White paper

Using Bedside Labeling to Reduce Errors and Improve Efficiency

How Printing Labels at the Bedside Improves Patient Safety, and the Printer Capabilities Needed to Do It

Intermec®

Positive patient identification rightfully receives a lot of emphasis as a key to protecting patient safety. Preventing procedural and medication errors depends on accurately identifying patients. But consider that for each individual patient, there may be dozens of different samples and test results the hospital has to manage. While the patient can only be in one place at one time, his or her blood, urine, tissue and other samples may simultaneously be in departments throughout the hospital and other labs and healthcare facilities.

Patient safety demands accurate identification of both patients and samples. Accurate sample identification and management processes need to begin at the patient bedside. The greater the time or distance between when a sample is drawn and when it is identified, the greater the chance for error.

This white paper explores the link between sample identification and patient safety, documents the benefits of bedside sample labeling, explains effective bedside labeling processes, and identifies the printer and label media features that are required to be successful.

Patient Safety Requires Accurate Sample Identification

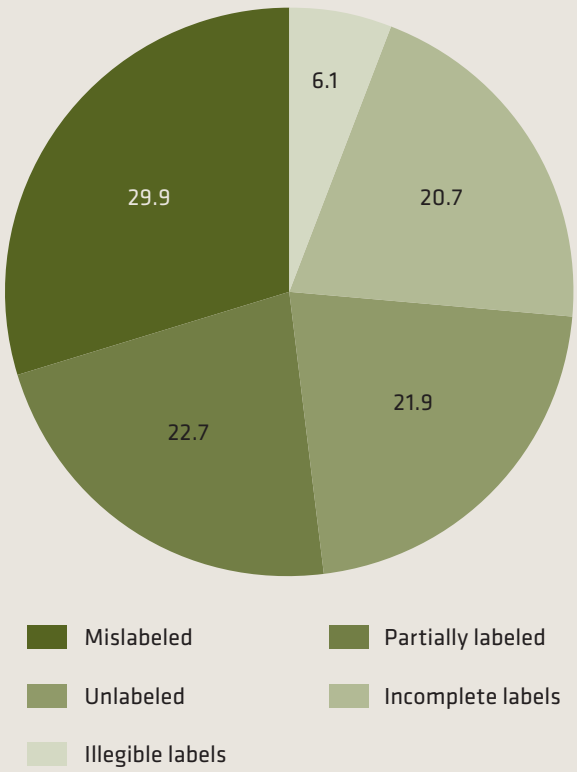
"*Improve the accuracy of patient identification*" has been the number one National Patient Safety Goal (NPSG) established by the Joint Commission (JCAHO) every year since the NPSG program was established in 2002. In 2010, one of JCAHO's two accreditation requirements for meeting the patient identification goal is: "*Label containers used for blood and other specimens in the presence of the patient.*" JCAHO has clearly been swayed by the growing body of evidence that links sample identification to patient safety.

A major study[1] of specimen labeling published in 2008 claims mislabeled specimens were the most common error (see figure 1). The authors fear patient safety problems resulting from sample identification errors, as this excerpt shows:

Mislabeled specimens are perhaps the most serious errors, since they may be associated with subsequent problems for patient care. A consequence of mislabeled specimens can be a wrong result for a patient, which may, in turn, cascade into wrong therapy. Mislabeled specimens can have a significant impact on patient safety and health care costs.

The adverse patient safety impact that the specimen labeling study authors feared has been documented: sample identification errors cause 161,000 adverse medical events in the U.S. each year.[2] A separate study[3] found misidentification was the root cause for 72 percent of adverse events, and that specimen mislabeling was a leading source of misidentification.

Figure 1: Sample Label Error Types



Totals exceed 100% because labels could have multiple errors.
Source: College of American Pathologists Q-Probe Study

There is a clear opportunity to improve patient safety by improving specimen labeling. JCAHO's requirement to label samples in the presence of the patient is a proven process for reducing these errors. Technology tools can make the process even more effective by solving leading labeling problems such as missing or illegible labels. By using mobile printers to produce sample labels at the patient bedside, hospitals can eliminate sample misidentification while also improving the durability and legibility of labels so they remain readable as long as they are needed.

Automating Bedside Labeling

Creating and applying sample identification labels at the time the sample is drawn can virtually eliminate unlabeled and mislabeled samples, which together account for more than 50 percent of all sample labeling errors. Using the proper printer and label material can help ensure the labels will not become illegible or fall off the sample container during transport, testing and storage. To gain these benefits, hospitals need the proper processes, computers, scanners, printers and media to ensure label quality and effective identification.

