White paper

Improve Patient Safety with a Quality Wristband Solution

How Printer Choice and Other Variables Impact Wristband Quality, Patient Identification and Medical Errors

Intermec®

Introduction
The foundation for patient safety is positive patient identification, which begins with the wristband. Poor quality wristbands can lead to patient misidentification and medical errors. Poor quality wristbands can also prevent organizations from leveraging processes and tools for enhancing patient safety, including automated Five Rights checks, bar code point-of-care (BPOC) systems and electronic medical administration records (eMAR). By improving wristband quality, and improving the convenience of how wristbands are produced, healthcare organizations can improve the accuracy, efficiency and quality of patient care.

A wristband's ability to enhance quality of care depends on the quality of the wristband itself. Unfortunately, wristband quality varies widely and cannot be taken for granted. Incidents of wristbands falling off or becoming illegible are not uncommon. Consequently, transcription errors and patient misidentification aren't uncommon either. Wristband print quality will become even more important as bar coding becomes more prevalent in healthcare.

Wristband quality and consistency depend heavily on the print technology, printer model and wristband material used. This white paper highlights how these variables impact wristband quality, documents the links between wristbands, positive patient identification and patient safety, and provides guidance for wristband solutions that deliver accuracy, safety and convenience throughout the patient care path.

Why Wristband Quality Matters to Patient Safety
Wristband quality directly affects accuracy in patient identification. Patient misidentification was the root cause of 72 percent of adverse events according to a U.S. Veterans Administration (VA) Health System study[1]. A UK study found that missing wristbands and wristbands with incorrect information were directly responsible for 236 incidents and near misses in a 19-month period[2]. Numerous patient safety studies, organizations and government agencies have called for improving positive patient identification processes, often citing the benefits of bar code-based automated wristband checks. Despite some progress in this area and increased use of bar code medication administration, electronic medical records and other automated safeguards, there is still substantial room for improvement. In recognition of this need, the Joint Commission (JCAHO) made its top National Patient Safety Goal (NPSG) for 2010: *Improve the accuracy of patient identification*. It has been the number-one goal every year since the NPSG program began in 2002.

The implications of patient misidentification are clear. For example:

- Medication errors harm more than 1.5 million people in the U.S. each year[3];
- Hospitals alone spend an estimated $3.5 billion annually treating erroneous drug-related injuries contributing to unnecessary care costs[4];
- There were 116 wrong-site surgeries, including surgery on the wrong patient, reported to the Joint Commission in 2008 (the last year for which data is available), making wrong-site surgery the most-reported sentinel event in 2008[5];
- Two thirds of blood transfusion errors are associated with incorrect recipient identification at the patient bedside[6].

There are several common wristband problems that contribute to patient identification errors. Leading problems include wristbands that are missing, damaged or contain illegible information. Sometimes wristbands are smudged or fade from the time they are printed. If bar codes are used, slight imperfections like these can easily make the symbols unreadable. Wristbands with no initial quality problems may become unreadable or fall off after several days of wear and exposure to common things like water, soap, alcohol and other sanitizers. Many of these quality problems and their causes are not readily apparent, but the medical error data previously referenced clearly shows some of the risks of poor wristband quality.

Why Print Method Matters to Wristband Quality
The durability, quality and performance of a wristband usually relates back to the print technology and the material used to create it. The longer a wristband needs to remain in use, the more important each of these variables becomes. When wristbands need to last for more than an hour or two while a patient undergoes outpatient testing, or may be exposed to soaps, solutions or creams, or perhaps include linear or two-dimensional (2D) bar codes, then higher quality wristband-compatible printers and material should be used.

Bar code printing introduces additional print quality requirements. All bar codes require sharp lines and edges, bars and spaces that are free from spots, smudges or voids, and strong contrast between dark and light elements. Because wristbands are curved when they're worn and typically do not have a lot of space, it is more challenging to print readable bar codes on a wristband than it is on labels or documents. Therefore bar code print quality is more important, and general-purpose printers that do fine for documents and basic labels may not be sufficient for wristband printing.

