Medication tracking is more regulated than it is accurate. One in five medication doses administered in hospitals or skilled nursing facilities in the United States is given in error, and at least 7000 Americans die each year from preventable medication errors (1, 2). These statistics motivated FDA to announce proposed new rules in March 2003—with the final rules expected by the fourth quarter of this year—to require bar code identification on unit-of-use pharmaceutical packaging. Bar codes provide a highly accurate, reliable, and proven way to improve patient safety through automated control systems.

Benefits beyond the bedside tend to get overlooked in the passionate discussions about the need to improve patient safety and the burden that unit-of-use labeling places on manufacturers. Ironically, it is the pharmaceutical manufacturers themselves who are best positioned to gain immediate and sustainable benefits from automatic identification at the unit-of-use level. Besides planning to meet FDA compliance requirements, manufacturers should take a fresh look at their own business processes to find ways to leverage label changes to bring new levels of control to their operations.

“Why do most manufacturers in the consumer goods, grocery, automotive, and other industries apply a standardized product ID bar code? Because they have to,” says Bruce Philpot, managing director of the Center for Automatic Identification at Ohio University (Athens, OH), a leading research and educational organization that has taught thousands of professionals and students in many disciplines about how automatic identification technology can be applied to improve their industries. “However, nearly every company that was forced into bar coding by their customers or some other mandate has learned the lesson that the company can keep much better track of production, inventory, and productivity if it uses the bar codes it prints,” Philpot continues. “The pharmaceutical industry has a unique opportunity to grab these benefits right up front rather than to just manage this like a compliance requirement.”

The benefits that can be gained from item-level control include reduced materials and finished-goods inventory requirements, automated compliance with the reporting requirements of 21 CFR Part 11 (electronic signatures rule), improved compliance with the Prescription Drug Marketing Act and sample...
management rules, fulfillment of FDA good manufacturing practices and greatly streamlined recall management. To achieve these benefits, however, companies must have a thorough understanding of the information-encoding options that FDA has proposed, technologies for printing and reading bar codes, non-bar code alternatives, and how specific business processes could be improved with a more granular layer of information.

Data and symbology options
The bar code symbol and the data encoded in it are related but must be considered separately to choose the optimal bar code symbology, content, and printing method for unit-of-use labeling. Bar codes are data carriers, like CD-ROMs, in which many different types of data can be stored. Data structure refers to the information content, how it is organized, and how it is presented. The FDA proposal specifies the national drug code (NDC) as the minimal requirement for data content and permits the lot or batch number and expiration date as optional data that may be encoded. FDA further recommended that companies follow the international EAN.UCC data structure for encoding NDC. The use of the EAN.UCC format, developed by the voluntary standards organizations EAN International and the Uniform Code Council, Inc., is strongly endorsed by AIM Global (Warrendale, PA), the trade association for the automatic identification and data capture (AIDC) industry.

FDA was less specific about what symbologies, or types of bar codes, may be used as the data carrier. The proposed rule only specifies the use of linear symbologies, which rules out the use of two-dimensional (2D) symbologies such as Data Matrix that some pharmaceutical manufacturers already use. FDA also recognized the potential value of using radio frequency identification (RFID) technology as a data carrier. RFID tags can easily hold any possible data requirement and save precious label space because they can be overprinted. However, FDA will not allow RFID to be used instead of bar codes in its first rule, and current technology is probably more appropriate and cost-effective for case- and pallet-level identification.

According to Dave Shoemaker of Checkpoint Systems (Thorofare, NJ), a provider of product identification and shrink management solutions, there is future value to unit-of-use labeling with RFID. "RFID could be used with bar codes to add a level of security for certain items like OxyContin," he says. "With RFID and smart shelves, you could automatically create a record that showed OxyContin left the shelf 22 times that day, but there were only 18 prescriptions. With RFID identification cards you could even know who picked them up."

To satisfy current requirements, there are hundreds of linear bar code symbologies that can encode an NDC, but relatively few are used commercially or are even viable options. Some symbologies are much more space efficient than others, and some are impractical for encoding lot codes and expiration dates. As a result, the list of appropriate symbologies for unit-of-use bar coding is actually quite short. It includes Code 128, which is the standard for blood-product labeling; Code 39, the most-used symbology in the industry; and the reduced space symbology (RSS) family, a relative newcomer that was created specifically to provide a means to automatically identify single-dose pharmaceuticals and other small items. Each symbology is backed by international standards and supported in multiple commercial products. Manufacturers should not assume that encoding lot numbers and expiration dates is space-prohibitive. RSS, for example, can encode NDC and this variable information in less space than other popular symbologies require for encoding NDC only. If FDA in its final rules specifies that the international EAN.UCC data structure formats must be followed for encoding NDC, it is anticipated that the appropriate symbologies will be limited to the codes that are part of the EAN.UCC system.

