Extending DICOM to integrated information environments: IHE
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Disclosure
• Receive royalties from SPIE for a book I co-edited
• Member of an advisory board for Stentor
• Have consulted for: Memorial Hospital, Hollywood, FL, and Delnor Hospital, Geneva, IL

Introduction
• DICOM and imaging
• Replacing film with PACS
• What is wrong with the scenario?
• Going beyond DICOM
• IHE impact: workflow problems

Introduction
• The IHE Profiles: examples
• How IHE grows
• What is on the IHE horizon
• Conclusion

DICOM and imaging
• DICOM has had a 20-year history of providing interface specifications for imaging equipment
• DICOM is one of the most successful standards in medical imaging

Replacing film with PACS
• The idea of early PACS implementers:
  — Made practical with low-cost computers, displays, and storage
  — The challenge was engineering: how to get needed performance with available hardware

Replacing film with PACS: what is wrong with this scenario?
• Analysis of the “old way”
• What happens if we “plug-in” PACS to replace the film-based functions?
Replacing film with PACS: what do you gain?
• Eliminate (or nearly so) purchasing film and processing chemistry
• Remove most film processors
• Eliminate waste water problem
• Reduce film library personnel requirements
• Images are available in multiple locations

Replacing film with PACS: what do you gain:
• Reliable, fast archive
• Improved workflow?
  – Let’s look at this more closely
  – What actually happens in a radiology department or practice?

The “old way” film and paper (but with information systems)
• Analysis shows a LARGE number of manual steps and interactions with different systems
  – In our study, 32 steps (with a RIS, HIS, and PACS but not integrated)
  – In Dr. Siegel’s study, 59 steps (assuming no RIS or PACS)

The “old way” film and paper (but with information systems)
• Each step is a potential delay point and any manual data entry operation is a potential error source
  – As a side study of research we did, technologist data entry can have error rates as high as 20%

What is wrong with this scenario?
• The whole process typically takes from 1-3 days
• Emergency requests require effort on the part of the requesting physician

What is wrong with this scenario?
• There are multiple points of potential error or failure (e.g., patient is transferred; the report is printed on the wrong floor)
• The process imposes workload on personnel

What happens if we simply replace film with PACS?
• Do we improve workflow?
• What have we done to solve the problems that film creates?
• What new problems have we made for ourselves?
Examples of workflow impact
• Study of x-ray technologist tasks pre- and post PACS
• Study of ultrasound sonographer task times

X-Ray technologist task comparisons
• Our studies have shown an approximate 50% increase in technologist time (general radiography) AFTER PACS implementation

X-Ray technologist task comparisons
• Reasons for increased time:
  — Increased interaction with information systems
  — Very lengthy process for correcting mistakes
  — Queues for QA workstations (we created this problem)

Study of ultrasound sonographer task times
• Sonographers spend approximately 5 minutes (median time) interacting with the RIS and entering patient data for each patient
• For a 20,000 patient per year section, that 5 minutes per sonographer is equal to 69 person DAYS per year!

Why doesn’t DICOM solve these problems?
• DICOM primarily addresses the communication of images and associated information between imaging equipment and other devices

Why doesn’t DICOM solve these problems?
• DICOM does not address what happens in other health information systems that affects PACS and vice versa

Enter IHE: Integrating the Healthcare Enterprise
• 1997 – 1999: the Radiological Society of North America (RSNA) and the Healthcare Information and Management Systems Society (HIMSS) decide to collaborate

IHE
• The scope is to address the clinical scenarios underlying the interaction of PACS with other information systems (IS)
• DICOM is the standard widely used by PACS vendors
• HL7 is the ubiquitous healthcare IS standard
What does IHE do?
• Develops the clinical scenarios and information models to support them
• Determines the features of DICOM and HL7 needed to support the information models
• The resulting profiles are demonstrated at RSNA and HIMSS meetings

What doesn’t IHE do?
• IHE is NOT a standards developing organization;
• It fully makes use of the DICOM and HL7 standards, but does not (in itself) extend or modify those standards

How can IHE help solve these problems?
• When we re-examine our ultrasound ordering scenario but this time assuming the IHE Scheduled Workflow Profile has been implemented:
  — Step count is reduced to 9
  — Technologist workflow bottlenecks are eliminated

IHE Scheduled Workflow
• A major foundation for the IHE Profiles
• Supports the transactions and communications between HIS, RIS, and PACS
• Uses existing standards

Impact of Scheduled Workflow
• When we implemented just part of Scheduled Workflow, the 50% increase in technologist time became a reduction in technologist time (about 15%) compared to film

Scenario two: “Crash in the ER”
• An unconscious patient is brought into the ER
• The patient clearly needs multiple studies
• Scenario two: “Crash in the ER”
• So, how do the imaging studies (and laboratory studies) get done if the patient’s name and any record number he has are unknown?
• In the past, we did these with “trauma patient” as a name and a sequential, nonrepeating ID

Scenario two: “Crash in the ER”
• The problem is not doing the studies, but how to reconcile them afterwards once the patient’s name IS known.
• Otherwise, the studies may be “invisible” to the rest of the record.
How does the IHE help this situation?
• The Patient Information Reconciliation Profile is designed to fix exactly this problem.
• Interactions between the PACS, HIS, and RIS allow for after-the-fact record matching and updating.