1 Elizabeth A. Wagar, Ana K. Stankovic, Stephen Raab, Raouf E. Nakhleh, Molly K. Walsh (2008) Specimen Labeling Errors: A Q-Probes Analysis of 147 Clinical Laboratories. Archives of Pathology & Laboratory Medicine: Vol. 132, No. 10, pp. 1617-1622.
2 Paul N. Valenstein, MD; Stephen S. Raab, MD; Molly K. Walsh, PhD "Identification Errors Involving Clinical Laboratories: A College of American Pathologists Q-Probes Study of Patient and Specimen Identification Errors at 120 Institutions," Archives of Pathology and Laboratory Medicine: Vol. 130, No. 8, pp. 1106–1113.
3 Edward J. Dunn, Paul J. Moga (2010) Patient Misidentification in Laboratory Medicine: A Qualitative Analysis of 227 Root Cause Analysis Reports in the Veterans Health Administration. Archives of Pathology & Laboratory Medicine: Vol. 134, No. 2, pp. 244-255.

The general process for automating bedside sample collection begins with using a handheld computer to automatically identify the patient by scanning his or her bar-coded wristband. The scan triggers a patient record lookup, either from the handheld computer's onboard memory or by accessing a host system over a wireless network. Once the patient is identified and the physician's order for the sample is confirmed, the clinician or nurse collects the sample and records the transaction on the handheld computer. This action automatically triggers the computer to send a label request (either wirelessly or through a connection cable) to a mobile printer. The printer then outputs the sample label. This label may include the patient name and ID number, clinician ID, sample type, time of collection and other information, plus a unique serial number to identify the sample, with a bar code to facilitate automated tracking and confidentiality. The clinician or nurse then immediately applies the label to the sample. A duplicate label may be printed and affixed to the patient's chart.

Perhaps the biggest benefit of the automated process described above is that sample labels are printed at the time they are needed and can be applied immediately, which significantly reduces the chance that the label will be applied to the wrong sample. Preprinting patient sample labels is a common practice, and the process has been cited as a leading source of specimen mislabeling.[4] Dr. Elizabeth Wagar, director of clinical laboratories at UCLA and lead author of the College of American Pathologists Q-Probe study on specimen labeling errors, noted the link between labeling delays and sample misidentification in an interview: *"Some laboratories will generate a whole stack of label sheets for the phlebotomists, and it's really easy to mix sheets of labels.[5]"*

Eliminating the delay between when sample labels are produced and when they are applied directly addresses the leading source of errors: mislabeled samples. The process also helps prevent the second-leading error: unidentified samples, which can occur when the clinician does not have preprinted labels at the time the sample is drawn (perhaps because of a stat order that wasn't part of the original schedule, or because all the patient's preprinted labels have been used and additional ones have not been printed yet). On-demand printing also reduces waste, because labels are only printed if needed.

There are many other benefits to using mobile computers and printers to verify sample orders, record draws and produce labels at the patient bedside. These include:

- Elimination of handwritten records and the need for transcription;
- Prevention of manual data entry errors;
- Automatic time stamping of records;
- Ability to report transaction information to LIMS and eMAR systems in real time.

Misapplying labels is a common sample identification error that threatens patient safety, but it is not the only one. Sometimes samples are misidentified because the label falls off or becomes unreadable during processing. As shown in Figure 1, unlabeled samples (21.9%) and illegible labels (6.1%) together account for nearly as many errors as mislabeled samples (29.9%).

Missing and illegible labels usually result from using an inappropriate combination of label media and printer. The equipment and supplies used to produce sample labels are important variables for label quality and durability, and therefore are important variables to patient safety. The following sections highlight special considerations for bedside labeling and what to look for in printers and media.

Printer Technology and Product Considerations

The printer and media selected for bedside labeling will have an impact on identification error rates. For sample identification, the label media is as important as the printer. Because sample processing may involve sterilization, freezing, extended duration water baths, centrifuge, UV light and many other processes and exposures that can destroy labels, hospitals need to use specialty materials plus printers that can handle them. The first requirement of the printer-media combination is label quality, so the label must remain legible and durable throughout the collection, processing and storage phases. It is also essential for bedside label printers to be easy to use, because performance issues or unnecessary manual steps can cause distractions that lead to labeling errors.

