Technology Options for Healthcare Color Label & Wristband Printing

Overview

Color has earned a permanent place in healthcare processes because it has proven to be an effective enhancement to labels, files, forms and wristbands. Selective, appropriate use of color can enhance patient safety by providing an extra visual reminder to differentiate potential lookalike or soundalike medications, highlight dosages, dietary restrictions, allergies and other alerts, and to easily identify specimens to streamline sorting and prioritize processing. Color on files, records, specimen labels, test orders, meal tickets and other documents also supports more efficient workflows.

The value of using color is much more clear than determining the best way to create color. Typically, inexpensive office and consumer printers are slow and do a poor job of handling label and wristband media. Inkjet printers produce outstanding color output, but haven't traditionally been used for labeling, while thermal is a leading label printing technology but can't easily produce color. Laser printers excel at document output, but have limitations that make them inappropriate for precision color and barcode printing. As a result, many healthcare organizations use a variety of preprinted color media with laser and thermal printers. This satisfies color requirements, but provides little flexibility for selective color enhancement, and creates the need to order, store and manage multiple inventories of materials. Quality can also suffer, because consistent registration of the variable information printed in specific pre-printed color fields is unreliable.

This white paper highlights how color is commonly used in healthcare environments, explains the advantages and limitations for each printing and labeling technology for these use cases, and provides guidance to help healthcare organizations decide which technique is best suited to their workflows, user needs and IT environment.

Color has earned a permanent place in healthcare processes.

Color Uses, Effectiveness Run the Spectrum

There are many proven ways to apply color to improve processes. For example, the Agency for Healthcare Research and Quality (AHRQ) report, *Mistake-Proofing the Design of Health Care Processes*[1] cites multiple examples of how color enhancement and color coding can be effectively applied to protect patient safety, prevent errors and make processes more efficient. In practice, color is commonly used in three general ways in healthcare environments:

Color coding and color enhancement help facilitate patient safety.

• On wristbands to highlight allergies and other warnings or special conditions
• On labels applied to specimens, medications and supplies
• On labels applied to patient records, test results, meal forms and other documents

There are many variations to these common uses, and each has its own material needs and printer requirements. For example, laser printers are impractical for label-intensive applications, because they must be sheet fed, which makes for inefficient use of materials, and because label media tends to jam the printer. However, laser printers are often an outstanding option for document printing. Processes that require both information and color to be produced on demand require inkjet, which is the only technology capable of doing so.

It is important to differentiate between color *enhancement* and color *coding*. Color enhancement for wristbands and labels can be very effective for reinforcing warnings and special needs related to patient care, and to streamline processes for sorting and processing samples. Color coding has produced decidedly mixed results, with some studies suggesting excessive use of color or over reliance on it can contribute to errors.

There is agreement that color enhancement is more effective than color coding. For example, several experts who testified at FDA hearings on the use and value of color for pharmaceutical labeling reinforced the distinction between color coding and color enhancement and expressed their preference for the latter. American Society of Health-Systems Pharmacists (ASHP) Vice President Charles Myers said the organization opposes dependence on color to identify drugs (e.g. mandatory

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[1] John Grout, PhD, "Proofing the Design of Health Care Processes", for the Agency for Healthcare Research and Quality, US Department of Health and Human Services, May 2007.

color coding), but: "*… color differentiation could be an effective tool to make information on drug labels stand out.*[1] "At the same meeting, Institute for Safe Medical Practices (ISMP) President Dr. Michael Cohen made several recommendations[2] regarding the use of color, including:

> "Because color enhancement is variable and selective, it is highly desirable to be able to produce color on demand."

- Color can be used successfully to differentiate products, to draw attention to important information or to enhance recognition of unique letter characters.
- Reserve color coding for only high-alert drugs such as insulin, neuromuscular blockers, and concentrated electrolytes but only after testing and feedback about prototypes.
- The use of color may be effective, but only when it's one of several different variables.

Color enhancement applications necessitate the selective use of color. Not every wristband, specimen label, etc. will have color on it. This is an important fundamental difference from color coding, which requires color on every item, and thus requires the healthcare facility to maintain multiple color media stocks. Because color enhancement is variable and selective, it is highly desirable to be able to produce color on demand.

