



Integrating the Healthcare Enterprise: A Primer

Part 3. What Does IHE Do for ME?¹

David S. Channin, MD • Charles Parisot • Vishal Wanchoo • Andrei Leontiev • Eliot L. Siegel, MD

Introduction

The Integrating the Healthcare Enterprise (IHE) initiative brings together users and developers of medical information systems to advance data integration. Each of these stakeholders in the healthcare delivery process is vital to successfully caring for patients in an expert, efficient, and cost-effective manner. Each of the different members of this community has a slightly different perspective on why IHE is important and how IHE can (positively) affect their role in delivering healthcare.

In this article, we present eight differing perspectives. Readers are referred to the second article in this primer series (1) for a more detailed explanation of these integration profiles. Readers from other (nonradiology) segments of the healthcare enterprise and industry should see in this collection of user perspectives kindred spirits with vested interests in addressing analogous problems from their domains.

The Departmental Chief or Chairman

As a radiology departmental chief, I have the ultimate responsibility to provide the highest possible quality of care for our patients in addition to prompt, reliable, and responsive consultation for our clinical colleagues in as cost-effective a manner as is practical. I am accountable for analyzing and optimizing departmental work flow and productivity and for creating a vision and road map for the future direction of the department. Selection, procurement, and integration of imaging equipment and information systems are integral parts of my job.

Abbreviations: DICOM = Digital Imaging and Communications in Medicine, HL7 = Health Level 7, PACS = picture archiving and communication system, RIS = radiology information system

Index terms: Information management • Picture archiving and communication system • Radiology and radiologists, departmental management • Radiology reporting systems

RadioGraphics 2001; 21:1351–1358

¹From the Department of Radiology, Northwestern University, 448 E Ontario St, Suite 300, Chicago, IL 60611 (D.S.C.); Global Connectivity Center, GE Medical Systems Information Technologies, Buc, France (C.P.); Department of Radiology Systems, GE Medical Systems Information Technologies, Mt Prospect, Ill (V.W.); Radiology and Imaging Solutions Division, IDX Systems, Burlington, Vt (A.L.); and Department of Diagnostic Imaging, University of Maryland School of Medicine, Baltimore (E.L.S.). Received May 29, 2001; revision requested June 27 and received July 11; accepted July 11. **Address correspondence to** D.S.C. (e-mail: dsc@radiology.northwestern.edu).

In 1989, a work flow analysis of our radiology department was performed, which, to our surprise, demonstrated that 59 steps and a dozen people were required to produce a routine chest radiograph of an inpatient. With the transition to the use of computers alone, there would have been very little reduction in the number of steps or the time required for them without integration of the various information systems and modalities within the entire healthcare enterprise. During the past 10 years, we have subsequently redesigned our work flow and have been forced to create custom interfaces with our vendors by using DICOM (Digital Imaging and Communications in Medicine) (2) and HL7 (Health Level 7) (3) interfaces. These efforts have drastically decreased the number of work flow steps to less than 10 and have similarly reduced our departmental turnaround times. Unfortunately, these custom interfaces were often slow and unreliable (especially the initial ones) and, in many cases, quite expensive. Today, fortunately, most of these work flow enhancements can be obtained by using the IHE integration profiles.

During the past several years, I have often felt like Charlie Brown from the comic strip *Peanuts*, after he has once again charged down the field at the football held enticingly in place by Lucy only to have it snatched away at the last possible moment. In one of the comic strips that has been archived in the American History Museum, Lucy even gives Charlie Brown a signed document “proving” she won’t pull away the football and she still manages to yank it away just before he’s able to kick it. This scenario has been repeated in our department for the past 10 years, as we’ve been promised by earnest and presumably well-meaning vendors that our brand new modality or information system will “plug and play” virtually seamlessly with our existing systems by using DICOM and HL7, without any need for any significant customization. The consistent need for major “customization” of our new modality or information system after delivery has typically resulted in problems. These difficulties have ranged from the need to perform additional manual work flow steps to “temporarily work around” the problems to major delays in our ability to use the equipment and major additional unbudgeted expenses to attempt to provide the promised full functionality of the system. These idiosyncratic interfaces also add to the complexity of the system, which has resulted in increased equipment down time especially when software upgrades are installed on our modalities or infor-

mation systems, which need to be further modified to continue to function properly.

