

Protecting Patient Safety with Laboratory Bar Code Labeling



A ZEBRA BLACK&WHITE PAPER





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Executive Summary

The hospital laboratory is an important checkpoint for detecting and preventing errors that threaten patient safety. Marking and tracking lab samples and specimens with bar codes is a highly effective method for preventing errors in the first place. Using bar coding for lab sample management prevents mistakes, improves patient safety, and adds efficiency to laboratory operations. This white paper illustrates the benefits of automated sample labeling and tracking and provides guidance for implementing labeling systems that provide safe, accurate sample identification.

Opportunity for Improvement

Patient identification errors occur on about 1 percent of laboratory samples,¹ and approximately one in 18 sample identification errors leads directly to an adverse event.² As a result, there are 160,900 adverse events in U.S. hospitals each year because of sample identification errors.³ Errors can also occur in the laboratory during sample receipt, testing and result reporting processes. For example, one study found a 0.46 percent error rate in the transcription of patient data,⁴ which translates to approximately one transcription error per every 217 tests. A Scottish study of critical care settings found inaccurate blood test transcription in 8.8 percent of cases, and concluded “This study highlights that our current system of recording blood results is unreliable.”⁵

Sample identification and results reporting errors can lead to misdiagnosis and inappropriate treatment with deadly consequences. A 2006 Wall Street Journal article reported malpractice claims for pathology errors are relatively low, but they are the second-most costly.⁶ Malpractice problems aside, the redraws, retesting and additional treatment resulting from sample errors cost hospitals an estimated \$200 to \$400 million per year.⁷

1. Paul N. Valenstein, RL Sirota “Identification errors in pathology and laboratory medicine,” *Archives of Pathology and Laboratory Medicine*, Vol. 129, No. 10, pp. 1228-1233.

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. Ibid.

4. Laura Sciacovelli, Paolo Carraro, Mario Plebani “Errors in Laboratory Medicine: Transcription Errors and Interpretative Comments in Report,” *Institute for Quality in Laboratory Medicine Conference*, April 28, 2005.

5. R. Black, P. Woolman, J. Kinsella “Variation in the transcription of laboratory data in an intensive care unit,” *Anaesthesia*, Volume 59 Page 767, August 2004.

6. Wall Street Journal “Hospitals Move to Cut Dangerous Lab Errors” June 20, 2006.

7. Bologna L, Hardy G, Mutter M. Reducing specimen and medication error with handheld technology. Presented at 2001 Annual Conference and Exhibition. Healthcare Information and Management Society, Feb 4-8, 2001, Chicago, IL, cited by Margaret Herrin in “A Pledge of Safety: How one laboratory automated its specimen collection process to increase productivity, streamline workflow and improve patient care.” *ADVANCE for Administrators of the Laboratory*, October 2006.



Preventive Processes

Accurate sample labeling is the best defense against misidentification errors and their consequences. Labeling samples and aliquots at the time they are drawn is a proven method to reduce errors. The accuracy and error prevention benefits can be extended into laboratory operations by using bar codes to identify samples and by scanning them to record transfers and to support test result entry. Automated data entry is highly accurate, which improves patient safety by eliminating errors. As a side benefit, bar code sample identification and data entry also saves time, enabling lab staff to spend more time on activity that is clinical rather than clerical.

For example, Hamilton Medical Center in Dalton, Ga., reported turnaround times for lab test results were reduced between 3 percent and 59 percent per procedure after bedside specimen labeling and bar code sample tracking were implemented.⁸ The hospital attributed the improvement to time saved from re-labeling and elimination of manual entry of test results.