General Printer Considerations

It is important to understand how various printer and media features, performance specifications, print methods and other differentiators translate into the actual user experience and system reliability. For example, a printer that produces a crisp wristband may not support material suitable for producing sample labels that will be exposed to sterilization processes or cold storage. The printer that best fits into the healthcare information system may not work best for the caregivers or medical technicians who have to use it on the floor. The following sections introduce these and other important performance considerations and evaluation criteria, and are followed by sections that detail the specific pitfalls associated with each printing and labeling option.

[1] "Meeting Summary: Use of Color on Pharmaceutical Labeling and Packaging Part 15 Hearing," U.S. Food and Drug Administration, March 7, 2005.
[2] Ibid.

Print Quality

Labels and documents that are unclear or illegible create unacceptable risks in patient care and clinical settings. Unfortunately, label quality can't truly be determined by the naked eye. Most labels look fine when they come out of the printer unless there is a major obvious flaw, such a void running through the label caused by a wrinkled ribbon. A perfectly legible label may have quality problems lurking, which typically don't arise until after the label is put in use.

For example, low-quality printers and media, or mismatches between the printer and label material, produce labels that can quickly fade. Exposure to conditions and materials common to healthcare environments, such as fluorescent lights, saline, alcohol, etc., can hasten the fading process. Fade resistance is an especially important concern in color applications, because a faded image could be misinterpreted as another color (which is another reason color enhancement is favored over color coding). Fade resistance is also important for labels used on specimens, charts and other items that will be stored for a long or indeterminate amount of time.

Barcode usage is growing steadily at both the pharmacy and point of care.

The sharpness and precision of the printed image itself also plays a role in the effectiveness of label-based healthcare processes. Barcode adoption is growing steadily for dispensing both at the pharmacy and at the point of care, and for file and records tracking, specimen identification, materials management and other uses. Barcodes must be produced to very demanding specifications for the widths of bars and spaces (which are measured in mils, or thousandths of an inch) and for the contrast between dark (bar) and light (space) elements. Printers developed for text-intensive document output often can't satisfy these requirements. Similarly, printers that produce acceptable traditional linear barcodes may not provide the same quality and reliability for two-dimensional (2D) barcode formats such as PDF 417, Data Matrix and Reduced Space Symbology (RSS), which are increasingly used for unit-of-use labeling, specimen tracking and patient wristbands.

Poor quality barcodes usually fail to scan, requiring workers to fall back to time-consuming and error-prone manual recording processes. Print resolution is measured in dots per inch (dpi), which is generally a good predictor of the ability to create sharp images and readable barcodes, with higher numbers indicating higher resolution and quality.

Media Support

Print quality is highly dependent on media. Label material that is poor quality or not matched to the usage environment will undermine print quality and create the possibility of unreadable, unidentifiable samples, wristbands and documents.

Assessing material quality is not a straightforward task, because the media must be matched to the environment. Labels differ by much more than their size, shape and color. Important variables include the adhesive and the substrate that the image is printed on. For extreme environments, any substrate is likely to need a protective coating or overlaminate. The adhesive, substrate and coating must all be optimized for the use case — the combination that is best for printing a prescription label is not also best for identifying a specimen container that will be sterilized at high temperatures and later placed into frozen storage. Label media is formulated to provide different resistance to temperature extremes, moisture, humidity, bacteria, blood, alcohol, saline and other liquids, UV exposure and other environmental factors. The printer must be able to support the required media, and ideally a range of media, if the printer will be used to support multiple applications.

Ease of Use

Ease of use contributes directly to productivity, so it is important to understand the time requirements that different printer types will impose on nurses, pharmacists, technicians and other users. Printer features should minimize time users spend loading media, clearing jams and other routine troubleshooting. Media capacity is also an important product differentiator — the more material the printer can hold, the less time users will spend on reloading it, and the less time will be wasted waiting for output when the printer is empty. Some printers are much easier to load than others, which is another ease-of-use consideration. In addition, the printer size, or "footprint" is often an issue because available space is usually limited.
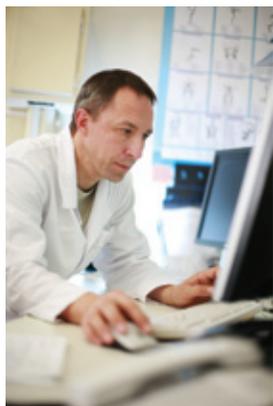
The ability to produce color on demand adds to ease of use. Printers that can't produce color on demand must use preprinted color media. Each time a color output is required, the user must select the appropriate media stock from storage and load it into the printer. Each label produced may require a media change. The ability to produce color on demand eliminates the need for these time-wasting media changes, because the printer has the ability to create color fields, and can apply different colors to multiple fields in a single pass, using a base stock that can support multiple print jobs. In many cases, multiple printers are used side-by-side