As departmental chief, it is important for me to have the flexibility to purchase equipment that is “best of breed” rather than staying with a single vendor or a short list of vendors that happen to have a custom or “approved” interface to my existing systems. Universal adoption of the IHE integration profiles will make it much easier for me to have the flexibility to purchase what I want rather than settle for second best. Similarly, I do not want to feel constrained to utilize my information technology staff’s choice of a hospital information system provider for my radiology information system (RIS) or radiology picture archiving and communication system (PACS) but would rather know that by conforming to IHE integration profiles, my own choices will be likely to integrate seamlessly with the hospital systems.

In today’s job market in which there are severe shortages of qualified radiology personnel, I need to make sure that I provide an optimized work flow process and adequate tools for my departmental administrator, technologists, and radiologists to get their jobs done as effectively as possible with a minimum of frustrations. I also need to ensure that the unique requirements of our clinicians, information technology staff, and vendors are addressed as well. I have been impressed with the IHE progress thus far and remain optimistic that it will continue to evolve to serve the needs of my department, staff, and associates.

The Department Manager or Administrator

As the department of radiology administrator, I am focused on providing superlative service to our patients and our referring physicians in as cost-effective a fashion as possible. I am struggling against tighter budgets, rising costs, increasing procedure volumes, and an extremely tight technical labor pool.

As I walk through my department, I want to see patients moving through the system comfortably and efficiently. I do not want to see idle, expensive modality devices when I know that we have backlogs of outpatients waiting for procedures. I do not want to see technologists jumping from one information system to another to complete routine tasks. I want to see more procedures done per technologist per modality device. I want my electronic environment to reduce the number of steps we take in any given process. I do not want to add work flow steps because of information systems. I do not want to see technologists “sneaker-netting” paper around the department where once we ran films.

Since we are now in a filmless environment, I want to be confident that studies are performed

according to protocol, manipulated by the technologists appropriately, stored correctly and permanently into the PACS, and ready for viewing on both workstations and, as necessary, film.

I want to make sure that our referring physicians can access radiology information—images and reports—from the information systems they use. When they access this information, I want to be confident that they are getting the images they expect in a format that is displayed correctly. Although I understand that the return on investment from information systems comes from more than film cost reductions, I still want to minimize not only my film costs, but also the costs associated with managing these requests for radiology information. Authorized users of radiology information should be able to query and retrieve the information they need for patient care from my systems so that I do not have to manage pushing this information to them.

I want to reduce the opportunity for errors by the technologists, because these errors are not only dangerous to the patient but very labor intensive and therefore expensive to correct. In the days of film, when modalities were islands of functionality, a stick-on label and a pen could correct an error. Now, modalities are intertwined with the RIS, PACS, and other information systems, and errors on one device have significant upstream and downstream repercussions on other information systems.

I understand fully that the return on investment from my information systems comes from increasing these efficiencies and reducing tangible and intangible costs, not from reducing film costs. I believe that the IHE initiative will foster these efficiencies.

The Technologist

As a technologist, I am focused on performing the highest quality possible radiologic procedures on my patients. I want my patients to be as comfortable as possible, wait the least amount of time, and move through our department as quickly as possible.

I know how to perform a procedure on my modality. I know how to problem solve to get the procedure done, and I know when to get help in problem solving. Yet, as the department has added more and more information systems, I have had to learn how to use all these different systems. I have no clear mental picture of how these systems interact. Each information system refers to parts of the radiologic procedure and the steps involved in the radiologic process differently, and each system has different means for modifying information and correcting mistakes. Figuring out what to do next in any given sce-

nario or in the case of an exception is getting more and more complicated not simpler.

I often find myself repeating steps in my work flow unnecessarily. For example, if I zoom, pan, and select window levels once to film a study or to send it to PACS, I may have to repeat these steps over and over for a given procedure. Worse yet, if I do some image manipulations, another user of a different information system may have to repeat the work I have already done. Either I should be able to do the work once or they should be able to do this step once, but both of us should not have to reproduce each other's work.

