RSNA 2011
Course ICII51

Reporting Workflow: IHE Solutions for Structured Reporting – CDA and Beyond

Harry Solomon

Disclosures

Harry Solomon – employee of GE Healthcare

In accordance with ACCME requirements:

- the information presented is generally recognized and accepted by the profession as within the basic medical sciences, the discipline of clinical medicine, and the provision of health care to the public.
- the presentation promotes improvements or quality in health care and not the products or services of any specific commercial interest(s)

Who?

1978 - network communication protocols (ARPANET)

1993 - medical imaging networks (digital cath lab)

2000 - interoperability architect, GE Healthcare

Active in DICOM, HL7, IHE, SNOMED and other healthcare standards organizations

Lecturer, Medical Informatics, Oregon Health & Science University (BMI 516: Interoperability and Standards)

Learning objectives

1) Relationship of relevant standards including DICOM SR, HL7 CDA, and codesets including SNOMED, LOINC, RadLex, and ICD-9/10
2) Relationship between structured reports, displayable reports and evidence objects
3) IHE Profiles including Cardiac Imaging Report Content (CIRC), Displayable Reports (DRPT), and methods for distributing reports using Cross-Enterprise Document Sharing (XDS) and XDS for Imaging (XDS-I)
4) Features that structured reporting facilitates, such as report auto-population, decision support and evidence-based medicine.
5) Recent reporting template activities in RSNA, DICOM and IHE.

Why are we here?

Drivers of electronic radiology reporting

ARRA / HITECH

"Health Information Technology for Economic and Clinical Health" (HITECH) provisions of the American Recovery and Reinvestment Act (ARRA – economic stimulus)

- Incentive payments for *meaningful use* of *certified EHRS*
  - Multiple financing mechanisms (grants, loans, differential reimbursement)
  - Interoperability, clinical decision support, quality measures
- Grants to states to establish Health Information Exchanges, and support of interoperability pilot projects

Meaningful Use Objectives

Three time scales (Stages)

- Preliminary objectives and goals established by HIT Policy Cttee

2011 focus on prescriptions, primary care and hospitals, collecting quality measures

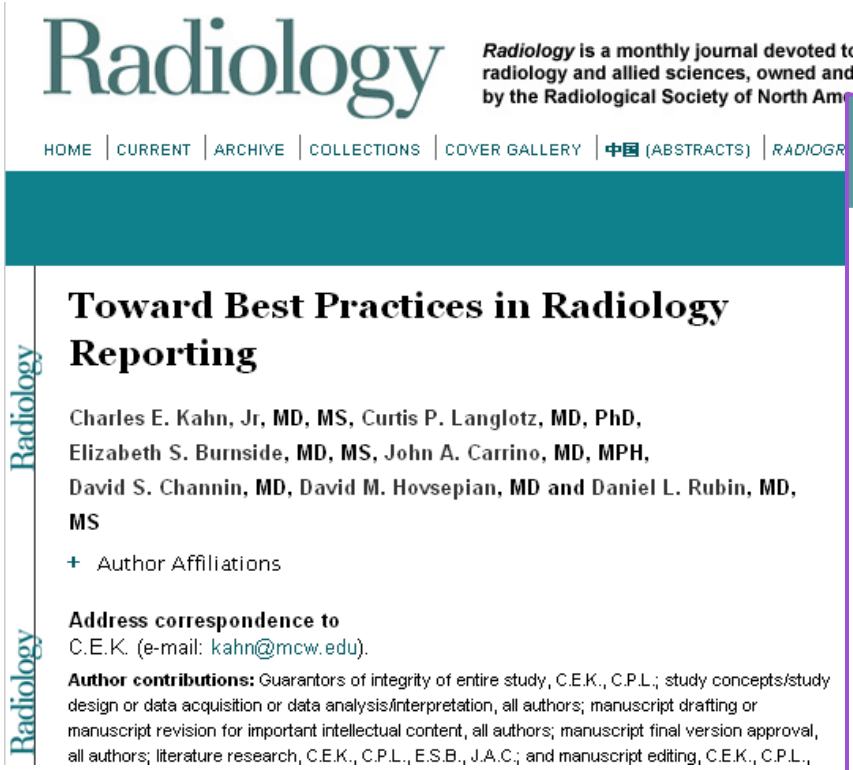
~~2013~~ 2014 increases requirements

- Care coordination documentation in accordance with Consolidated CDA Implementation Guide
- Presumably may include structured radiology reports (not mandated)