Hundreds of printer models can print labels, but only a relative few are suited to the specific needs of bedside labeling. Common document and form printers used in nurse's stations and administrative offices have particular limitations when it comes to specimen labeling. The first limitation is convenience – most document printers are too large for clinicians to carry, and too expensive to install in every room. Some hospitals mount laser or inkjet printers on carts, which improves convenience but does not address other limitations, namely lack of label media support. Printers designed to print documents are not optimized for specialty label media, which can result in jams, torn labels, poor print quality and the misidentification risks that result.

Key Factors

Just as bedside labeling has specific media requirements, there are specific printer features and performance attributes that impact the quality of labels printed and the convenience and efficiency of the labeling process. Key bedside label printer performance requirements and beneficial capabilities are explained below.

Media support – The label media needed to ensure accurate sample identification throughout testing and storage processes may dictate the choice of printer. If media is chosen based only on what a preferred printer supports, instead of selecting the most appropriate printer and media combination, the specimen labels may fall off or become unreadable, putting the hospital at risk for sample misidentification and the mistakes that result. Adhesive is an important component that should not be overlooked when selecting sample label media. Label adhesive that is appropriate for the surface provides better resistance to corner lift, which is important to prevent in all types of labeling and can be especially challenging when working with small vials.

4 Ibid.

5 As quoted in "Punching a Hole in Specimen ID Errors" College of American Pathologists CAP Today, June 2008.

Speed – Print speed is much more important when clinicians are at the patient bedside waiting for a label than when labels are preprinted. Printer features that can affect label print speeds include wireless connectivity, native support for needed bar code formats (bar codes that are treated as fonts or are bitmapped take longer to print), amount of memory, connectivity method (cable, Bluetooth or wireless LAN), battery power (for mobile or cart-mounted printers) and compatibility with the handheld computer used as part of the specimen collection and labeling process.

Wireless support – Because bedside labeling printers are mobile, they should have the ability to wirelessly connect to the devices, networks and central systems they need to work with. Both Bluetooth and wireless LAN (e.g. 802.11b, g, n) connectivity is available in mobile and cart-mounted printers.

Network security – Printers are not exempted from HIPAA regulations for protecting patient data. Wireless printers must be able to support hospital security protocols and IT policies.

Certification – Many leading healthcare software providers certify specific printer makes and models for use with their systems. Certification is a valuable attribute because it gives organizations confidence that the software provider has independently tested the printer and determined it interfaces correctly. Non-certified printers often require custom interface development for use with healthcare software, so certified models take less time and expense to deploy.

Memory – Printers perform faster when label formats, graphics and data can be loaded directly from memory instead of received from a cable or wireless connection to a host computer or database. The more memory a printer has, the more label formats, fonts, graphics and data files it can hold.

Displays and control panels – Printers with screens that can display prompts, reminders, warnings and error messages, plus easy-to-use controls, save time for users and can prevent data entry errors and misprinted labels.

Ergonomics – Printers should be easy to load, use and transport. For mobile printers that will be carried or worn on a belt or strap, size, weight and ease of access to controls and the label output are especially important. These factors impact the time needed to complete the labeling process and operator fatigue, so they are important variables to productivity.

Reliability – Printer reliability can have a major impact on the user's productivity. If mobile printers consistently break down organizations may revert back to batch printing processes, and bypass the accuracy and efficiency benefits bedside labeling provides. Breakdowns also cause delays in sample collection, which can delay test results. Printers used for bedside labeling should be proven for the environment, so the busy, highly trained nurses, phlebotomists, clinicians and technicians who use them do not need to take time from their primary responsibilities to deal with faulty equipment.

Batteries – If mobile printers are used, it is important to ensure the battery can power the printer for an entire shift without having to be recharged. It is also important to consider whether users can easily replace batteries themselves, whether batteries need to be removed from the printer to be recharged, and the time required for recharging.

Technology-specific Considerations

Label quality and printer reliability issues often relate to the specific print technology used. Laser, inkjet and thermal printers all have specific performance characteristics that are important factors when printers are used for bedside labeling. The following sections identify the leading technology-specific characteristics and considerations.

Laser

Media support and ease of use are the leading limitations to using laser printers for bedside labeling. For one, suitable sample label media is limited. How lasers print labels is another concern.

Lasers are more effective for printing labels in batches than they are for printing individual sample labels on demand at the patient bedside. That is because laser printers are sheet fed, and have to process an entire sheet even when only one label is needed. The sheet can be reused, but that requires additional handling. By the time the final label on the sheet is printed the sheet will have been fed through the printer and reloaded several times, which increases the chances it will be folded, torn or jam the printer. Laser printers do not provide a straight paper path, which increases the chances of jams and wasted media.

