs
- 6) determining when to distribute the Clinician IDs
- 7) handling lost or forgotten barcoded IDs

The selection of the Clinician ID number proved to be a challenge, since there are different types of personnel that use the pumps. The Clinician ID number set to be a 6-digit fixed length numeric-only identification number. Employee Numbers are

assigned by the Human Resources PeopleSoft system and were deemed to be a suitable number for employee pump operators.

Non-employee pump operators, which include anesthesiologists, physicians, fellows and residents, also needed to be identified and assigned clinician ID numbers based on a different numbering system. The College of Physicians and Surgeons Identification (CPSID) number was used as a basis for the Clinician ID numbers for these operators.

Another group of operators include the nursing instructors, professional development (PD) students and nursing students. Since they come from a variety of institutions, there was no existing single numbering system. A sequential numbering system which did not overlap with either the Employee ID numbers or Physician ID numbers was developed for Nursing Instructors and PD Students. Nursing students are not issued separate IDs but use their instructors IDs. Non-clinical personnel are not issued barcodes.

An investigation of existing barcoding systems revealed that barcoded Clinician IDs were being used with glucometers. Rather than run parallel Clinician ID systems, the pump Clinician ID system and the glucometer IDs will use the same barcoded Clinician IDs. A 1D barcode symbology (Code 128) was selected for compatibility between the two systems and because it scanned more quickly than some alternatives.

The Security Department is the central department for distributing Employee ID cards and is issuing the Clinician IDs. In the future, a fully integrated system is envisaged which will entail the automatic data transfer from the Human Resources system to the Security System and print the Clinician ID directly on the plastic Employee ID cards. Including this was deemed to be beyond the scope of the IV Medication Barcoding project. Since reissuing the plastic Employee ID cards just to add the barcode would be expensive, a low cost and simple system was implemented to issue the Clinician IDs. A table of employee information was downloaded from the Human Resources System, filtered on Clinical Position descriptions and used to print an initial batch of Clinician IDs on self-adhesive, laminated labels using an inexpensive printer. Security recommended not printing the clinician number in text adjacent to the barcode symbol. Clinicians are responsible for maintaining the confidentiality of their clinician ID numbers. The labels were distributed to the Clinicians at the time of their barcoding training.

In cases where clinicians have forgotten their ID cards, the Alaris system allows the entry of Clinician IDs using the keypad as a backup system. Special

training Clinician ID numbers are used to exclude training drug limit violations events from the clinically valid data for Continuous Quality Improvement (CQI) reporting purposes.

## TRAINING

Much of the success of the implementation depended upon the pump operators knowing how to use the new system when it became operational. A key training point was to advise operators to scan the barcodes about 10 cm from the scanner, since operators had a natural tendency to scan much closer. The training was provided in several ways:

- 1) Super User Classroom Training sessions
- 2) End User Classroom Training sessions
- 3) Mediasite (Audio-Visual) demo
- 4) Self learning packages (including Eduquick, case studies, Frequently Asked Questions (FAQ))
- 5) Alaris pumps for training were set up in clinical locations with a barcode- enabled training dataset and printed self-directed learning materials. Super Users used these pumps to train others and operators used the pumps for individual practice.

The training for the clerks creating the Patient and Clinician IDs, and for the Pharmacists using the Pharmacy system was provided largely one-on-one by Super Users within these departments.

## IMPLEMENTATION

The implementation was phased to build confidence that each of the three major barcode systems were independently operational before expecting them to interact successfully. Over the three weeks leading to *Go Live* the team completed the following tasks, either to avert or correct issues:

- 1) Advanced deployment and promotion of the new barcoded Patient ID resulted in a modification to permit printing first names of over 20 characters, since the Operating Room requires the full name
- 2) Mounting of the Auto-ID modules with tamper-resistant screws to prevent removal and disabling of the Auto-ID functionalities on pumps
- 3) Prize draws to increase staff participation in classroom training; Training pumps available to clinical units for staff who could not attend
- 4) Analysis of the communications that not all personnel were being reached. Consequently, communication efforts were increased.
- 5) Issuance and scanning of barcoded IV drug labels by Pharmacy for Quality Assurance purposes
- 6) Distribution of handheld scanners and installation of hooks on IV poles ahead of time was necessary but confusing to staff

- 7) Casual & new staff without barcoded IDs requested labels at the last minute

*Go live* day:

- 1) Early (7am) release of the barcode-enabled dataset (i.e., drug library) to allow for maximum number of unused pumps to be activated
- 2) New dataset rapidly downloaded via wireless to pumps that are turned on
- 3) Activation of the barcode-enabled dataset occurs at a clinically convenient time, after a pump is turned off, on and a new patient is selected. It may take days to activate all pumps, but most would occur, at latest, when IV sets are changed.
- 4) Prepare for the repair of many pumps that had not been sent from clinical areas for repair earlier.

## RECOMMENDATIONS AND BENEFITS

Recommendations for success include:

- 1) Use a project manager to coordinate the three sub-projects which run in parallel and then must smoothly integrate.
- 2) Recognize that the Pharmacy requires significant internal resources and external custom programming to adapt their system.
- 3) Review the environment for conflicts or synergies.
- 4) Allow time for testing, or be prepared for delays.
- 5) Phase the implementation of the sub-projects

The standardization and process improvement of the Patient ID system has already reaped significant benefits. There is not enough experience with the system to assess the benefits due to error reduction resulting from the barcoded medication labels. However, scanning the barcoded medication labels appears to be a faster and more accurate entry method which is expected to improve patient safety.

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