Two case studies available on www.zebra.com also illustrate the safety and efficiency benefits of using bar codes to support laboratory operations. Northeast Medical Center, an acute-care hospital in North Carolina, began labeling specimens at the patient bedside using mobile thermal printers and label material developed for use on test tubes. Labels are bar coded for identification and color coded to provide an extra visual indicator of what tests should be performed. Producing sample labels on demand instead of applying preprinted labels led to a significant reduction of mislabeling errors, and thermal printing has also proven to be more reliable and accurate than the previous method. Another Zebra customer, NHS Argyll & Clyde, a Scottish healthcare provider that is part of the U.K.'s National Health Service, improved its sample identification accuracy from 85 percent to 100 percent with an on-demand printing system. The bar codes on sample labels are used in lab operations, greatly reducing the need for manual data entry and saving hours per week.

The accuracy of bar code data entry has been widely estimated at one error per 3 million characters, which is much more accurate than typing or other forms of manual data entry. Identification and data entry accuracy should not be a concern provided the bar code is produced correctly and remains affixed to the sample. Labeling operations are thus essential to the success of bar code-based patient safety and laboratory automation initiatives.

Lab Labeling Considerations

The print technology selected and labels used with the printer are major variables in the success of bar code label printing for laboratories. Important considerations include:

- Where to produce sample labels?
- What material to print them on?
- What type of printer to use?

8. Margaret Herrin, Kenneth Lowery, Larry Early and John Forrester, Hamilton Medical Center; Sandra Trakowski, Mary Wojcik, Care Fusion Inc. "Hamilton Medical Center Finds That Deployment of a Positive Patient Identification (PPID) Specimen Collection Solution Improves Both Patient Safety and Work Flow Processes."



Labeling Location Options

Ideally, sample labels will be produced and applied at the patient's bedside at the time the sample is drawn. This practice virtually eliminates the possibility of applying the wrong label to the wrong sample. The Valley Hospital in Ridgewood, N.J., analyzed specimen identification errors and found that carrying multiple labels into a patient room was the leading cause of specimen mislabeling. Labeling away from the bedside was the second-leading cause.⁹

Bedside sample labeling with bar codes is also an effective method to help comply with the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) (now called The Joint Commission) 2006 National Patient Safety Goal (NPSG) to establish processes to maintain sample identities throughout pre-analytical, analytical and post-analytical stages and to use at least two patient identifiers whenever collecting lab samples.

Hospitals that have adopted bedside labeling report dramatic reductions in erroneous and misidentified samples. Point-of-care labeling also eliminates the need to re-label in the lab, saving time for laboratory staff. For in-depth information about bedside specimen labeling, including more case studies, documented results and statistics, plus discussion of relevant JCAHO and HIPAA requirements, see Zebra's white paper "Benefiting from Bedside Specimen Labeling" (available at www.zebra.com).

Bedside labeling is not a prerequisite for hospitals to take advantage of bar coding in the laboratory. There are no major technology, integration or cost hurdles to setting up bar code label printing systems in labs. Even if bedside labeling is used, laboratory staff will want on-demand label printing capability so aliquot samples can be accurately labeled and tracked with bar codes. Files, forms and even test equipment can also be bar coded to support efficient, automated operations.

Print Technology Selection


One of the challenges is to implement systems and procedures to apply bar code labels to as many samples as possible. Labs that use legacy laser or ink jet printers for sample labeling may be frustrated with their efforts because office-type printers don't easily accommodate the variety of label sizes and materials that comprehensive laboratory labeling requires.

Bar code scannability is also a consistent frustration with these technologies. Label readability is the most important criteria when selecting a printer for specimen labeling. Bar codes, text and graphics must be clear and long-lasting to provide accurate identification from the time of collection through to final disposal or storage.

Laser and ink jet printers are adequate for pre-printing sheets of paper-based labels, for example for file folder labeling, but specialized printers and materials are more practical and effective for producing lab sample tracking labels. Ease of use is also a concern if label sheets jam during printing or if the printer has to be frequently loaded and unloaded to switch between plain paper and label media. Printers should also be fast enough to produce labels on demand, without inconveniencing the user.

The following sections explain bar code printing requirements, how thermal print technology works, and thermal printing's specific advantages for use in laboratories.

