

A Deep Dive into the Enabling Technologies in Electronic Health Records



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Organizations continue to experience paperwork inefficiencies and the healthcare industry is among the top suffering sectors. Thus, whether by regulation or not, healthcare organizations are more and more desperate for relief from paperwork via electronic health record (EHR) solutions.

It's no secret that the market for EHR solutions continues to face challenges. But, the industry is also plugging away with increased EHR adoptions and modifications to improve the EHR experience. While the market for EHR vendors appears to be dominated by a handful of companies, there are more than 1,000 vendors. These vendors provide a mix of application types and support.

Contrary to some opinions, paperwork alongside digital processes will continue into the foreseeable future and the use of paper remains as strong as ever. It can be argued that a failure to understand and embrace this is why EHR adoption is struggling. Thus, EHR vendors would do well to embrace efficient image capture into their solutions.

In addition, robust and established technologies such as barcodes and optical character recognition (OCR) are vital. These tried-and-true technologies can bridge this gap and help fuel EHR comfort and adoption. For these reasons, leveraging existing technologies that people are familiar with can help remove adoption barriers.

This eBook helps healthcare administrators understand the important enabling technologies behind EHR and the steps necessary to getting EHR satisfaction.

CHAPTER 1

Fundamental Technologies

The Scan Component

Healthcare organizations deal with a ton of different types of documents in their daily work. These include insurance cards, driver licenses, patient charts, treatment authorization forms and much more. Inefficient paperwork and digital processes have been cited as being at the heart of defocusing care providers from delivering great service to patients. It's worse when you also consider the required sharing of documentation between third-party service providers.

According to the American Hospital Association, paperwork adds at least 30 minutes to every hour of patient care provided. Of the 10 countries surveyed, 8 rated paperwork as the most wasted spending on their healthcare system. The remaining two countries rated paperwork the second most wasteful item.



40% of time is lost by the typical employee searching for files.



Every 12 seconds a document is lost by a large organization in the US.



18 minutes is the average time it takes a typical employee to find a document.



Physicians spent 27% of their time in their offices seeing patients and 49.2% of their time doing paperwork, which includes using the electric health record (EHR) system.



10,000 sheets of paper are used every year by the average office worker.



The gross revenue of International paper in the United States: \$23.6 billion.

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By 2020, the paper production section is expected to have increased outputs by 77% when compared to 1995 numbers.



Despite paper usage being reduced in North America, it is growing throughout the world. Paper is expected to exceed 50% of the world's logging industry in the near future.

Source: Brandongaille | Forbes

The continued explosion of paper documents in health care is what has grown the emergence of the EHR in the first place. An EHR with a good document capture feature enables healthcare organizations to reduce paper use, thereby improving work efficiency.

With such systems, digitization of paper documents is proving to be vital in lowering administration costs. But, if not leveraged properly, an EHR can also be the source of frustrations. It's critical that any document/image capture solution be implemented in a way that adds efficiency in managing digital health records. So, the first important technology is the simple ability to easily scan and capture paper documents to use them as digital assets.



Scan Workflow

Importance of Barcodes in Healthcare

Barcode technology helps improve workflow and efficiency across a myriad of industries, but in the medical field, it can also help save lives.

The use of barcodes in healthcare markets has been advocated since the 1970s. For decades, the healthcare industry has been a leading adopter of barcode technology.



Source: Wikipedia

According to the U.S. Food and Drug Administration (FDA), more than 7,000 deaths happen each year, the FDA proposed a rule requiring bar codes on certain drug and biological product labels. This was to ensure drug dosage and administration could be more accurately administered to the correct patients at the appropriate time.

The Healthcare Information and Management Systems Society (HIMSS) has emphasized a high priority on using barcode technology to reduce medical errors for better patient safety. The technology has helped eliminate many human errors. For example, the US Department of Health and Human Services has stated the use of barcodes has reduced medication error rates by as much as 85%.



Human Error Stats

Source: Getreferralmd | Klipboard

According to an article published in the *New England Journal of Medicine*, the use of barcode technologies provided a 41.4% relative reduction in errors. *Healthcare IT News* recently referenced a report stating that processing prescriptions through a computerized provider can cut drug errors in half and could avoid more than 17 million adverse incidents annually.