Scenario three: “My monitors all look different!”
• With film, the same image was seen by the radiologist and other physicians
• With workstations, image display is distributed and is heavily influenced by the local monitor setup

Scenario three: “My monitors all look different!”
• The DICOM Grayscale Display Function Standard was developed to address this problem
• The IHE Consistent Presentation of Images Profile expands on this and also adds DICOM Presentation State Storage

IHE and consistent displays
• The DICOM Presentation State Storage Service Class allows for storage of information about how the image was displayed and viewed along with the image
• The goal: have consistent image displays throughout an enterprise

Scenario four: “You sent me an MRI with a thousand images!”
• With a large number of images in an examination; which are relevant to the clinical problem?
• Many physicians use the images to consult with the patients; which ones should they show?

IHE and key images
• The IHE Key Image Note Profile supports the flagging of particular images in an examination as significant
• A note may be linked to these images
  – Explaining a finding
  – Posing a question to a consultant

Scenario five: “We scanned the patient head-to-pelvis; who will read these?”
• A “single” CT study (from the head through the pelvis) is to be read by three different radiologists (neuroradiology, chest, abdominal imaging)
• We can’t ask technologists to start and end three separate examinations!
IHE and Presentation of Grouped Procedures
• The IHE Presentation of Grouped Procedures Profile addresses this clinical problem
• It allows a single examination to be broken up virtually into component examinations

Scenario six: “Why do I have to access PACS for images and the RIS for reports?”
• Though many PACS support reports along with examinations, there is no link between the reports and the images
• If the radiologist does not provide a reference, it is left to the referring physician to link them

IHE and reports
• The IHE Simple Image and Numeric Report Profile is designed to be a first step towards integrated, structured reports

Scenario seven: “Why can’t I get radiology information from all our systems?”
• Referring physicians have to interact with multiple systems
• Radiology (like laboratory systems) is ubiquitous in healthcare
• Why should the physician have to access separate systems?

IHE and access to radiology information
• The IHE Access to Radiology Information Profile supports a number of query transactions designed to allow disparate systems to access radiology images and reports in a consistent manner

Scenario eight: “We did the study, how do we get paid for it?”
• Sometimes part of an HIS, more often another IS is a billing system
• Detailed information about the examination is in the PACS and RIS

IHE and Charge Posting
• Makes the information that resides in PACS and RIS necessary for billing systems available to them

Scenario nine: “How does IHE address HIPAA security?”
• We are now required to provide security for medical records
• We have to restrict access to such records, yet provide the information when legitimately needed
IHE and Basic Security
• Provides the first level of a security infrastructure
  — Manages cross-node security
  — Provides for consolidation of audit trails

Scenario ten: “How do I get workflow into CAD and 3D reconstruction?”
• Increasing use of CAD systems and 3D and 4D workstations requires that they be able to employ the same workflow information that a PACS has

IHE and Post-processing Workflow
• This IHE profile extends the basic scheduled workflow profile to support the additional steps such as CAD and 3D reconstruction

The value of IHE
• We don’t gain from PACS unless we can be more productive
• We need automation to be more productive
• The IHE Profiles provide tools to support the replacement of manual steps

How the IHE effort grows
• Domain-specific planning and technical committees (represent users and vendors)
• Partnerships with other US and international (Europe, Asia) standards and medical informatics groups

How the IHE effort grows
• Strategic Development Committee (formed in 2002)
  — Expand the IHE process to meet the integration needs of the entire healthcare enterprise
  — Engage experts from other key domains
  — Identify integration needs, possible barriers and problems, and potential solutions across domains

What’s on the IHE horizon?
• IT Infrastructure Committee
  — Electronic master patient index
  — Query/Display
  — Synchronized patient views
  — Advanced security
• Primarily led by HIMSS
What’s on the IHE horizon?
• Expansion into other domains, e.g.,
  — Cardiology
  — Laboratory
  — Pharmacy/medication management
  — Clinical engineering

Where to find out more
• www.rsna.org/ihe
• Start with the IHE Primer
• All of the current, and most historical, documents can be downloaded as PDFs

Conclusion
• IHE is bringing together manufacturers of different clinical information systems, much as DICOM did for imaging equipment
• The potential for IHE to improve productivity and reduce errors is very great

Conclusion
• Some aspects of IHE, already in operation, are having an impact on workflow now

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