The labor required for laser media handling is an inconvenience. The other major convenience disadvantage for laser printers is that they must be cart mounted for bedside labeling. Organizations that prefer smaller, compact printers that users carry or wear must look to thermal options.

Printing labels on lasers designed for documents can shorten the printer's lifespan because over time, the adhesive material on sheet-fed labels builds up inside the printer and degrades its performance. The buildup can block the photoreceptor drum or fuser, leading to premature failure for that critical component.

Bar code label printing can drive up the cost of using lasers. Producing quality, readable bar codes requires approximately 50 percent ink coverage, which is considerably more coverage than is required for printing quality text. Therefore bar code printing consumes more toner (and ink in inkjet printers) than text printing, which increases the supply cost.

Inkjet

Many inkjet printers are sheet fed, which is inconvenient for label printing. Print quality consistency is a leading concern for inkjet printers. When inkjet cartridges are running low, printed images appear faded and may include streaks or blank spots; new cartridges and low-cost inks are prone to smudging. These print quality problems can make labels illegible, especially if the labels include bar codes.

Media is a major drawback for inkjet printers. Relatively few inkjet label media options include the material, protective coating and appropriate adhesive to withstand sample collection, testing and storage processes. Inkjet printers are typically used to create mailing labels and other general-purpose labels, so the media is not optimized for specialized healthcare uses.

Document-oriented inkjet printers used for labeling have the same risk as lasers for premature failure because of adhesive buildup. Adhesive can also block elements of the printhead, which results in voids where ink should have appeared. This is another print quality problem that can make bar codes unreadable and unscannable. Mobile versions of inkjet printers are designed for document printing, so carts with a battery pack are required when inkjet printers are used for bedside labeling.

Thermal

Unlike laser and inkjet printers, thermal models are designed specifically to produce bar code labels. As such, they offer several advantages, including roll-fed media, the ability to print labels on demand in the exact quantity needed, and native support for bar codes. Most importantly, thermal printers support the widest range of specialty media used for sample labeling, including specialty paper and durable synthetic materials that are suitable for use in laboratory processes which could degrade or destroy general-purpose label stock.

The thermal category also offers the widest selection of mobile printer options. Mobile thermal printers capable of producing quality sample labels are available with secure 802.11 and Bluetooth wireless communication capability or cables, durable construction, display screens, native bar code support and other features, and are available in models that can easily be carried, clipped to a belt, worn with a strap or used with a cart without requiring power from the cart.

Thermal printers are extremely well suited to meeting the needs of bedside labeling. The greatest potential challenge to using thermal printers is integrating them with healthcare information systems. Thermal printers use proprietary printer command languages, which are not always supported by laboratory and patient management software systems. Healthcare automation technology vendors natively support interfaces for laser and inkjet printers, so generating output from these applications on general-purpose printers is not usually a concern. If software applications do not expressly support thermal printers, an emulation or interface will need to be developed to enable information from the software application to be output on labels. This is not a universal requirement, and must be assessed for each specific printer-software combination.

The Case for Thermal Printers

The most compelling reason to use thermal printers for bedside labeling is the quality of media and printed output. By using labels that are optimized for healthcare processes, and creating them on printers that are designed specifically for label printing, hospitals can attain excellent print quality and label durability. There are also convenience and cost benefits to using thermal printers instead of laser or inkjet models. These include freedom from the labor requirement and recurring cost of replacing toner and ink, the reliability and long lifecycle made possible by using a purpose-built label printer, the ability to produce individual labels on demand instead of having to print entire sheets, independence (and cost savings) from having to use a cart with the printer, and less productivity loss from downtime and maintenance. Many of these benefits are explained and documented in detail in Intermec's white paper How to Select the Right Label Printer, which is recommended reading for those that want to explore the differences between print technologies for label output in more depth. The following sections highlight the specific thermal advantages for bedside labeling.

Superior quality – Thermal printers are best suited to prevent label legibility and durability issues because they produce very precise images and support the widest range of label media. It is worth noting that thermal is the most widely used technology for bar code printing, which requires excellent print quality because bars and spaces must be produced within exact tolerances. Common printers cannot always satisfy bar code quality requirements, especially on small labels. Thermal printers are advantageous even when bar codes aren't used, because of the clear text and images they produce, and because of their resistance to the smudging and fading problems found with other print methods. Unlike laser and inkjet printers, direct thermal output won't become weaker as print volume increases, because no toner or ink are used.