Although we are now in a mostly filmless environment, we are still generating and manipulating too much paper. We get orders on paper, electronic orders printed on paper, requisitions, protocol sheets, flow sheets, quality assurance sheets, and patient history sheets. We have manual logbooks and protocol notebooks. I have no choice but to put my comments and questions on all these sheets of paper. I am constantly on the phone clarifying orders, rendering generic orders more specific, and manually scheduling inpatients and outpatients into the system. Even so, I must still spend time interrupting the radiologists for more clarifications. This reduces my efficiency and their efficiency.

When I complete a procedure on my modality workstation, I want to be assured that the images are permanently stored and that they will be presented for viewing as I have manipulated them. I take responsibility for the appearance of my images, and I want to know that my time and effort is not being wasted.

I want to receive fewer requests for radiology images and reports from outside sources. Once I hand off the images to PACS, I want users to query and retrieve the images from the PACS. I do not want to spend my time pushing images to various three-dimensional postprocessing, surgical, or research workstations.

My job is to perform high-quality radiologic procedures on sick patients. I hope that the IHE initiative can foster information systems that help me and my equipment do just that.

The Radiologist

As a radiologist, I am focused on providing the highest possible quality of care for my patients and the highest level of service to the referring physicians who entrust me with the care of their patients. I am struggling to do this in the face of increasing bureaucracy, increasing regulation of my practice, and decreasing reimbursements, all

within the context of a very competitive market that includes a very tight technical and professional labor pool. I must continually work harder and smarter to keep up.

I routinely use a number of departmental information systems, including RIS and PACS. At my institution, 95% of the 250,000 procedures we perform per year are acquired, stored, transmitted, and interpreted from a PACS. I now spend the majority of my clinical time in front of one or more workstations. On occasion, I use a small number of other terminals and personal computers to access other hospital information systems located outside my department. In between clinical responsibilities, I use the RIS to edit and sign reports. I then coordinate with our practice manager to make sure that the professional billing information gets entered correctly into our practice's billing system. Although these information systems are adequate for getting my work done, my frustration lies in the fact that they do not work better together to facilitate my work flow and make me more efficient.

Consider the routine scheduled work flow. When a technologist finishes a study, he or she places the requisition, which is stapled to numerous associated pieces of paper, in a pile in a letter tray. Although we are filmless in our department, we are far from being paperless. Currently, there is no way to electronically annotate the study. I want to capture electronically what are now scribbles in the margins of the various papers. I also want my residents to be able to annotate images.

Every few minutes, I retrieve a stack of requisitions and return to my PACS workstation. By virtue of the accession number printed on the requisition, I can usually identify the study that needs to be interpreted. On occasion, a study is listed as "unspecified" because the image information received by the PACS from the modality workstation does not match the order information received by the PACS from the RIS. This happens frequently for trauma patients and other "John Does," but also when the hospital's admission/discharge/transfer system is down. For either of these scenarios, I must wait for the RIS administrator to manually enter the order and the PACS administrator to manually merge the image information with the order information once it arrives in the PACS. This not only delays me in interpreting the study, but I worry that the referring physician will not be able to find the imaging study in a timely fashion when clinically needed.

Because of our reliance on paper requisitions, it is also very difficult for us to distribute work

efficiently among the available radiologists. We are bound to the paper requisition. We must also be in proximity to the technologists so that we can confirm exactly what was done, when, and why. The scheduling and specification of imaging protocols for work to be done is very inefficient. My residents and I are constantly being interrupted to schedule and specify protocols for studies.

On occasion, the image folder on my PACS workstation is empty because, for example, images from a computed tomographic (CT) examination of the abdomen are stored with CT images of the chest, since the images were all acquired in one data acquisition. I can almost always find the correct images, but it does slow me down. Again, I worry if my clinical colleagues will find the images in a timely fashion.

More important, images are often not presented to me as I wish to see them. In the good old days, the technologists would adjust the images on the modality workstation before filming them. Now, even when they do make adjustments to the images for an occasional hard copy, those changes don't show up on my PACS workstation and I must redo the manipulations. This duplicated effort, again, slows down the technologists and slows me down.

Since I no longer interpret studies from film and therefore do not see filmed images before they are released from the department, I am concerned that the quality of filmed images sent from the department may be suboptimal.