As a result, dispensing medication nowadays largely relies on Bar-coded Medication Administration (BCMA) systems. It's arguable that no other industry has benefited more from barcode technology than healthcare. Also, it's likely no one has more at stake than healthcare practitioners if barcode technology is improperly implemented.

The Power of Optical Character Recognition

Another common barrier to the acceptance of EHR applications is an inability to meaningfully use content in an image. Optical Character Recognition (OCR) technology can be used to make content in an image usable.

OCR is a mature technology with wide business uses. It extracts text from an image so it can be manipulated in a word processor or database. In other words, it turns an otherwise difficult-to-use image into meaningful content. In healthcare, it turns paperwork into powerful digital assets by extracting usable data from insurance forms, ID cards, doctor's notes in a patient's individual record, and so on.



Using OCR to extract such information from documents and forms enables greater efficiencies by converting this information into meta tags for EHR files. One can think of metadata of a document as behind-the-scenes information about a file. It is all the associated pieces of information that are stored in an EHR database. Metadata can be both manually entered and automatically populated from barcodes or OCR results. With these capabilities, the system can also use metadata with PDF or TIFF files to enable auto indexing and other content management capabilities.

For example, if you want to find all patients under Dr. Jones or that use ACME Insurance, with metadata tagging you can quickly pull up this list. With this metadata, efficiencies are realized. These features save staff time from manual data entry and combing through physical files for information. It's also proven to reduce human errors.



OCR Patient ID Capture to Populate EHR Database

CHAPTER 2

Healthcare Use Cases

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Now that we understand the fundamental technologies that enable an EHR system, it's also very important to examine the possible ways a user would interact with these technologies in the application.

Barcode Uses in Healthcare



Meds





Authentication

Inventory / Asset Tracking

Barcode Scenarios

There are a variety of ways to use barcodes. There are clear time and cost savings benefits in using scanning, barcodes. There is also the benefit of familiarity – they are technologies that users know and are comfortable with.

1. Document Routing

You can batch scan documents with barcodes and save the documents into different groups based on the barcode value. For example, with a 1D barcode that stores a patient ID, a patient record can be routed automatically to the correct patient folder.

You can also use barcodes to identify the clinician who oversees the patient and route the related documents accordingly.

2. Inventory

Medical devices are costly and represent significant investments that a healthcare facility makes. Using barcodes to track their location, such as when one device is checked out or in and by whom, can help prevent their theft or misplacement. For medical implants, the barcode can help populate a patient's EHR with necessary information about that device or the performance of that device.

3. Asset Tracking

Barcodes can also be used to track devices given to a patient. This can work both ways. You can track a device to each patient it was given to and you can track who administered it. For the administrator, this can include a doctor, nurse or other staff. For tracking where the device came from, this can include suppliers or manufacturers.

These trails in an EHR are all helpful in administering patient care or for managing device vendors and their transactions with you. This is just the tip of the iceberg for their potential inventory tracking uses. Virtually anything you want to assign or give to a patient can be inventoried and updated to the EHR with barcode technologies to maximize accuracy and efficiency.

4. Authentication

There are also obvious uses for barcodes in authentication procedures. These include authenticating a patient in a room or the patient's doctor or nurse. For example, a barcode could be affixed to a physical record in a room to match with patient data in an EHR. This helps prevent administering the wrong care to the wrong patient. Barcodes can also be used to authenticate whether a procedure has already been administered or not, such as medication.

Barcodes might also be used to extend collaboration with pharmacists, to quickly automate access to an EHR's prescription information for processing. In addition, they are widely used in laboratory and specimen collection to authenticate patients and test results. With real-time tracking tied to an EHR, test results can be conveniently updated and the doctor instantly notified.

OCR User Scenarios

When you scan a document, they are usually saved as an image type. You can tag these documents with key parameters for proper indexing. Sometimes these tags are not enough.

You might need to search or edit content within a document. So, if someone completed a wrong social security number on a submitted paper form, you might want to later be able to correct that. This is where OCR technology helps.