> "The ability to produce color on demand eliminates the need for time-wasting media changes."

to accommodate different colored pre-printed color label stock, for example a lab may have various colors for various high priority "stat labels." This approach saves media changing time, but drives up total cost of ownership because multiple printers must be purchased, installed and supported.

IT Compatibility

Label printers are not equally easy for IT staff to configure, integrate and support. For example, laser and inkjet printers use standard, common command languages, which makes it fairly easy to integrate them with healthcare information systems and other existing enterprise applications. In contrast, each brand of thermal printer has its own proprietary command language, which necessitates custom label and interface development and/or additional software applications so the printer can output variable information held in existing IT systems. This effort and expense often makes it cost prohibitive to install printers from another vendor, which discourages comparison shopping and creates a long-term commitment to the original supplier. Proprietary technologies are also harder to integrate into IT asset management applications, which can create dangerous blind spots.

Printers with standard interfaces and network connectivity can be included in management applications so administrators can remotely monitor their status, update configuration settings and perform routine maintenance and troubleshooting to prevent downtime. System administrators can receive immediate notification of problems and potential problems, such as when media is running low. Without these capabilities, printers that go offline or stop their print queues because they are out of media may go undetected, causing delays in the ability to create labels, which impairs productivity in all instances and could impact patient safety in point-of-care and clinical operations. Most leading thermal printers provide for this remote management.

Label printers must be easy to integrate into healthcare information systems.

Total Cost of Ownership (TCO)

The differences in how printers work and how users interact with them leads to distinct differences in total cost of ownership. Given the difficulty in maintaining staffing levels, features that save time for nurses, pharmacists or IT support staff are very valuable. To maintain uptime and productivity, printers should be monitored continually through an automated management application. Printers used for specimen labeling and other high-volume operations may need their media to be reloaded every day. The time required for these simple operations is a major variable

Healthcare Color Label & Wristband Printing

in TCO. Enterprise-class printers should be expected to last more than three years in healthcare environments, so features that support day-in, day-out time savings can easily offset any differences in the printer purchase price.

Supply costs are other major TCO factor, and are a major differentiator among print technologies. Preprinted media carries a hidden cost because materials managers must spend time maintaining accurate inventory levels of all configurations so there are always adequate stocks of all the color combinations and label sizes used. On-demand color printing greatly simplifies the materials management task. Organizations should also consider how efficiently each printer type makes use of consumables such as ink, toner, ribbon and label material.

Printer Technology Options

In healthcare environments, where workspaces are tight, labels are small and users are extremely busy, no printer type has been considered the top performer for all the major criteria: print quality, media support, color capability, ease of use, IT compatibility and TCO. As a result, adding color to support processes has required tradeoffs between performance, convenience and cost. The necessity of tradeoffs has also been a significant barrier to adoption — specialized label printers traditionally have been more popular with professionals responsible for patient care and clinical operations than with those responsible for IT support.

Printing technology continues to mature and improve, which reduces some barriers to adoption and introduces new considerations. The following sections provide capsule overviews of the current state of color output options, and highlight issues specific to healthcare users.

Color Laser Printers

Color laser printers provide the convenience of on-demand color printing and remain a good option for document-intensive use. Color laser technology is well supported by healthcare information systems and is familiar to IT departments. The primary limitations for color laser printers in healthcare environments are media support and cost. The most obvious drawback is the need for sheet-fed label media, which often makes inefficient use of materials. However, the bigger restriction is the limited range of label materials that color laser printers can accept. Many labels with the specialty coatings and adhesives required for healthcare use aren't available for color laser printers, and the printers themselves are prone to jam when thicker and

COLOR LASER PRINTERS

Pros
- Color on demand printing
- Supported by major health-care systems
- Support high-volume printing

Cons
- Require sheet-fed label media
- Limited support for label materials
- Relatively high cost
- Waste many labels from sheet-fed labels

adhesive media is used. The unavailability or incompatibility with materials that maintain image quality after exposure to moisture, liquids and temperature changes relegates color laser printers to general-purpose document printing applications. Other disadvantages when compared to thermal printers are their size and the relatively long time they require to output the first label after receiving the print command.