1 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.
2 Wristbands for hospital inpatients improves safety. National Patient Safety Agency, Safer practice notice 11, November 22, 2005.
3 Preventing Medication Errors. Institute of Medicine/National Academies, 2006.
4 Ibid.
5 Top Sentinel Events Reported by Year, The Joint Commission. Accessed June 13, 2010 from http://www.jointcommission.org/NR/rdonlyres/67297896-4E16-4BB7-BF0F-5DA4A87B02F2/0/se_stats_trends_year.pdf
6 Improving the Safety of the Blood Transfusion Process. Pennsylvania Patient Safety Authority Patient Safety Advisor (2), June 2010.

It is advantageous to print text, graphics and bar codes directly on the wristband, rather than printing labels separately and applying them to blank wristbands. Printing a separate label introduces several potential points of failure and adds to the time and labor required to create wristbands. If separate labels are used, the hospital must ensure the media has appropriate, durable adhesive that will not fail after becoming exposed to water, alcohol and other common substances. Even if the label does not fall off completely, it can begin to peel away, which makes it harder to read (or impossible to read for a bar code scanner). Peeled labels also create a place for dirt and bacteria to collect. Printing directly on the wristband prevents this problem and eliminates several variables to wristband quality and performance.

Laser, inkjet and thermal (including direct thermal and thermal transfer) printers have all been used to produce patient wristbands. There are specific quality, cost and convenience considerations associated with each print technology. The following sections highlight issues to be aware of when printing wristbands with the various print technologies.

Laser

Laser printers are convenient in the sense that most organizations already own them, but are not especially convenient for wristband printing. Patient wristbands are usually needed one at a time, but laser printers process an entire sheet at a time. This means the sheet must be reloaded and the printer directed to print on the unused media location the next time a label is needed. Excessive handling also increases the time to print and the chances sheets will develop creases or folded corners that can jam the printer. If the laser printer for wristbands is also used to print documents, a second media tray will need to be added for wristband material, or else users will repeatedly have to switch and load paper and document media. This process adds cost because of the labor time required to load media. It is also an inconvenience that should be carefully considered, since admissions departments are often busy and have high potential to cause patient-flow bottlenecks.

Lasers are capable of very high print quality, including the quality required for bar codes and graphics used on wristbands. The quality concern about laser printers is consistency. Laser output becomes lighter the more toner is consumed. The change may not immediately be perceptible to the human eye, but can make bar codes unreadable and can hasten the fading process that can naturally occur after wristbands are worn. Toner itself is expensive, and recurring toner cost is a major reason laser printers are more expensive to own and operate than inkjet and thermal alternatives, along with their higher purchase price.

Inkjet

Consistency is also the main concern with inkjet printers, whose print quality varies more widely than lasers, both from model-to-model and wristband-to-wristband. Inkjets consume ink more quickly than lasers consume toner, which means faint printing resulting from low ink occurs more often, and staff will need to replace cartridges more often. Inkjet output is also prone to smudging when cartridges are new.

Other convenience and use factors for inkjet printers are similar to lasers. Most inkjets use sheet-fed media, the effort required to switch trays and managed unused portions of sheet should be taken into account when considering ease of use.

Thermal

Thermal printers work by essentially using controlled heat to create an image onto the media. There are two thermal print technologies: direct thermal and thermal transfer. In direct thermal printing the printhead applies heat to coated thermal media, which turns dark where the heat was applied. There is no ink or toner consumable – the only supply needed for direct thermal printers is the wristband material. In contrast, for thermal-transfer printing, the printhead heats a ribbon, which transfers wax or resin to the media. The difference in print method has major implications for wristband printing. In thermal transfer printing, a reverse image of the printed output is retained on the ribbon. Therefore it creates a copy of patient data, which must be secured according to HIPAA standards. With direct thermal printing, there is no equivalent data vulnerability, which is one reason it is more commonly used for producing wristbands.