Worse still, there are scenarios in which our clinical colleagues must manipulate images to ensure that they are viewed correctly. Images may be technically labeled correctly, but they are not displayed conventionally. For example, we find that they often must be flipped manually horizontally or vertically. Because these manipulations are not sent from the modality workstation to the PACS, they must be performed again on the PACS. This needs to be done very quickly, as I worry that clinicians may not notice that the images, although labeled correctly, are not displayed as expected. This could lead to disastrous patient outcomes.

I need to be able to quickly identify and mark images that are important to the clinicians. I need better reporting tools. I need to record measurements and comments and to have them integrated into a consistent model for reporting radiologic findings.

IHE has addressed a number of common, problematic scenarios that crop up in my electronic world. For me, the solutions embodied in the IHE technical framework cannot be implemented fast enough. Waiting for them to become realized in the products and systems I use daily

makes me feel like a chained dog faced with a steak just out of reach.

The Nonradiologist Clinician

As a clinician, I am focused on providing the best healthcare possible to my patients. I must provide this superlative care to more and more patients, and I must juggle more and more patient needs. I do so in the context of an ever-changing healthcare environment with rising bureaucracy, increasing administrative chores, decreasing reimbursement, and more and more information systems. These information systems are supposed to make my life easier and more efficient. Instead, they add steps to my work flow and reduce my efficiency, exactly the opposite of what they are supposed to do. I must have all the information I need to support my decision-making process when and where I need it. I spend too much of my time hunting and gathering information, and this strains the time I have available to digest the information and see my patients.

When I place a request for a procedure, I want to know when the procedure has or is going to be started, and I want to know when the study is completed. I want to see my patient's images when I need to see them. This might be 2 minutes after they leave the procedure room or 2 years after they leave the institution. I want to see the images and reports in my office, at home, in the clinic, and in the operating room.

When I access the images, I do not want to manipulate the images to highlight image features and findings. The technologists should have done this, and this is part of the value added by the radiologist. I rely on the radiologists more than I am willing to admit. I need their report, but it must be available in a timely fashion. I can't sift through 100 or 1,000 CT or magnetic resonance images looking for key findings. I need and trust the radiologists to filter and consolidate this vast amount of information for me. I need them to make annotations and comments that I can see when I am looking at the images.

My institution is now filmless, which has pros and cons. I greatly appreciate the positive impact of PACS on our institution. I especially appreciate no longer having to wait for films in the film file room. I appreciate that studies are almost never lost now. However, I still need film on occasion, and although I understand that the radiologists no longer check each film, I need to have good-quality hard copies available when I call for them.

When I access the images on a workstation, I don't want to spend time looking for images in folders. I don't care if the chest, abdominal, and pelvic CT images are acquired in one spiral, one

helix, or one "double helix": I want look at the chest when I need to see the chest and I want to look at the abdomen when I need to see the abdomen. When I need to look at today's abdominal CT images, I don't want to wade through a bunch of neck and chest images from the previous examination before I get to the abdominal images. I can't afford to waste precious time surfing the PACS looking for the images. Similarly, when my patients come in as John or Jane Doe or change their names or need to have their identity protected, I don't want to waste time looking for their images.

I am looking for the IHE initiative to make the information systems with which I interact perform more cohesively such that I can work more efficiently, not less efficiently, in an electronic environment.

The Chief Information Officer

As the chief information officer, I am responsible for protecting and serving the data of the patients of our institution. As the steward of this information, I am responsible for the oversight and management of dozens if not a hundred or more information systems. I face this responsibility in the context of increasing internal policies and procedures for information management that are themselves a reflection of growing local, state, and federal regulations. I am also facing this information management challenge in the context of tighter budgets, rapid technology growth and the associated rapid obsolescence curve, increasing personnel costs, and a very tight technical labor market.

In the good old days, I was less concerned with information system purchases in departments such as radiology. We understood that there were information systems buried in the modalities, but at the time they didn't communicate with other information systems. Now, as the modalities and departmental information systems become more sophisticated and need to interact with other departmental and hospital information systems, the level of complexity has gone through the roof. I now have to understand how work flow is processed in each department, and I need to define the points of contact between these information systems.