"The unit-of-use labeling challenges for manufacturers are space, space, and space," says Ed Dzwill, manager of packaging development for pharmaceutical and biologic products at Johnson & Johnson (New Brunswick, NJ). "Then it's symbology. We just can't be sure how FDA will rule."

Despite the many options, choosing a symbology will not be difficult once manufacturers decide what content they want to encode and review the packaging space available. Repackagers, distributors, and healthcare providers are all affected and should be engaged in the label-planning process. "To make the right symbology choice, companies must consider how the label will be used in the supply chain, right down to the unit-of-use event," says John Ingerslew, vice-president of sales at Data2 (St. Peters, MO), a preprinted label service bureau. Ingerslew also disputes the notion that variable information won't fit on packaging labels—his firm successfully created tiny bar code labels that were affixed to the backs of honeybees to automatically collect data for a scientific study.

Sarah Schabacker, business development manager at Datamax (Orlando, FL), a thermal label printer manufacturer, also believes that including variable data is the best option. "It is more cost-effective to change printing operations once to support variable data up front rather than to just begin printing NDC and changing again later," she says. "Do it once. It's a larger project, but it will be worth it."

Reading options
Another erroneous assumption is that most currently used bar code readers can't handle additional data content or newer symbologies. Most bar code readers used for point-of-care applications today are lasers, wands, or charged-coupled devices (CCDs). Each type of reader has limitations and none can read every type of 2D symbology. The 2D symbologies were ruled out because of FDA concern that many existing readers are not capable of reading 2D data. Laser and CCD readers have some 2D reading capability and can process any of the linear symbologies under consideration. Most units manufactured in the past five years can also be conveniently upgraded to support additional symbologies.

Imaging bar code readers can read all types of 2D and linear bar codes and can also function as digital cameras to capture signatures or other images. Imaging bar code readers were initially very expensive, but technology advances and economies of scale resulting from the shared components used in digital cameras have made imagers less expensive now than they were 10 years ago, according to Rob Hussey, image technology manager of...
Hand Held Products (Skaneateles Falls, NY), a manufacturer of bar code imagers and other data collection equipment.

All bar code scanners have autodiscrimination, which enables them to determine which symbology is being used so the bar code can be decoded properly. Autodiscrimination will enable hospitals, distributors, repackagers and other members of the supply chain to easily process pharmaceuticals marked with different symbologies from different manufacturers.

"Once the symbol is chosen and deployed, ensuring it reads from the point of manufacture to when it is administered is crucial," says Peter DiMaria, founder of Accu-Time Systems Inc. (Ellington, CT), a manufacturer of high-speed printed-matter controllers for verifying bar code and RFID unit labels. "It would be disappointing, even disastrous, to put all the time and effort into reducing or eliminating errors if the bar code will not read or, worse yet, the wrong label gets applied."

Ensuring 100% source labeling makes good sense for pharmaceuticals as well as cosmetics, vitamins, and other precision consumer products. Devices to monitor the point of manufacture are available and can accommodate small, high-speed automated packaging equipment. Because the technical capabilities of bar code readers put few limitations on symbology selection, equipment choice should once again be guided by application needs.

Printing options

Bar code readers can effortlessly process all the possible combinations of symbology and data content options FDA may allow, but the variables have a significant effect on printing operations. Pharmaceutical manufacturers must modify packaging lines that may currently produce 400 labels/min to accommodate printing a tiny bar code on each pill package to exact specifications so that the symbol will remain readable at the point of care after traveling through production, packaging, and logistics processes. Success will take planning, but much of that may be educated guesswork because there is no certainty about what content FDA will require or what symbologies it will allow. Thermal printing is the most common method of producing bar codes across all industries but is seldom used for pharmaceuticals because of its relative slowness for packaging applications.

The challenges described previously give a good indication of why unit-of-use bar code marking is not widespread. However, each of the challenges has been overcome in the market, and there are several proven strategies manufacturers can follow.

"It is nearly trivial for manufacturers to add a fixed data field to any unit-dose packaging," says Sprague Ackley, staff technologist for Intermec Technologies (Everett, WA). Ackley holds numerous bar code patents, has helped create some of the most widely used bar code standards, and is well known in the bar code industry. "But the whole thing changes when you get to variable data such as lot codes or expiration dates."

RSS is the most space-efficient linear symbology for encoding NDC numbers and for optional lot-code and expiration dates. However, few printing presses, ink-jet coders, or other print technologies used for pharmaceutical packaging currently support RSS. Some of these print technologies may be challenged to produce small bar codes that conform to published quality standards and also may need to run at significantly lower speeds to process and encode variable data.