Thermal printers are ideal for specialty applications such as wristband and label printing. Their specialized nature provides some key advantages. Specialization is an advantage, because users won't waste time switching between wristband and other media. Because thermal printers are designed to support specialty media, they are compatible with durable wristband materials that can cause challenges for document-oriented printers like laser and inkjet. Thermal media enables hospitals to produce more durable, higher quality wristbands (including wristbands with embedded RFID tags) without taxing the printer. The primary limitation of thermal is the printer cannot be leveraged for document printing and other general uses.

Making the Choice

Quality is not optional for patient wristbands, but the choice of printers and other variables do impact wristband quality. Accuracy in patient dose monitoring in critical care settings requires a consistent, durable image to minimize scan time so caregivers can focus on patient care. Ask the following questions to assess the quality, convenience and operating costs of different printers that are being considered for wristband printing:

- Can the printer support media that resists processes and substances used in patient care?
- What is the total time required to print a wristband (including the time spent loading wristband media, if applicable)?
- Could wristband printing time create a bottleneck at admissions or for patient transfers?
- Do positive patient identification processes include bar code or RFID identification, or could processes be upgraded to include these technologies in the future?
- Does your healthcare organization currently have or is like to have a bar code requirement for wristbands to improve patient safety?
- Can bar codes be printed directly on the wristband, or is a separate bar code label needed?
- Does the printer support the 2D bar code formats commonly used in healthcare, including Aztec Code, Data Matrix, PDF417 or QR (Quick Response) Code?
- Does the media have a tamper-proof design to prevent fraud by patients?
- What happens when wristbands are poor quality and can't be used? Are there any special disposal steps needed to protect patient privacy?

- What is the total cost of ownership (TCO) for the printer, including wristband media and imaging supplies (toner, ink or ribbons)?

Several of the key questions revolve around ability to support bar codes. There is growing recognition that positive patient identification via bar code scanning is an important foundation for improving patient safety. The Healthcare Information and Management Systems Society (HIMSS) highlighted the fundamental role bar code wristbands can play in enabling advanced patient safety processes:

Utilizing bar code technology at the point of registration enables an organization to construct a foundation upon with to further utilize bar code technology across the continuum of patient care. By bar coding the patient wristband that must be worn by the patient, caregivers and hospital support staff can use BPOC systems to ensure that patient identification is completed before administering medications, processing diagnostic procedures or simply transporting the patient to another part of the hospital[7].

The HIMSS statement is more valid now than when it was published in 2003. Bar code use in hospitals continues to grow as more pharmaceuticals are being bar coded at the unit-of-use level, more BPOC and electronic medical records systems are implemented, and more evidence establishes the link between bar coding and improved patient safety. For example, in May 2010 the New England Journal of Medicine published a study[8] that found medication error rates were 42 percent lower and adverse drug events were reduced 51 percent when bar code technology was used with eMAR systems compared to when eMAR was used alone. There were transcription errors on 6 percent of units that did not use bar codes and eMAR, and no errors on units that used it.

Thermal printers are an excellent option for all types of wristband printing, and the superior choice when bar codes are needed.

