

Case study

Massachusetts General Hospital



At a glance

Application: Healthcare

Solution: Intermec PX4i Smart Printers, MiSim MLPS

Massachusetts General Hospital Uses Smart Printers to Ensure Patient Safety

One of the most important safeguards to protect hospital patients from medication errors is the “Five Rights Check.” Before administering any medication, the nurse or other caregiver performs checks to make sure the 1) right patient is receiving the 2) right medication in the 3) right dose by the 4) right route (e.g. oral, intravenous) at the 5) right time. One in five medications administered in U.S. hospitals is given in error because it does not meet at least one of these criteria, according to one study¹. Mistakes can cause complications, and sometimes lives. Hospitals could eliminate 50 percent of their medication administration errors by scanning bar codes at the point of care to positively identify patients, the medication they are about to receive, and match the information to a physician order, according to the U.S. Food and Drug Administration (FDA)².

Massachusetts General Hospital in Boston is a pioneer in using the type of bar code-based medication administration systems cited by the FDA. Before Massachusetts General could incorporate bar code scanning into its Five Rights check procedures, it had to get bar codes onto its medicine. Very few

of the pharmaceutical products received at the hospital were bar coded at the unit-of-use level. The hospital pharmacy had extensive experience with medication repackaging and relabeling, but had no experience with bar coding at the level needed for the patient safety initiatives. Massachusetts General had to build its unit-of-use labeling system from scratch.

Building Best Practices from the Ground Up

The hospital formed a team of stakeholders that included representatives from pharmacy, nursing, IT and other disciplines. The team decided to phase in unit-of-use bar code labeling and scanning, beginning with medications that were dispensed from programmable IV pumps. Although pumps automatically control the rate the medication is dispensed, in some ways they create more opportunities for dispensing errors. Not only must IV pump medications pass the Five Rights check, the pumps themselves must be programmed correctly to dispense at the prescribed rate (which varies by medication, concentration and patient). This adds steps to the medication administration process.



¹“Medication Errors Observed in 36 Healthcare Facilities,” Archives of Internal Medicine, 2002;162:1897-1903.

²“Bar Code Label Requirements for Human Drug Products and Biological Products; Final Rule” Department of Health and Human Services, Food and Drug Administration. Federal Register Notice, February 26, 2004 (Volume 69, Number 38) Page 9120. Viewable online at: www.fda.gov/OHRMS/DOCKETS/98fr/04-4249.htm.

Massachusetts General engaged MiSim, Inc., a bar coding specialist, to assist in designing a system by which scanning a bar code on the IV bag would not only identify the medication at the point of care, but would also automatically program the pump to dispense the medication at the right rate. The hospital and MiSim worked with programmable pump manufacturers to get their support for bar code input, and simultaneously started developing an IV pump programming data specification for use on IV bag labels that could accurately encode all the necessary patient information, drug identification, dispensing rate and programming instructions.

The labeling system would be sophisticated, because it needed to process data from the pharmacy system and format it into bar codes and text, yet it also needed to be easy to implement, use and maintain. The system needed to be fast and have high label print quality. To devise a labeling system with a simple user interface and powerful back-end data integration and processing capabilities, Massachusetts General and MiSim worked with the pharmacy information system vendor and pharmacy staff to develop the system. MiSim studied the bar code needs, the IT infrastructure and pharmacist work processes, then developed a solution that takes advantage of programmable smart printers with middleware that analyzes and processes the label data into the bar codes required for programming IV pumps and to meet other medication administration requirements.

Accurate Identification from the Pharmacy

Labels from the pharmacy information system are printed on Intermec PX4i Smart Printers running MiSim MLPS, a software application created in Intermec's Fingerprint programming language. Fingerprint is a programming language with a BASIC-like command structure that gives developers the ability to control any printer function. Fingerprint applications run directly on the Smart Printers, enabling the printers to run printing operations independently, without requiring a PC or network connection to another host computer.

"The application runs directly on the printer," explained Harry Manolopoulos, MiSim principal. "Pharmacists do not need to access a server to create and release the labels. The printers are seen by the pharmacy information system as its regular label printers; there isn't any special interfacing outside of the normal print processes. The printer itself does all of the work."