It converts the text in a scanned image document to searchable and editable text. Full-text indexing can be automated with OCR. You can also have template fields correspond to specific document types.

CHAPTER 3

Other Technical Considerations

As always, there are technical hurdles your team must overcome. Start with drafting the detailed platform requirements of the EHR system you use or plan to use. This includes any desktop, web or mobile application, or a combination of any of these.

Desktop vs. Web

When scanning documents, a distributed capture, and scanner setup can accelerate image acquisition. A common setup involves a client/server architecture. Users capture data from different terminals and save the data to the database on a central server. On the client side, a desktop-based EHR application can work.

However, a web-based EHR application provides different flexibility, such as more seamless mobile captures. Done correctly, and using common industry standards, developers can ensure users accomplish document captures from common web browsers on almost any device.

Support for Mobile

A web-based EHR approach can more easily allow for mobile captures from devices such as smartphones and tablets. It's ideal for EHR application designers to start with support for at least iOS 9 and Android 4.4 as basic system requirements. This is primarily because, according to Apteligent DATA, 98.5% of devices are using iOS 9.3 or above. For Android, 95% of devices are using Android 4.4 and above. Thus, you stand to have the greatest support for most devices from this starting point.

Support for Multi-Type Documents

As mentioned, medical documents nowadays are often a mix of digital and paper. For example, dictation, lab, and x-ray results might be available electronically. But, progress notes, provider information, graphic sheets, and doctor's order might be on paper. Thus, it's important to utilize a document capture solution that can integrate both.

There are common digital document formats including PDF, TIFF, and JPEG seamlessly load image files or view the images in standardized viewers, such as a browser.

Cross-Platform Support



Common File Types

Common Web Browsers

Support for Webcam and Scanner

Using a webcam, a patient at home could snap a picture of their ID and have their information properly captured to fill out a form or application. Then the types of application programming interfaces (API) to be supported can be sorted out. An API is necessary to enable software component interactions with each other. This includes how it accesses a database or specific hardware.

For example, you could use the TWAIN standard to interact with scanners and capture documents like patient records, prescriptions, etc. It is supported in operating systems such as Microsoft Windows, Mac OS X, and Linux. TWAIN is designed primarily for C/C++ development.

You might instead opt for the WIA standard. WIA is a Microsoft driver model and API for Microsoft Windows, which has been around since the days of Windows Me. In Windows Me, it enabled graphics software to communicate with imaging hardware such as scanners, digital cameras, and digital video equipment. Since that release in 2000, Microsoft has steadily added features, including OLE integration. However, since the release of Windows Vista, WIA has been more targeted towards scanners.

Another option is DirectShow to interact with webcams to capture photos and store in your central database. DirectShow is a multimedia framework and API produced by Microsoft. It can be used to perform various operations with media files or media streams. DirectShow is a replacement for Video for Windows (VFW), also known as Video Compressions Manager (VCM). Most webcams, including FireWire cameras, support the main interfaces of DirectShow. But, you should note that USB Video Class (UVC) cameras have the most market share.

After determining the APIs to use, you then have to choose whether to create the application from scratch), or you could take advantage of third-party pre-built components offered in software development kits (SDK), which save a lot of time and money since you don't need to learn the intricacies of creating all the code yourself related standards, APIs to implement, and so on.



Devices Used for Capture

Barcode Optimization

When developing an application, what it's supposed to do and how it performs is paramount. Barcode usage is a significant component in EHR workflow so enhancing this part would greatly improve the overall system performance.

1. Pre-Specify the Symbology

First, if you know you will be using a certain barcode type, pre-specify it within the code of your application. This will save time in your application process to not have to perform a check for a barcode type. It also adds assurance against incorrect barcode type auto-selections.

2. Image Quality

When it comes to barcodes, the quality of the barcode image is important for better accuracy of barcode recognition. It's known that when scanning documents with barcodes, a resolution of 300 dpi or above is recommended. Make sure you don't reduce image quality significantly to save space at the expense of disrupting data quality or workflow optimizations. Also, make sure the barcode is complete when scanning the documents.

3. Manual Verification

Besides image quality, it's a good idea to allow users to verify scanned data and manually correct it in cases where errors are found. This is a particularly important step to consider in any EHR workflow. Just as with a scanned document, it's also a good idea to allow capabilities to manually verify and correct scanned barcode data when errors are found.