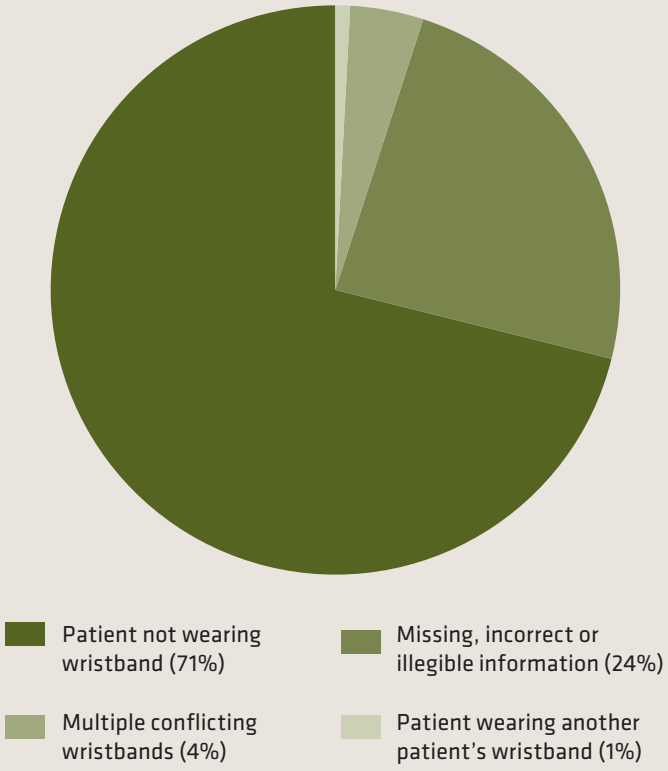
The Case for Thermal Printers

Several distinctive characteristics of thermal printers are advantageous for producing wristbands. These include support for a range of durable materials, outstanding print quality, bar coding capability, optional RFID support, reliability, small footprint, ease of use and low operating costs. Thermal printers are especially good for producing compact bar codes, including 2D symbols – advantageous for wristbands because they enable a lot of information to be included in a small space, and to be encoded to protect patient privacy. The following sections describe how these attributes apply to wristband printing and accurate patient identification.

Quality

Wristband problems can cause patient identification problems, which as noted are at the root of most medical errors. The chart below shows the source of wristband errors as identified in a College of American Pathologists study[9]. Thermal printing can mitigate some common patient identification problems, both by improving the quality of wristbands themselves, and by enabling proven patient identification processes.

Sources of Wristband Errors



Source: College of American Pathologists Q-TRACKS Study

As shown, patients not wearing wristbands, and missing, incorrect or illegible information account for 95 percent of wristband errors. Producing wristbands on thermal printers can address both these issues.

The most common wristband problem – patients not wearing a wristband – is often a quality issue. Though patients sometimes intentionally remove their wristbands, many times wristbands are missing because they fell off after becoming wet, torn or twisted. Because thermal printers are designed to handle specialty media, they can accept durable synthetic wristband stocks that resist twisting and tearing and are coated to protect against moisture and exposure to soaps, alcohol and other substances that can destroy paper. If a general-purpose document printer is used to produce wristbands, the media options are often limited by what the printer can support. This limitation may not allow users to choose the best material for usage conditions and patient comfort. Patients commonly try to remove wristbands that are tight or irritate the skin. Removing wristbands significantly raises the risk of patient misidentification.

About a quarter of wristband errors result from missing, inaccurate or illegible information. Bar coding can solve the accuracy issue, and thermal print quality can eliminate illegibility. Thermal printing produces very crisp images and can print to exact tolerances, which is why is the most widely used technology for printing bar codes, which require consistently high print quality.

7 Implementation Guide for the Use of Bar Code Technology in Healthcare. Healthcare Information Management Systems Society, 2003.
8 Effect of Bar-Code Technology on the Safety of Medication Administration. New England Journal of Medicine. May 6, 2010, Volume 362:1698-1707 Number 18.
9 Howanitz, P. J., Renner, S. W., and Walsh, M. K. (2002). Continuous wristband monitoring over 2 years reduces identification errors. A College of American Pathologists Q-Tracks study. Archives of Pathology and Laboratory Medicine, 126, 809-815.

HIMSS acknowledges some of these advantages in its *Implementation Guide for the Use of Bar Code Technology in Healthcare*, which recommends producing patient wristbands with thermal printers and quality wristband stock. Specific recommendations from HIMSS include:

- Don't skimp on the stock. The quality of wristband stock is a major satisfaction determinant for both patients and employees/clinicians.

- Print on fluid-resistant labels using thermal printers. The use of inkjet printers can result in smearing that will be problematic for scanners at the bedside.

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. Consistent print quality is only one of the advantages associated with thermal printers.

