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Validating Medical Orders with Barcode and Optical Character Recognition

Minimizing the risk of populating the wrong patient data in
pharmacy workflow systems

November 2008

Abstract

Image based medical order (MO) management systems for hospitals have been available for several years. Their fundamental purpose is to display an electronic image of a hand-written MO to pharmacists and/or pharmacy technicians. Several benefits result from this type of implementation. Paper is eliminated, lost orders are minimized and efficiency is improved. One feature of these systems is their ability to read barcodes. Typically, patient labels are printed when a patient is admitted and placed in the patient's chart. When a physician writes an order, a label is affixed to the order before it is either scanned or faxed to the pharmacy.

Since no recognition technology can provide 100% accurate results, there is a possibility that an incorrect read can occur. This paper takes a look at the challenges associated with reading barcodes from faxed or scanned images and addresses techniques used to minimize the probability of misidentifying a patient on the MO.

Barcode and Optical Character Recognition

Barcodes

A Barcode is an encoded set of lines and spaces of different widths that can be scanned and interpreted into numbers or text. There are many different types of barcodes; however, most symbologies look at the ratio of black line widths to white line widths in order to determine the barcode's value.



Figure 1

Printers on the market today are capable of printing at very high resolutions so the printed barcode looks very clean, as the figure 1 shows. However, when this barcode is scanned, we get image degradation¹. This occurs because documents are typically scanned at much lower resolution than they are printed. Figure 2 shows a MO label that was scanned at 200 dots per inch (dpi).

Scanned images are subject to several different types of image degradation. Skew is caused by the paper not feeding straight through the scanner. Stretch is caused by the paper dragging as it is fed through the scanner. Dirty scanners can cause streaks or "combs" on the scanned image and faulty scan heads can cause

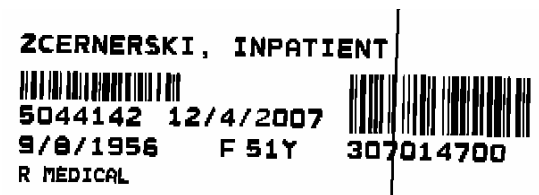


Figure 2

blank streaks across the document. (These types of degradation are far more common with faxed images than with scanned images.) Finally, human contact with paper can cause degradation such as handwriting, finger smudges and fluid stains.

Skew, stretch and human contact usually result in the software being unable to read the barcode. Combs and blank streaks are most often what cause the recognition software to read the incorrect value, however other factors can cause this problem as well. Since barcodes recognition is the process of measuring the ratio of white to black space, a black comb or white streak can actually change the value of the barcode when it is read. Keep in mind that this is not a problem with the recognition software; the image that it is reading has been altered!

Optical Character Recognition

OCR recognition is similar to barcode recognition in many respects. The fundamental difference is that the OCR engine is trying to recognize individual printed letters instead of black and white line widths. This is a much more difficult problem for the computer to solve, especially since there are so many different fonts available today.

OCR recognition is more susceptible to misreads than no reads. Like barcodes, image degradation can have a negative impact on recognition results. Skew, as shown in figure 3, will also cause problems when the rest of the text on the page is aligned correctly.



Figure 3

Of course, the simple solution to the problem in figure 3 is to train the staff to place the label correctly. If the label is placed correctly, using OCR to extract the patient identification is a viable method of recognition.

Validation of Recognition Results

From a patient safety perspective, incorrect identification of a patient on a medical order can have a very negative impact. Several methods of validation are available to the users of the Metabolyst Pharmacy Order Management system.

We will discuss using barcode and OCR together in just a moment, but first let's take a look at barcode recognition by itself. Most barcode labels contain a patient identifier of some sort. This is usually a number, but can be a combination of numbers and letters. After recognizing the barcode, the value should be compared to current admissions data (ADT) in order to see if it is a valid identifier. If the comparison fails to find a match in the ADT data, the MO should be flagged. Usually, this entails passing the image to the MO management system with no patient data attached. This requires the pharmacy staff to manually enter the patient name and identifier. If the comparison does yield a match, then additional information about the patient can be passed to the MO management system. For example, if the patient identifier yields a match, the patient name, room number, bed number, date of birth and referring physician data can be obtained from the ADT data.

As we have described above, just because the barcode value returns valid patient data there is no guarantee that it is the correct patient. While our experience shows that barcode recognition accuracy can be as high as 99.999%, even 1 misread out of a 1000 is a problem. In order to minimize this probability, we need additional ways to validate the recognition process.

Several years ago, Metabolyst began implementing OCR in conjunction with barcode recognition. This is possible because most MO labels contain text versions of the data encoded in the barcode. So, after performing barcode recognition, we perform full text or zonal OCR on the order. This OCR result is then parsed looking for the patient identifier. If the patient identifier is not found, the order should be flagged so the pharmacy staff will know to visually confirm that the correct patient has been identified by the barcode recognition. If the patient identifier is found, we will compare it to the results from the barcode recognition. If the results from both the barcode and OCR match, the order is passed to the order management system with no warning flags set. However, if the two values don't match, the order should be flagged for manual confirmation.

Other Observations


This method of validation does create more flagged records, primarily because the OCR is less accurate than the barcode recognition. However, our customer's would "rather be safe than sorry". In other words, while clearing the flag does create slightly more work, the benefit is the reduced likelihood that an MO will be processed with the wrong patient information.

We have also implemented pharmacy order management systems with more strict routing rules. For example, if the flag is not cleared, don't allow the order to be routed to the next step in the process. This forces the pharmacy staff to clear the flag and visually verify that the order information matches what is on the image itself.

In addition to this validation, we can record the number validated and non-validated orders processed. This data can be compiled in a report and analyzed for process improvement. For example, it is possible to identify nursing units that consistently place the patient labels in a skewed orientation. By monitoring the recognition rates, it is possible to measure improvements when changes to the label are made. As discussed elsewhere, increasing the barcode size and/or font size will typically improve recognition results.

Conclusion

Image based medical order management systems improve the efficiency of the hospital pharmacy and while barcode recognition is widely used, they introduce risk. The risk is associated with associating the medical order with the



wrong patient. Image degradation due to improperly maintained fax machines are the number one cause of poor recognition results.

The risk of incorrect association of medical orders is reduced by the introduction of OCR validation to the process. While this can cause a closer review of orders that are correctly associated using barcode recognition, this is a small price to pay for the reduced risk. No recognition technology will ever be 100% accurate, but every hospital pharmacy should strive to do everything possible to eliminate these types of medical errors.

For more information on this subject, please call Metabolyst at 770.953.8916.

ⁱ See the white paper “Success with Barcode and OCR Technology” for more details on the problems associated with scanning printed documents.