9. Lawrence J. Bologna, MBA, MS, FACHE, Michael Mutter, MS, RPH "Life After Phlebotomy Deployment: Reducing Major Patient and Specimen Identification Errors," *Journal of Healthcare Information Management*. Winter 2002 - Volume 16, Issue 1.



Bar code scanners collect and decode the information from bar code symbols by measuring the differences between narrow and wide elements, and the contrast between dark bars and light spaces. If the ratios or contrast are slightly off, the bar code may be difficult or impossible to read, or may be read incorrectly. Smudges, specs and torn or wrinkled bars can also impair accurate reading. Appropriate printers and supplies greatly reduce the chances of these problems occurring, and thus are important contributors to patient safety.

Thermal bar code label printers are engineered specifically to produce the exact bars and spaces and durable images that bar coding requires, and to conveniently print labels. Thermal printers are especially effective for laboratory labeling because they don't require a lot of space, excel at printing small labels, and are easy to load and use. Many models don't use a ribbon, which eliminates the associated disposal and HIPAA concerns. Thermal printers are also compatible with a wide range of paper and synthetic label material that can stand up to laboratory testing and storage processes.

Thermal printing is classified as either direct thermal or thermal transfer. The two technologies are suited to different applications. Direct thermal printers create images by using a printhead to apply heat to selected areas directly to the chemically treated label material. There is no ribbon or ink required. In thermal transfer printing, the printhead heats a ribbon, which melts the image to the material. Thermal-transfer is used for high-durability, long-lasting labeling applications. Thermal printing technologies have many advantages for laboratory use and a few limitations:

- Thermal printers usually have the native ability to produce all the linear and two-dimensional (2-D) bar code formats used in laboratories and hospitals without requiring additional font installation, firmware upgrades or programming. Supported symbologies include Codabar, Code 128, Code 39, Reduced Space Symbology® (RSS), Data Matrix, Aztec Code, PDF417 and others.
- Labels can be printed individually on demand or in batches with virtually no waste.
- Small labels and a variety of label sizes are easily accommodated, so test tubes, slides, Petri dishes, bags and other specimen containers can all be labeled appropriately.
- Thermal printers accept roll media and cannot print 8 1/2- by 11-inch documents.
- Direct thermal printers are simple to operate compared to most other print technologies, with no ink, toner or ribbon to monitor and replenish.
- Ribbon-free printers simplify HIPAA compliance.

For more information about evaluating print technologies and the benefits of thermal printing for hospital and laboratory uses, see Zebra's white paper "Evaluating Print Options for Hospital Bar Code Labeling" available at www.zebra.com.

The Importance of Supplies

The label provides the critical link between the physical specimen and all the information in software systems associated with it. The range of label sizes and materials available for thermal printers helps automated sample management systems run accurately and effectively, and also helps keep operating costs down. Thermal printers make it convenient to carefully match specific labels with items to be identified, (test tubes, slides, etc.) and the environments where they'll be used (e.g., frozen storage, warming). Thermal printers provide this flexibility because they can quickly and easily be loaded with different media, and are also compact and cost-effective enough so multiple printers can be installed in the lab.

Supplies and printers work together as a system. For top quality and durability, label supplies should be matched for use not only for specific testing and storage needs, but also with the specific make and model of the printer used. Adhesives and protective coatings that work perfectly well for labeling one type of container or test may not be ideal for others. For more information, see Zebra’s guide “The Do’s and Don’ts of Selecting Hospital Bar Code Labels and Wristbands.”

Many labs try to consolidate on only one or a few types of label materials because of the time and hassle associated with loading media. This means that expensive materials that labs need to withstand the most challenging exposure to temperature extremes, chemicals and solutions used in testing and other environmental conditions are also used on samples that could be labeled with less expensive media.