Thermal Printers

Thermal printers enjoy the widest range of supported materials and can be used for a multitude of specimen labeling, patient identification and general-purpose labeling needs. It is important to note there are two types of thermal printing technology, direct thermal and thermal transfer, and there are important distinctions between them.

Direct-thermal technology is commonly used in fax machines and receipt printers. It requires chemically treated media, which darkens when heat from the printhead is applied.

Thermal-transfer printers use a ribbon to produce the image. The printhead applies heat and pressure to the ribbon, which melts the imaging material onto the media. Thermal-transfer printers produce more durable and long-lasting images than direct-thermal models. Thermal transfer fell out of favor with many healthcare organizations after HIPAA took effect because a negative of the printed image is retained on the ribbon, which creates a privacy vulnerability.

Most direct thermal and typical thermal transfer technology cannot produce color on demand. Color on demand is available with more expensive four-color thermal-transfer printers. Color thermal transfer models tend to be much larger than regular thermal printers because they may have to accommodate four ribbons. They can also be more complicated to use (some use a single ribbon with multiple colors). In either case, color thermal-transfer printers are more expensive and more complex (e.g. they are more difficult to reload correctly) than common monochrome models.

The standard resolution for thermal printers is 203 dpi, which is usually adequate for producing barcodes and other high-quality images. Thermal printer manufacturers also offer higher-end 300 dpi and 600 dpi models, which are often recommended for producing small labels (such as unit of use barcodes or small specimen labels) and 2D barcodes. Higher-resolution printheads add to the cost of the printer, so required resolution must be taken into account.

Thermal printers are fairly easy for operators to use, but require specialized support. As noted previously, thermal printers use proprietary command languages that are not widely supported in operating systems, IT management applications, or healthcare information systems. As a result, system administrators usually need to learn a new printer language and use additional labeling software to create the labels and interfaces needed to enable output from existing computer systems. The need for additional software, or assistance from a systems integrator, should be factored into TCO calculations.

Inkjet Printers

Inkjet printers are the most widely used technology for color document printing but have not been widely adopted for specialized healthcare applications. The broad inkjet printer category, which ranges from entry-level home document printers to high-quality models that rival digital offset printers for top-quality forms and documents, now also includes models specifically developed for healthcare label and wristband printing. Inkjet is easy to work with for users and IT support staff in general, and also offers several specific advantages for healthcare label and wristband printing.

Flexibility is the largest differentiator between inkjet and other technologies for healthcare labeling. Like thermal, enterprise-class inkjet label printers can accept a broad range of media (including wristbands) suitable for use in healthcare processes. Like color lasers, inkjet also provides the flexibility to produce color on demand. Color can be applied anywhere on the label or wristband, and the use of colors and symbols can vary from label to label without having to change media. Flexibility also extends to printer management, because inkjet printers usually operate through Windows drivers and are natively supported by most IT management systems, making it easy to add printers to networks and manage them remotely.

It is inaccurate to make generalizations about inkjet quality because of the broad range of product options. General-purpose inkjet document printers will not generally provide the image durability needed to support specimen identification and patient wristband applications, particularly if the printed output will be exposed to moisture, sterilization, temperature extremes and other challenges. Enterprise-class

inkjet label printers with permanent pigmented inks provide high-quality output and support the media needed for patient care and clinical uses. These printers produce precise colors and are fully capable of traditional and 2D barcode printing.