Reliability

Thermal printers are known for their reliability and long lifecycles, which reduce TCO. Thermal label printers should be expected to last many years, which creates a favorable amortization period for the initial investment. Some thermal printhead manufacturers warranty the printhead for 1 million inches, which is enough for at least 100,000 wristbands.

Convenience

There is no question that direct thermal wristband printers are more convenient to use than lasers or inkjets: there is no toner or ink to replace, and users will not have to switch media between wristband material and document paper. The question is whether the convenience of having a dedicated wristband printer is worth the cost. That question is best answered by assessing how the time saved can impact productivity for admissions staff and others who produce wristbands, and whether it can reduce delays and improve patient flow. With a dedicated thermal printer, wristbands can be produced quickly on demand, with no delays while the printer is set up for wristbands. As HIMSS notes:

Underestimating the equipment requirements needed to support the registration process will ultimately lower employee and patient satisfaction because that will cause increased waiting times during the registration process.

Other thermal printer advantages that support user convenience include easy loading, roll-fed media, native support for bar code printing with no font or firmware updates required and sensors for proper printing alignment, eliminating costly media waste. Plus, many thermal printers are designed specifically for space-constrained environments and offer near-silent operation.

Deployment and set-up is simple, and with a wide range of connectivity options, thermal printers can connect with existing network infrastructure while adhering to wireless LAN and other security standards. Many thermal printers can encode RFID wristbands for secure, wireless patient identification. Mobile thermal printers are also available, which would be convenient for producing wristbands in disasters and other patient-surge situations.

Cost Effectiveness

Convenience helps make dedicated thermal wristband printers cost effective, and low operating cost is another major contributor. To determine the cost value of convenience, compare the time it takes to produce a wristband with a dedicated thermal printer compared to a multipurpose laser or inkjet, multiply the time difference by the number of wristbands produced per day, and multiply that sum by the hourly wage rate for personnel who produce wristbands. It is often cost effective to save time for busy admissions staff and caregivers by supporting them with a dedicated printer.

For example, if a hospital averages 40 admissions per day and it takes 45 seconds each time to set up a laser or inkjet printer to produce a wristband, the hospital spends 30 minutes a day on setup. Multiplying by 365 days in a year produces 182.5 hours annually spent on setup time. If the admissions personnel makes $20 per hour (equivalent of a $40,000 annual salary), setting up the document printer to produce wristbands results in $3,650 in annual labor cost, which far exceeds the cost of purchasing a thermal printer dedicated to wristband printing. This calculation does not reflect the full labor cost associated with using laser and inkjet printers, because it does not account for time spent changing toner and ink.

While wristband media costs are comparable for laser, inkjet and thermal printers, many direct thermal printers feature the total lowest cost per wristband because there are no added expenses for toner or ink. Thermal transfer printers may not have a supply cost advantage because of ribbon expense.

There is also a cost benefit associated with wristband quality. This paper has documented the quality advantages that producing wristbands with thermal printers can provide. It has also documented the relationship between wristband quality problems and medical errors. High print quality reduces the risk of an illegible wristband, which in turn reduces the risk of a medication error, adverse drug event or other patient safety problem. The cost savings from avoiding having to treat a single medical error or malpractice claim would be enough to equip multiple departments with their own thermal wristband printers.

Conclusion

'Improve the accuracy of patient identification' remains the top National Patient Safety Goal, and for many healthcare providers it remains elusive. With patient misidentification the root cause of 72 percent of adverse events, improving patient identification clearly provides a strong opportunity to improve patient safety. Improving patient identification can be as simple as improving how wristbands are produced, by using printers and media that are optimized for wristband printing. Thermal printers can help prevent the leading wristband quality problems that lead to patient misidentification and compromise patient safety.

With safety and quality of care depending on accurate patient identification, wristband system components must work together flawlessly. Intermec printers and media, including the compact, easy to use PF8d direct thermal printer with INband wristbands, are optimized to deliver superior performance when used together. Our rigorous testing and co-engineering ensures consistently high print quality, proven performance in demanding real-world healthcare environments, and maximum printhead service life for reduced downtime.

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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