Increase OR Safety with **Automated Inventory and Labeling**

Medication use in the perioperative setting is of paramount importance. In general, medication management in this setting is both challenging and essential, given the number of high-risk medications used, the variety of practitioners accessing these medications, and the vulnerable nature of surgical patients. The inclusion of children and young adults in this population means the potential for risk is even greater. It is with this in mind that the Texas Children's Hospital pharmacy department, in collaboration with anesthesia, nursing, and surgical practitioners, evaluated and incorporated automation and standardized labeling technology early in 2013.

Over the past year, we have implemented and integrated automated anesthesia workstations and automated medication labeling systems in the effort to automate medication management and distribution in operating room (OR) areas and mitigate the bulk of our risk points. The most significant areas of risk were identified during the lead up to implementation, and included proper storage, preparation, and dispensing of high-risk medications in all perioperative areas. Each of these risk points was impacted by our approach to labeling and bar code identification of all medications used. We have found that through proper and consistent use of these automated devices, we have been able to increase safety and decrease risk in the OR.

Previous Practices

Before the implementation of automation technology, medications were provided to perioperative areas via kits, trays, boxes, and anesthesia-specific fanny packs. These practices raised concerns because most perioperative medications are high-risk, including anesthetics, anticoagulants, benzodiazepines, electrolytes, neuromuscular blockage agents, paralytics, sedatives, and vasopressors. Under our prior process, many high-risk medications were manually stocked in the kits, trays, boxes, and fanny packs, which were signed out to OR personnel according to the daily surgical schedule. Given the sensitivity of perioperative medications, compounded by the risks of labeling or identification errors in a manual distribution process, along with the potential for diversion, the need for automated medication management in the OR was glaring.

Inside the OR, medication doses are often calculated and prepared in advance, with some final dilutions performed prior to administration. Before the implementation of the anesthesia workstations and the automated labeling system, medication labels were pre-printed and stored in drawers together with the medications. Because there were no automated mechanisms in place to ensure medication syringes were labeled appropriately or that the labels were clear and legible, there was undue potential for medication errors, especially for look-alike, sound-alike

drugs. Furthermore, the lack of standardized labels meant that medications requiring further dilution steps could potentially be prepared incorrectly.

Effects of Automation

Among the goals of this project was to integrate medication management systems that would bring us inline with The Joint Commission's National Patient Safety Goals for safe medication use processes. The automated labeling system we selected follows the American Society of Anesthesiologists' (ASA) color guidelines and the American Society for Testing and Materials (ASTM) standards (see **SIDEBAR**).[1] The system is also able to receive data imports from a nationally recognized electronic drug formulary service, which facilitated configuration of the drug database. The automated labeling devices were implemented at the same time as the anesthesia workstations in the OR department, and because pharmacy supports both technologies and their associated medication databases, we coordinated the training process to take place over the course of several weeks so that all affected staff would have ample time to become familiar with the new processes. Due to the range of practitioners that would be affected by this new workflow, we designed a training program that would provide hands-on instruction to all staff that would interact with the automation, including anesthesiologists, nurses, pharmacists, physicians, and OR support personnel.

Gaining acceptance for the OR automation was challenging initially, given staff concerns that the technology could negatively affect workflow. In addition, some staff members expressed a lack of comfort with the new technology. However, the enhanced safety provided by the OR automation was widely recognized, ultimately overcoming the initial reticence of certain health care providers. Throughout the implementation process, we encouraged input from multiple team members, which further increased staff confidence. The increased availability of medications, streamlined paperwork process, and minimized workload were among the most important benefits of the technology. Data were reviewed by the Pharmacy and Therapeutics committee, and members of the medical staff agreed with the chair of the Anesthesiology Quality and Safety committee that the use of these technologies would contribute to a safer environment.

Controls and Processes

Both systems (the anesthesia workstations and the automated labeling system) have provided significant safety and inventory management improvements in our OR medication workflow and addressed the bulk of our risk points. All

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Labeling of Pharmaceuticals for Use in Anesthesiology[1]

Clinicians often select medications based upon the location and visual features of the container. Object recognition depends on shape, color, brightness, and contrast. As these elements become increasingly distinctive, identification of the object becomes faster and more accurate. Of course, medication selections must then be verified by reading the label. Therefore—although multiple factors contribute to medication errors—consistency and clarity of pharmaceutical and syringe labeling, in accordance with human factors, are important elements in the prevention of these errors.