I want to deploy best-of-breed computer systems to best support my clinical, research, educational, and management user communities. I love information systems standards. When standards work as intended, I can buy best-of-breed systems. Standards also encourage a healthy competition between my vendors to improve performance and

service. Unfortunately, standards don't completely address all of my needs. Until they do, I can no longer afford to develop, test, and manage more point-to-point interfaces between systems. I must, therefore, consolidate to fewer information systems, even though this means occasionally giving up best-of-breed end user functionality. I know that I will never be able to consolidate to one system from one vendor, and so I look to the IHE initiative to define a framework that I can ask my vendors to implement to help me consolidate to a handful of systems that act in concert to process work flow in my institution.

The Imaging Information System Vendor

"Connectivity" of imaging acquisition systems is a nonnegotiable customer expectation. Providers transmit images from their modality workstations to a variety of imaging information systems, which include stand-alone analysis or review workstations, cluster archiving systems, hard-copy film and paper output devices, and an increasing number of PACS. The level of connectivity expected by our customers now reaches well beyond point-to-point image transfer, taking into account increasingly sophisticated work flow processes.

Many customers wonder why radiology requires more than what DICOM delivers for imaging. It is widely known that DICOM development has been a challenge; however, over the last 8 years, we in industry have optimized DICOM to provide good interoperability between radiology systems.

Now the "bar of clinical information integration" has been raised. New demands, such as linking images to radiology documents, accessing RIS and other clinical information systems, and communicating these data beyond the walls of the radiology department, require a broader level of connectivity. And this leads to the challenge of the new decade: increase efficiency and comfort of patient care and decrease the risk of medical errors. To achieve these goals, the imaging industry needs to reach out to healthcare information vendors to develop a complementary range of connectivity standards, among which HL7 plays a central role.

Through the IHE initiative, industry reaches practical agreements on the best use of information technologies and standards to solve real-

world clinical problems. This is good for customers who desire flexibility to select best-of-breed imaging systems. In addition, for vendors it greatly simplifies the design and installation of new equipment and the process of upgrading previously installed equipment.

IHE is about teamwork, and not only teamwork between vendors, but also that between users and vendors. This is a novel approach to the complex problems of healthcare information systems integration that now has reached maturity in its definition. The capabilities of IHE have been proved through several multivendor demonstrations at RSNA 1999 and 2000 and at HIMSS 2000 and 2001. In addition, since any integration effort is difficult to test in the field, the IHE "connect-a-thon" which precedes these demonstrations is an extremely beneficial forum in which to test integration in a neutral environment.

To exploit the benefits of the IHE efforts to date, two specific actions need to be taken. First, vendors need to enhance and align DICOM and HL7 capabilities of their imaging and nonimaging products with the IHE initiative. Second, customers who plan to leverage the benefits of IHE by purchasing new products or upgrading existing scanners need to demand IHE participation from their vendors.

Although IHE takes a rather extensive perspective at specifying how each of the seven integrated work flow processes (or integration profiles) can be implemented in the institution, it does not require that the user upgrade all information systems at once. Each work flow process can be implemented in incremental steps, preferably starting with the Scheduled Work Flow integration profile. For example, users may elect to integrate one or two modalities with the RIS or PACS (or both) to support the Scheduled Work Flow integration profile. Overall, IHE is a key element in reducing the risk of encountering integration roadblocks. IHE significantly increases the level of the confidence in planning and executing these projects in a successful manner. This benefits both the customer and the vendor.

IHE also is an opportunity for vendors to maintain a simpler dialogue with customers in understanding their integration requirements. In addition, it provides a common framework for vendors to reach agreement on solving provider problems. For example, the IHE Consistent Presentation of Images integration profile ensures that images are consistently displayed on any display system within the institution (film or soft copy). This benefits both the user and the vendor

in that images will appear consistent across all calibrated display systems. Users no longer will have to call their local service person to “tweak” the image to make it look like their films. Vendors benefit from reduced service calls.

The Nonimaging Information System Vendor

The mission of many imaging and nonimaging medical information systems vendors is to transform healthcare delivery by helping customers improve efficiency and provide consistent quality care to patients. In making this transformation, it is challenging to overcome the barriers to access information across system boundaries. Yet, there is a better approach than the “interface engine” method of data integration, which adds undue complexity, poor maintainability, and higher costs to the institution.