4. Pre-Define the Barcode Area

It's a good idea to pre-identify the rough barcode area within your application code. This saves time and effort in the barcode application trying to locate where the barcode is or how many barcodes there are. These small considerations can add up to significantly improving the barcode reading performance and workflow.

Common Barcode Problems









Barcode Angle

Barcode Curved

Barcode Damaged

Barcode Glare









Barcode Low Contrast

Barcode Low Light

Multi Barcodes

Barcode Shadow

Optimize Results for Effective OCR

1. Image Quality

To optimize results for effective OCR, image resolution is important. For the usual font size (10 pts or above), a resolution of 300 dots per inch (DPI) is recommended. Smaller font sizes will command even higher DPI resolutions. Also, when scanning, you can generally choose among three color modes: black and white, grayscale or color. Usually, grayscale is optimal for OCR. Black-and-white can also work if the document to be captured starts with a larger quality font.

2. Compression

Other considerations to ensure the best OCR results include using lossless compression. So, saving as a TIFF or PNG file is best. These allow for better future processing, for example, compared with the JPEG format that loses quality with each edit and save.

Also, for the brightness setting of scanners, adjust the balance of light and dark shades in your scanned images. Generally, a medium brightness value of 50% is best.

Human Bottlenecks

Often, migrating to a new technology can be a challenging and lengthy process for staff. Since healthcare providers might use multiple methods for documenting medication administration. For example, there might be a paper trail combined with a BCMA system. While the practice for dual documentation may be well intended, the duplicated effort may also contribute to medication administration errors. It's also very likely to reduce staff productivity.

Therefore, ensuring the adoption of a good BCMA system based on excellent barcode technology is so important. With it, staff is more confident in relying on a single system for medication administration. It can help with all kinds of tasks as mentioned before, from barcode scanning medications to populating the information for tracking and monitoring medication administration.

A BCMA system can be used to audit and check for proper medication administration. But, it's important to consider it not be used to document inaction or improper administration for punishment. The last thing any staff wants to do is use a system that adds more workload or that can be used against them. So, take advantage of a BCMA system's ability to verify proper administration in a way that positively reinforces its use and reliance with staff.

These key capabilities are a foundation for getting patient and user acceptance. For patients, it helps administrators easily lay out key benefits, such as efficiency gains during routine visits and security and control the patient will have over their EHR. For staff, it becomes easier to demonstrate how it adds convenience and speed to their daily workflow procedures. But, educating patients and users about this, and gaining their acceptance, must start with a solid EHR system that can deliver every single time. This includes using familiar technologies mentioned so far herein.

CHAPTER 4

Regulatory Requirements

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One can't ignore the compliance and specifications when it comes to the healthcare industry. The same applies to the software it uses. We must be aware of and take steps to comply with relevant laws, policies, and regulations.

Governing Laws

It's important to note the healthcare industry is bound by the Health Insurance Portability and Accountability Act of 1996, or HIPAA. The act defines security guides and policy about information handling in the healthcare industry. This is to protect the privacy of patients. To get compatible with HIPAA, many healthcare organizations go for a document management system (DMS) to manage related documents.

Access Control	Unique user identification (required) Emergency access procedure (required) Automatic logoff (addressable) Encryption and decryption (addressable)
Audit Controls	Record and examine activity in information systems (required)
Integrity	Authenticate ePHI (addressable)
Authentication (required)	Procedure to verify a person or entity seeking access is who they claim
Transmission Security	Information integrity controls (addressable) Information encryption (addressable)

Your DMS needs to have the necessary security features to be HIPAA compliant. This helps prevent unauthorized interception or access to sensitive information. The data transferred over a network, whether public or internal, needs to be encrypted. So, make sure you don't bypass any security protocols and even consider layering more on top.

Barcode Regulations

When it comes to the EHR market and barcodes, there are standards to consider. The GS1 provides guidance on barcodes standards. This includes healthcare-specific barcode standards. For example, there is coverage of standards for identification, for barcodes and EPC/RFID, and for data exchange.