▶ **Contrasting Background:** Maximum contrast between the text and background should be provided by high-contrast color combinations as specified in Section 6.3.1 of ASTM D6398. This has the added benefit of minimizing the impact of color blindness. Strong contrast pairings to use include:

Text	Background
Black	White
Blue	Yellow
White	Blue
Blue	White

▶ **Color:** Nine classes of drugs commonly used in the practice of anesthesiology have a standard background color established for user-applied syringe labels by ASTM D4774, *Standard Specifications for User Applied Drug Labels in Anesthesiology,* and ISO 26825:2008. For these drugs, the color of the container's top, label border, and any other colored area on the label, excluding the background as required for maximum contrast, should be the color assigned to the drug's classification. Using the colors established in ASTM D4774 and ISO 26825:2008, ensures that the container will identically match the color of the corresponding syringe label.

Drug Class	Pantone Color
Induction Agents	Process Yellow C (RGB 255.255.0)
Benzodiazepines and Tranquilizers	Orange 151 (RGB 255.102.0)
Benzodiazepine Antagonists	Orange 151 (RGB 255.102.0)/ White Diagonal Stripes
Muscle Relaxants	Florescent Red 805 (RGB 253.121.86)
Relaxant Antagonists	Florescent Red 805 (RGB 253.121.86)/ White Diagonal Stripes
Narcotics	Blue 297 (RGB 133.199.227)
Narcotic Antagonists	Blue 297 (RGB 133.199.227)/ White Diagonal Stripes
Major Tranquilizers and Antiemetics	Salmon 156 (RGB 237.194.130)
Narcotic/Tranquilizer Combinations	Blue 297 (RGB 133.199.227)/ Salmon 156 (RGB 237.194.130)
Vasopressors	Violet 256 (RGB 222.191.217)
Hypotensive Agents	Violet 256 (RGB 222.191.217)/ White Diagonal Stripes
Local Anesthetics	Gray 401 (RGB 194.184.171)
Anticholinergic Agents	Green 367 (RGB 163.217.99)

medications are now stored in the workstations and all nurses, anesthesiologists, and physicians use personal login codes to access the workstations, enabling medication accountability and tracking. Through this system, pharmacy retains control over and helps establish usage protocols, restocking requirements, and expiration tracking. The processes involved in medication preparation also have improved now that we have labels with consistent naming conventions and concentrations, which help ensure safe dilutions.

Automated dispensing of perioperative medications, in coordination with standardized bar coding technology, has given us the peace of mind that the correct medication is prepared and administered to the patient every time. Upon removing a drug from the anesthesia workstation, the nurse or anesthesiologist scans the vial using the labeling system (mounted on the workstation) to positively identify the drug and verify that it is correct. The user then selects and removes a dilution (configured by pharmacy), if appropriate, from the workstation. Once the medication is prepared and ready, the labeling system produces a standardized, bar coded label, eliminating the need to manually add a second bar code label to the final product. Upon administration, the medication label prepared by the labeling system is scanned again for additional verification prior to the drug being administered to the patient.

Conclusion

Given the risks inherent to most perioperative medications, manual management—including stocking, tracking, labeling, dilution, and administration—is rife with potential for error. Mistakes made in the OR have a high potential for patient harm, so it is particularly important to introduce standardization and automation in this environment. Likewise, taking into account the number of different health care practitioners working in the perioperative setting, it is vital that these groups work together cohesively utilizing common technologies. At Texas Children's Hospital, automation for the management of anesthesia and related products has addressed our points of risk and has improved medication safety in the perioperative setting. ∎

Reference
1. American Society of Anesthesiologists. Statement on the Labeling of Pharmaceuticals for Use in Anesthesiology. Committee of Origin: Equipment and Facilities. http://www.asahq.org/For-Members/Standards-Guidelines-and-Statements.aspx Accessed January 3, 2014.

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