"To get the quality that’s needed, you really have to use thermal," says Ted Kruse, president of Unibar (Rochester Hills, MI), a bar code labeling company that has developed several software packages to simplify complex bar code printing requirements. Thermal printing excels at producing high-quality variable information bar codes and could readily meet unit-of-use size and quality requirements. The drawback is that the fastest thermal printers top out at a maximum print speed of 12 in./s. "People have been looking for a better way than thermal transfer to print bar codes since the late 1970s, and they haven’t found it yet," says Bob Karr, vice-president and marketing manager at SATO Amer-
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Dzwill says Johnson & Johnson may not try to print bar codes at all and will give serious consideration to preprinted labels instead. Preprinted labels provide excellent quality and reliability, especially for small labels. Because they cannot be produced on demand, preprinted label inventories must be managed carefully to ensure material is on hand to mark product when it is packaged, especially if lot numbers and expiration dates are included.

Dzwill says that space is not the final frontier for successful unit-of-use labeling. “We’re doing testing and we’ve put RSS symbols on vials of Procrit,” he notes. “If we can preprint RSS there, we are encouraged that we can put it on other products.”

Other manufacturers have solved the space issue for variable information encoding. Pfizer, for one, has publicly committed to encoding NDC, lot number, and expiration date at the unit-of-use level. There are at least three good reasons for providing this level of identification detail. First, according to FDA data, an average of 3.9 Type I and Type II recalls were issued per week between 1997 and 2002. Second, the Healthcare Distribution Management Association (HDMA) estimates the industry processes $2 billion worth of returns annually (3). Lastly, 5% of all medicines are counterfeit, according to the World Health Organization (4). Encoded lot numbers and expiration dates could enable many automated processes to improve these problems through better tracking.

“FDA is taking an important first step in requiring the NDC at the unit-of-use level,” says Debbie Murphy, life sciences market development manager for thermal printing solutions provider Zebra Technologies (Vernon Hills, IL). “On the basis of our work with customers in all segments of the life sciences supply chain and different industry associations, we feel strongly that encoding the optional information would greatly reduce the administrative challenges and liability exposure that currently burden the industry.”

“The more information that you can get into a bar code, that’s ultimately the best solution,” says Rosalyn Ben-Chitrit, director of healthcare business development at label and printing systems supplier Avery Dennison (Pasadena, CA). “I think it’s going to be really important to have the optional information. When you distribute all these unit doses, how else can you track what lot they came from? When it comes to recalls, it’s really imperative to have that information.”

Tracking that’s good enough today may not be good enough in the near future. Pharmaceutical manufacturers whose products are sold over the counter at Wal-M art stores will have to apply RFID tags to their cases and pallets to satisfy the retailer’s latest logistics tracking mandate.

“Wal-M art is the best in the world at logistics and cost-efficient operations. They wrote the book. But they’re saying what they do is not good enough,” says Liz Churchill, director of marketing for RFID-solution manufacturer Matrics (Columbia, M D). “It will be the same for pharmaceutical manufacturers. They will find a way to leverage the work that’s been done in the other consumer goods industries to improve visibility and accuracy in the pharmaceutical supply chain.”

Fortunately, other industries that struggled with major compliance labeling mandates have put the troubles behind them. “The first people who put universal product code (UPC) symbols on products did it kicking and screaming,” says Ackley, recalling a compliance labeling parallel from more than 25 years ago. “It took a few visionaries in the industry, and it took a long time, but it’s something we all benefit from today.”

There is a tremendous body of resources available to help the pharmaceutical industry take advantage of unit-of-use coding. There are unique challenges in the pharmaceutical industry, but similar challenges have been solved before. AIM and its members have helped the electronics, retail, telecommunications, and automotive industries, and the Department of Defense, with a variety of auto-identification programs and have been very proactive in anticipation of the FDA proposal.

When pharmaceutical unit-of-use labeling does take hold, FDA estimates that 50% of medication errors will be intercepted if bar code scanning is used at patient bedside. Professionals experienced with bedside scanning applications feel the FDA estimate is low and note that the Department of Veteran’s Affairs (VA) hospital system reduced medication administration errors by 86.2% after it completed a project to scan medication at the patient bedside at all facilities. The results of unit-of-use bar coding are clear, and with the help of the AIDC industry the means of attaining them will be too.

Further information
This article was prepared by AIM Global, the global trade association for the Automatic Identification and Data Capture industry. AIM members are manufacturers, service providers, or users of technologies such as RFID, bar code, card technologies (e.g., magnetic stripe, smart card, contactless card, optical card), biometrics, and electronic article surveillance (EAS). For more information about AIM, including its official response to FDA’s proposed rule, visit www.aimglobal.org. Learn more about the FDA proposal by looking up docket number 02N-0204 on www.fda.gov.

References