Data Integrity

Keeping data secure is especially important when accessing health information on a personal smartphone or using an EHR that stores all patient data in the cloud. Security protocols must be meticulously followed when implementing new EHR upgrades or features. Any risks should be documented and addressed in your hospital's Health Insurance Portability and Accountability Act (HIPAA) risk assessment.

Authentication

We recommend minimum security as indicated in research done by Universidad de Valladolid, in Spain. These security recommendations are applicable worldwide. For example, access control should be user-centric whereby the patient oversees, allows or disallows, access to their medical record. To protect user identification and password authentication procedures, keys should use 256-bit encryption.

Security

Other recommended security measures to consider should also be for data transfers. It's ideal to use TLS with 256-bit encryption during transfers online. Check out the noted research for complete recommendations. Also, be sure your vendor contracts have clear language that states the vendor's responsibility in case of a data breach. There should also be defined clear steps you both will take to resolve any problems.

Integration

The HIMSS provides a lot of guidance for standards in healthcare information and technology. This includes calls for action on proper integration and interoperability between the varying systems involved in health information exchanges. The EHR is on the minds of just about anyone involved in the document management industry. Lots of changes have occurred and there will be more to come.

CHAPTER 5

Where to start?

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Today, there's a push to innovate away from desktops, paperwork, and similar workflow items without regard to considering how entrenched they remain to everyday business. The call to action is ensuring integration with cloud and mobile technologies. However, desktop use still remains as dominant as ever.

Platform Support

In looking at scanning first, scanning and inputting documents while sitting by a traditional scanner must be expanded upon. Image capture today must also include on smartphones, tablets, laptops and other such devices where built-in cameras can be leveraged. However, it also needs to happen securely and across cloud and local or remote server platforms. These are all capabilities that must be considered.

Browser Support

For an example, let's look at a potential platform requirement for a web-based application. You'll want to identify what browser types the application needs to support. This includes determining if users will be required to maintain a minimum browser type or version. So, for example, will your web-based application work only on IE version 9 or later? Or, is it important that you support other browsers too: Chrome, Firefox, Safari, Opera, and so on?

Ensuring support for browsers helps guarantee continuous workflow and reduces support issues.

Compatibility/Integration

Another important consideration is how well any new EHR solution integrates into existing workflows and systems. For example, you'll need to verify if desktop access is enough for your users. Or would users benefit from a web client to be able to check records from any computer containing a browser and network access? Ultimately, to ensure an increase in productivity and cost savings, you need to ensure simplicity in a user's efforts to use the EHR.

Off-the-Shelf or Custom-Built

To start, one needs to compare the advantages of building an in-house solution or using an offthe-shelf solution. Relevant staff and IT management need to understand the technical requirements involved with either type of solution.

There are quite a number of professional off-the-shelf EHR options on the market to serve the needs of health care practices of all sizes. Most commercial EHR systems are designed for a broad base of practitioners and may not suit the specific needs of all health care providers. For this reason, one may consider developing their own image capture solution to tailor it to specific requirements for that practice.

1. Off-the-Shelf

If you decide to choose an off-the-shelf EHR solution, there are several things to consider. The first thing is how easy it is to customize for your needs. Remember that most EHR solutions are designed for generic purposes. So, it's important to confirm whether it's possible to customize the solution to meet your unique requirements. It's equally important to evaluate the work/costs involved in such customizations. While not as time-consuming as coding everything from scratch, implementing an EHR is still a rather big project. You are likely to encounter unexpected obstacles before, during and after the implementation. So, it is vital that you choose a vendor with good technical support for all phases of the EHR's lifecycle.

2. In-House

While an in-house option allows full customization, it's important to evaluate the time and labor, as well as the research and development costs. Remember this includes the lifecycle of the application: planning, development, implementation, changes, and support during use. If you're planning to do it in-house, take advantage of online forums such as <u>www.twain.org</u>. The TWAIN forum, Stack Overflow, and MSDN provide a plethora of online technical information.