Here are some examples of labels offered by Zebra Technologies that show the breadth and capabilities of thermal supplies for laboratory use.

| Product | Description | Uses |
|--------------------------|---|--|
| 8000T CryoCool™ | Thermal transfer polypropylene labels, -196° C temperature resistance for liquid nitrogen applications. | Cryogenic storage, virology labeling, genetics labeling, DNA sequencing, cold-temp applications. |
| Z-Select™ 4000T All-Temp | Ultra-smooth top-coated thermal transfer paper label with glove-compatible adhesive. | Labeling of test tubes, vials, microscope slides, specimen containers. |
| Z-Select 4000D | Ultra-smooth top-coated direct thermal paper label with glove-compatible adhesive. | Labeling of test tubes, vials, microscope slides, specimen containers. |
| 8000T Blood Bag | Top-coated thermal transfer polypropylene label with permanent adhesive. Meets FDA Guidelines for Uniform Labeling of Blood and Blood Components. | Labeling of blood and IV bags; chemical, medical food and drug labels. |
| 8000D IR | Top-coated direct thermal paper label with glove-compatible adhesive that will scan in both visible and infrared ranges. | Labeling of test tubes, vials, microscope slides, specimen containers in both visible and infrared ranges. |

Besides the many specialty materials options, labels for thermal printers are also available in many shapes and sizes for convenient specimen labeling, including very small labels for slides and test tubes.

C o n c l u s i o n

The laboratory is an important line of defense against patient safety errors because of the role it can play in preventing adverse events related to sample misidentification. By establishing processes to accurately label and identify samples, laboratory staff can significantly reduce the incidence of misidentified, lost or unusable samples, and the related negative consequences, including redraws, misdiagnosis and inappropriate treatment.



Bar code labeling and sample tracking is proven to reduce sample identification and data entry errors. Specimen labeling systems can be implemented in the lab regardless of whether or not bedside specimen labeling is used, and most LIS/LIMS systems support bar code data entry, so bar coding is a convenient complement to legacy processes and technologies. Reliability is essential to successful sample labeling and improved patient safety. Bar codes must be crisp, readable and durable, and label material must be engineered to withstand challenging test and storage conditions. Finding the right printer and supply combinations usually requires expert assistance.

Zebra Technologies is a longstanding leader in providing solutions that protect patient safety and privacy. Zebra and its partners have provided bar code and radio frequency identification (RFID) solutions at the heart of many patient safety initiatives, including laboratory labeling, bedside bar code medication administration, positive patient identification to prevent surgical errors, point-of-care sample identification, automated drug dispensing, blood bag identification and counterfeit drug prevention.

Zebra Technologies Corporation delivers innovative and reliable on-demand printing solutions for business improvement and security applications in 100 countries around the world. More than 90 percent of Fortune 500 companies use Zebra-brand printers. A broad range of applications benefit from Zebra-brand thermal bar code, wristband, "smart" label, receipt, and card printers, resulting in enhanced security, increased productivity, improved quality, lower costs, and better customer service. The company has sold more than five million printers, including RFID printer/encoders and wireless mobile solutions, and also offers software, connectivity solutions and printing supplies. Information about Zebra bar code, wristband, card and RFID products can be found at www.zebra.com.



GLOBAL/AMERICAS

HEADQUARTERS

Zebra Technologies Corporation
333 Corporate Woods Parkway
Vernon Hills, IL 60061-3109 U.S.A.

T: +1 847 793 2600 or
+1 800 423 0442
F: +1 847 913 8766

EMEA HEADQUARTERS

Zebra Technologies Europe, Limited
Zebra House, Unit 14,
The Valley Centre
Gordon Road, High Wycombe
Buckinghamshire HP13 6EQ, UK

T: +44 (0) 494 472872
F: +44 (0) 494 450103

ASIA-PACIFIC HEADQUARTERS

Zebra Technologies Asia Pacific, LLC
16 New Industrial Road
#05-03 Hudson TechnoCentre
Singapore 536204

T: +65 6858 0722
F: +65 6885 0838

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California, Rhode Island, Texas,
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France, Germany, Italy, Netherlands,
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