Using the MiSim MLPS Fingerprint application, the smart printer extracts information from the label data fields and encodes it in an Aztec Code two-dimensional (2D) bar code symbol using the ANSI\HIBC 3.x standard data format. This standard facilitates creating a virtual electronic form of the information printed on the label, including patient, drug, order, medication administration and dose tracking information. The content of the 2D symbol can vary by the type of order, which is detected by the smart printer. For patient-specific IV medications, the printer application encodes pump programming instructions such as total volume and the infusion rate. Non-IV medication order types have medication administration (dosing) instructions encoded. This is the first system to encode the Five Rights in a bar code.

The application MiSim developed is fairly large, but that wasn't a problem because the PX4i Smart Printer has 16MB of standard Flash memory, which is expandable to 32MB, plus an additional 1GB of CompactFlash memory. Users can interact with the printer through a keypad and LCD screen when needed, such as when the printer detects a forms change is required. It provides excellent bar code print quality, which is important to Massachusetts General because the Aztec Code labels encode a lot of essential information in a small space, and must remain readable to support the patient safety system.

"You can't take bar code print quality for granted," said Massachusetts General's Chief Pharmacy Officer, Margaret Clapp. "When we scan the bar codes on products we receive, we can't always read them. Readability isn't an issue with the bar codes we print ourselves. I'm really confident the labels we produce will be able to scan."

Scanning for Safety

The bar code labels are scanned at the patient bedside prior to administration. Nurses use mobile wireless computers to scan their own bar coded ID badges, the patient's bar code wristband, and the bar coded medication. The scan data is sent over a wireless network to the electronic medication administration system, which verifies whether the patient should be receiving the medication identified at that time along with other safety checks, utilizing data in the bar code.

"Having the ability for a nurse to scan at the bedside and confirm the medication order is a huge step for patient safety," said Clapp.

"The system prevents wrong drugs from going to patients," added Ron Imperiali, associate chief of pharmacy, informatics at Massachusetts General. "There were lots of challenges to bringing this system together, but it works."

Expanding the Safety Net

After the initial pump systems were implemented, bar code programmable infusion pump systems at the hospital's outpatient chemotherapy program were upgraded to utilize the ANSI\HIBC 3.x standard 2D symbols. Those symbols are used to program wearable IV pumps that the patients take home, so they do not have to stay at the hospital for their treatment. The scanned data automatically programs the pump to dispense the medication at the prescribed rate. Each patient specific label produced by the pharmacy carries a unique dose tracking number. Smart imagers are utilized to extract this dose identification for integration into the pharmacy delivery confirmation systems.

Massachusetts General has expanded its bar code medication administration system to non-IV drugs, including pills, tablets, ampoules and syringes. A major benefit of the MiSim MLPS system is that it is compatible with the hospital's Omnicell Pharmacy Central picking system and its in-house manufacturing system. Other than dedicated repackaging machines, virtually all pharmacy labeling is performed by a total of 16 PX4i programmable printers running the MiSim MLPS application. Using the smart printer infrastructure throughout the main pharmacy and three satellite facilities reduces the cost of spares, supplies and support while fully leveraging the software.

Infusion pump manufacturers are working on pumps with embedded bar code imagers that support the ANSI\HIBC 3.x standards and the hospital is ready to go when these reach the market.

"The developments that have occurred so far provide a bridge to improved patient safety. Comprehensive open standards now exist that go beyond simple numbering systems. They now facilitate improved safety checks and workflow at the bedside. These provide a roadmap for healthcare providers wishing to implement or improve bar code systems for medication administration," said Manolopoulos. "Now we need more medical information system vendors, device makers and hospitals to step across that bridge and adopt the standards and technology."

Massachusetts General's efforts are improving patient safety far beyond Boston. The bar code development work done by Massachusetts General and

MiSim formed the basis of a standard that was adopted by the Health Industry Business Communications Council (HIBCC) and became the ANSI\HIBC 3.x standard mentioned in this article. The hospital holds a patent for IV pump drug libraries that has been licensed to programmable smart pump manufacturers. Infusion pump manufacturers are working on pumps with embedded bar code imagers that support the ANSI\HIBC 3.x standards and are preparing to introduce these products to the market. Other healthcare providers that want to implement bar code medication administration have a proven, standardized starting point that will save them all of the development work that has already been done by Massachusetts General.

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