3. Building or Buying Relevant Components

Once you understand such requirements, you can proceed with building or buying the relevant components. For barcodes, there are some open source barcode libraries available. A popular one is ZXing, also known as "Zebra Crossing". You might instead opt for a third-party barcode software development kit (SDK). Commercial SDKs typically provide better barcode processing results, wider barcode type support, and better customer service. Obviously, they can also save on development time and costs versus researching, understanding, identifying, creating and supporting an API you build in-house.

Developing a barcode reader as part of a complete system can really defocus an organization . There are immense short-term development efforts and costs that can come with it. Long term, there are technical support staff issues as well as time and costs that can mount..

If you want to take advantage of third-party SDKs for the scan, barcode, and OCR components, be sure to do your research. These pre-built solutions can turn months or year-long projects into days. Although SDKs have higher up-front costs, they save significant time and other costs in the long run that usually amount to much more than the initial cost of the SDK.

We've touched upon many technical considerations, including the device types to be used. You'll need to start with a feature list for an in-house EHR solution. Assemble a team from the different departments that will be core users. In doing so, you'll come up with a feature and capabilities list. Thus, various technical requirements will come forward. In your research of an EHR solution or SDK ensure they deliver the features, customization and technical support levels you require.

1D or 2D

Once you determine how you want to use barcodes, the next thing you must figure out is which symbologies are best suited for your needs. 1D barcodes are widely used in hospitals for purposes such as identifying medications or prices. However, there is a growing need for barcodes to store more and more data as well as be used in mobile applications. So, these two new requirements have many in healthcare practices looking to adopt 2D barcodes.

Compared to linear 1D barcodes, 2D barcodes have the advantage of more memory capacity and storing more information types within less barcode space. Obviously, this makes 2D barcodes more convenient for mobile scans.

Whichever you opt for, make sure you properly analyze your requirements to cover all workflow needs. Sometimes, a specific barcode type can work for many applications while other times, different barcode types may be needed for different usage scenarios. When deciding the barcode type, you must also research barcode scanning devices that support each. Some old barcode scanner models may not work with 2D barcodes.

Getting EHR Satisfaction

As is the case with almost any software development or adoption, analysis and testing of the application are also important. You'll want to try to uncover any potential problems. It helps to get different departments involved such as doctors, pharmacists, nurses, and IT during pre and post development of the solution.

One basic testing point is to ensure platform compatibility, which determines whether the application supports all the required user platforms and devices. This might include workstations, browsers, flatbed scanners or webcams, and more.

For other hardware, you want to ensure barcode scanner compatibility. This means you want to ensure your barcode scanner devices are able to read the barcode images and properly pass the data to your EHR system.

Finally, you must test data transfer workflows. This includes making sure the data from barcodes can be successfully added/updated to an EHR database.

The Adoption Process



If you're planning to build a solution in-house, or if you're an EHR system provider, consider taking advantage of as many SDKs as possible. They will help reduce costs, save you time, and save you headaches.

Imaging SDKs can help with just about any document capture requirements. A barcode reader SDK can fulfill barcode reader technology needs. And, an OCR SDK can help ensure information on paper-based assets are fully leveraged.

Each SDK can turn months or year-long projects into just days. Up-front costs are nominal compared to building a solution yourself. Long-term cost savings are even more beneficial. Also, often, SDKs will be loaded with features beyond your scope of needs allowing you room to expand as needed.

A good SDK provider will support their solution expeditiously and for the long run. To ensure this, you must research SDKs and their providers to confirm they deliver the features, customization, and technical support levels you require.

Whichever route you decide to take, consider the following additional resources.

References:

31 Insane Paper Consumption Statistics
Doctors Wasting Over Two-Thirds Of Their Time Doing Paperwork
Barcode technology in healthcare
30 Healthcare Statistics That Keep Hospital Executives Up At Night
8 Reasons Why Going Paperless Will Rocket Your Business



15+ Years Experience in TWAIN SDKs and Version Control Solutions

About Dynamsoft

Founded in Sep 2003 with the aim of being the dynamic center of software developers, Dynamsoft provides enterprise-class version control software, TWAIN software development kits (SDK) and other document imaging SDKs, with numerous generations for each product. Today many Fortune 500 Companies including HP, IBM, Intel, and Siemens trust Dynamsoft solutions for version control and TWAIN scanning SDK development.

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