Enterprise, commercial-grade inkjet label printers, however, cost significantly more to purchase than general-purpose models. Despite this higher purchase cost, inkjet label printers have lower total cost of ownership over general-purpose inkjets and other printing technology options. In the most common forms, inkjet labels are actually less expensive than direct thermal labels. Inkjet media does not require a top coat of thermally active material as with direct thermal labels. However, ink used in printing does add cost, making the total label cost above that of a thermal label. The trade-off is having color applied systematically or requiring human intervention to change labels. Commercial-grade inkjet label printers use different ink cartridges than the more common inkjet printers. Some are designed with higher capacity ink cartridges that hold 5 to 10 times more ink than consumer-grade cartridges, but are priced 2-3 times below consumer cartridges. Because users are familiar with inkjet printers and can easily change ink and media themselves, there is less training and productivity loss associated with the technology.

Preprinted Media
Preprinted media is not a technology per-se, but its ease of use, TCO and quality can be compared to the laser, thermal and inkjet options for color output. Organizations should have no problem finding high-quality preprinted color media to meet their labeling and wristband needs. Major suppliers offer thousands of color, material and size options. No material or color is best for all the use cases within an organization, so finding the best combination of quality and cost for each is simply a matter of matching the material to the application.

"The more pre-printed materials and sizes organizations use to meet their needs, the higher the total cost of ownership."

The more materials and sizes organizations use to meet their needs, the higher the total cost of ownership. The TCO associated with using preprinted materials may be hidden because preprinted materials are so common and ingrained in processes. Materials managers shop to get the best prices on media, but organizations often overlook the labor time and cost associated with monitoring stock levels for dozens or hundreds of labels, stickers and forms, filling out orders and restocking supply rooms, plus the space itself required to maintain materials inventory. Since an order for a particular label size must be broken up into smaller quantities of multiple colors, purchasing pre-printed stock carries a hidden price of multiple press

changes, and with that higher costs. Blank labels of a given size or pre-printed only with a logo require no press changes, thus saving money.

There are also productivity issues associated with preprinted media in patient care and lab settings. The growing trend toward color-enhancement applications means color is used selectively. Which color is used, and even the presence of color at all, often depends on variables that are specific to each patient. This doesn't pose a problem for printers that can produce color on demand. If pre-colored media is used, the material can't be preloaded into the printer, because the use of color is specific to each label or patient. That means users may have to load media each time they produce a label or wristband, which increases the labor costs for each output.

IT support requirements are relatively the same whether color output is achieved through preprinted media or by printing on demand. Some departments have multiple printers, each loaded with a different color label. This practice is more expensive and still prone to human error. The right stock needs to be loaded and the right printer selected to print a particular color label. Color on demand allows a system to apply color from a database, eliminating the complexity of roll changes and the risk of selecting the wrong label.

Conclusion

Color can be an effective resource to improve the quality of care by enhancing patient identification, reinforcing alerts and warnings, streamlining specimen management and enhancing other processes. There are many beneficial ways to use color labels and wristbands in healthcare and there have been many ways to produce them, though all current methods have drawbacks. Preprinted media was developed for specific healthcare needs and environments, but lacks flexibility. Traditional on-demand print technologies provide flexibility, but have been lacking in color and media capabilities. The best output option for each specific process depended heavily on the label or wristband materials required, the frequency that color was used, the range of colors and color locations needed, and the required barcode support and print quality. Printer and media options vary widely in these capabilities, and also in their ease of use and support requirements.

BENEFITS OF COLOR

- Highlights patient information
- Reinforces alerts and warnings
- Streamlines specimen management
- Helps reduce mistakes, hence lowering risk

Epson's Color-On-Demand Solution for Healthcare Color Label and Wristband Printing

Using its extensive expertise in printing and advanced color inkjet technology, Epson has developed SecurColor™ printers, the first inkjet printers that specifically address the needs of healthcare organizations and their color printing challenges. With SecurColor you no longer have to choose between the flexibility of producing color on demand and the durability provided by preprinted color media, or between the ease-of-use of familiar print technologies and the barcode and material capabilities of proprietary thermal printers.

Epson SecurColor printers can produce thousands of colors on demand, accept a range of durable media from 1.2 to 4.4 inches wide, offer user-selectable resolution of up to 720 dpi and support leading barcode formats. They also come with USB 2.0 or Ethernet interfaces to connect to existing information systems and are controlled through an easy-to-use Windows driver.

To find out more about SecurColor inkjet printers and how Epson can help you meet your color on demand printing needs and reduce your costs, email us at SecurColor@ea. epson.com or go to pos.epson.com/securcolor.

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