Each individual information system is highly dependent on work flow information from other systems in keeping the provision of radiology services responsive to the entire healthcare institution. In the past, custom ad-hoc integration solutions were viewed as insurance policies against losing customers. In reality, they have resulted in limited market growth while stifling technologic evolution. IHE provides a better solution.

In the radiology department, for example, three major forces are converging, which makes IHE a timely initiative. First, the “image factory” is becoming completely digital, which opens the door to higher efficiencies and quality of care.

The second force emerged from the dawn of the schizophrenic period when image information had to be separated strictly from the clinical and administrative information. Now the rapid adoption of PACS, its linkage to the RIS, as well as the Internet distribution of images and reports, are reinforcing the need for nonimaging and imaging product vendors to work together. With stronger linkages, the lines of RIS and PACS are being blurred, evolving into a new generation of information systems. These new systems are compelling radiology leadership to team up with the chief information officer.

Finally, the third force is the need to improve efficiency, cost effectiveness, and quality of care while concomitantly reducing medical errors. With this force, the “bar of patient information integration” has been raised. In the paper and film era, links between patient information and the acquired images were a manual process, which was both error-prone and time consuming. In this new era, patient information management becomes an integrated capability of the prescription, acquisition, review and diagnosis of a study.

Vendors view IHE as a mechanism to enable consistent exchange of clinical information and to allow healthcare providers to select best-of-breed information systems.

There is no question among vendors that the IHE initiative will lead to improved patient care and improved information accessibility for the healthcare provider. Yet vendors also look for growth, profit, customer satisfaction, and employee opportunity to fulfill their mission. Meeting the goals of IHE helps us make good on our corporate missions.

As an information system vendor, we need to ensure the future viability of our products. Through our involvement with IHE, we have gained insight and knowledge in enterprise information distribution. This insight has facilitated our ability to turn our vision of enterprise radiology into reality. IHE is helping to drive the future functionality of our products, and we believe this helps to secure our position in the future.

IHE gives us a forum to address our initiatives and priorities. Those initiatives are evaluated objectively along with the initiatives of other vendors. The end result is a solution that meets everybody’s needs, thus reducing turf battles between vendors. Healthcare providers are the driving force behind IHE. Our involvement has allowed us to create and maintain a close relationship with these users. Not only do we gain understanding of our users’ issues, but users also gain a better understanding of issues within the industry. This mutual understanding lends itself to a closer relationship.

In addition, our involvement has given us exposure to new users who share their ideas and experiences and may also become potential new customers. To move forward, we need the support of not only users but that of other vendors as well. Our involvement with IHE has advanced the quality of our relationships with other vendors, which has improved our ability to better serve the needs of our joint customers. Our involvement with IHE has given us insight into the various issues and challenges in the imaging world. This knowledge has been invaluable as we expand our product line.

Because of our IHE involvement, integration efforts with other vendors can be completed in less time. Even integration efforts with non-IHE compliant vendors are easier because we have a framework on which to build. With standard integration models, our customers are easier to support.

Our involvement in IHE has allowed our employees to expand their knowledge outside the radiology arena. This exposure to the healthcare industry makes our employees more valuable.

The bottom line is that IHE is good for business. Our involvement is helping us meet our objectives to deliver on our vision of the future. The truly remarkable thing about IHE is the fact that it's good for the patient, it's good for the healthcare provider, and it's good for all information systems vendors. IHE has created an environment where everybody wins.

Conclusions

Numerous stakeholders in the healthcare delivery process share common problems, at least some of which are addressed by the IHE initiative. Most

important, the IHE initiative provides a forum and a framework in which all these stakeholders can come together and work to resolve these problems. The model established by this initiative can and will be extended vertically within radiology, to other departmental areas, and horizontally across the healthcare enterprise.

References

1. Channin DS. Integrating the Healthcare Enterprise: a primer. II. Seven brides for seven brothers: the IHE integration profiles. *RadioGraphics* 2001; 21: 1343-1350.
2. National Electrical Manufacturers' Association. *Digital Imaging and Communication in Medicine (DICOM)*. Rosslyn, Va: NEMA, 1996; PS 3.1-1996-3.13-1996.
3. Health Level Seven. *Application protocol of electronic data exchange in healthcare environments, version 2.4*. Ann Arbor, Mich: HL7, October 2000.