Optimized media – Thermal printers support a wide range of media, including synthetic materials that are suitable for use in immersion, sterilization, frozen storage, clean room and other environments that would degrade or destroy general-purpose label stock. In addition to the label stock, specialized topcoats and adhesives are available to improve resistance and longevity in many environments. For example, there are thermal stock and adhesive combinations that can reliably bond to small vials through repeated freeze-and-thaw processes, without peeling at corners. This type of performance helps prevent samples from becoming unidentifiable because the label falls off during processing.

Minimal media handling – Most sample labels can be produced with direct thermal printers, which do not require the user to change toner, ink or ribbon. Thermal printers are also roll fed and produce labels in the quantity needed, which saves users the steps of managing paper trays and unused partial label sheets. By minimizing media handling requirements, hospitals can help their specialists be more productive and take unnecessary labor costs out of printing processes.

Speed and convenience – Fast label output also saves time and effort for users. Some printers may require half a minute or more to process a print request and output the label, while others can do so in a few seconds. The time to first label (also referred to as first label out) can be a big differentiator among printer models. Thermal printers often excel at printing labels quickly, because of their support for bar codes, graphics and other performance features.

More mobility options – Thermal printers can be used with or without carts, and battery-powered mobile models require no external power supply to last the full 8-hour shift and beyond. These characteristics give users more flexibility, and can also eliminate the expense of purchasing and maintaining carts to support bedside labeling. Wireless support enables thermal printers to connect to hospital information systems while mobile. Thermal printers are available with 802.11-standard network connectivity, certified CCX compatibility for use with Cisco networks, and support for leading wireless security protocols including WPA, WPA2, 802.11i, FIPS, AES, TKIP, LEAP et al).

Ruggedness and reliability – Thermal printers are made for specialized printing applications and are built for use in environments where labels are applied. Printers used for bedside labeling will be bumped and, dropped as they are rolled on a cart or carried from room to room. These conditions can shorten the lifecycle of document-oriented printers that were designed for use on a desktop. Thermal printers in general are known for their reliability and include printheads that are rated to produce hundreds of thousands of labels. Mobile thermal printers are available with rugged housing and other features to preserve performance and print quality in bedside labeling environments. Some models are rated to withstand multiple five-foot drops to hard floors and are sealed against dirt and moisture. Drop specifications and Ingress Protection (IP) ratings are good measures of a printer's durability.

Lower TCO – Thermal printers save money and provide total cost of ownership (TCO) advantages by eliminating toner and ink expenses, reducing waste from unused label sheets, reducing the labor cost component of label printing, having a long replacement cycle and potentially preventing cart costs.

Conclusion

There are typically dozens of samples and orders for each hospital patient, and losing track of just one of them compromises patient safety. Sample identification errors cause 161,000 adverse medical events in the U.S. each year, and specimen mislabeling is the root cause of many misidentified samples. Despite the emphasis on bedside labeling as part of a National Patient Safety Goal, sample identification and labeling errors continue to occur.

The leading causes of sample labeling errors are all largely preventable by using more automated bedside labeling processes with appropriate printers and media. Bedside labeling significantly reduces the chance that samples will be mislabeled, or will be unidentified altogether. Quality media and printers can prevent samples from being unidentified or becoming illegible.

Thermal printers and media are an excellent option for supporting bedside labeling and improving both sample identification and patient care. They provide the quality and durability demanded by bedside labeling, and are easy and cost-effective to use. Intermec invented the first on-demand bar code label printer in 1971 and currently offers a complete range of thermal printers plus various label and wristband media options for healthcare applications. Intermec's lineup of durable and rugged mobile printers for bedside labeling offers industry-leading secure wireless connectivity options, one of the highest mobile printer IP ratings, support and software resources that make it easy to set up and use, and the industry's fastest time to first label. Our bedside labeling printers support Code 128, Aztec Code, Data Matrix and other bar code formats used in hospitals, and are compatible with leading healthcare information systems.

Intermec Inc. (NYSE:IN) develops and integrates products, services and technologies that identify, track and manage supply chain assets and information. Core technologies include rugged mobile computing and data collection systems, bar code printers, label media, and RFID. The company's products and services are used by customers in many industries worldwide to improve the productivity, quality and responsiveness of business operations. For more information about Intermec, visit http://www.intermec.com or call 800-347-2636.

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