~~2015~~ ?? scope under discussion

- May have specialty structured reporting requirements

It's not only ARRA/HITECH



Radiology

Radiology is a monthly journal devoted to clinical radiology and allied sciences, owned and publishe by the Radiological Society of North Am

HOME | CURRENT | ARCHIVE | COLLECTIONS | COVER GALLERY | 中国 (ABSTRACTS) | RADIOGR

Radiology

Radiology

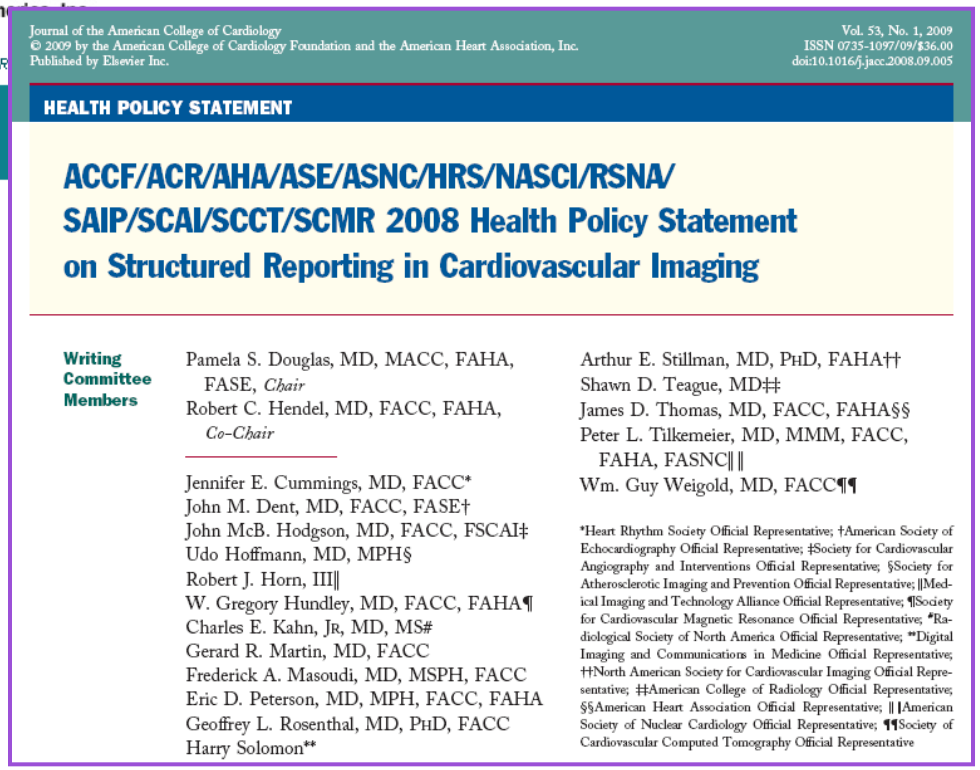
Toward Best Practices in Radiology Reporting

Charles E. Kahn, Jr, MD, MS, Curtis P. Langlotz, MD, PhD, Elizabeth S. Burnside, MD, MS, John A. Carrino, MD, MPH, David S. Channin, MD, David M. Hovsepian, MD and Daniel L. Rubin, MD, MS

+ Author Affiliations

Address correspondence to
C.E.K. (e-mail: kahn@mcw.edu).

Author contributions: Guarantors of integrity of entire study, C.E.K., C.P.L.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; manuscript final version approval, all authors; literature research, C.E.K., C.P.L., E.S.B., J.A.C.; and manuscript editing, C.E.K., C.P.L.,



Journal of the American College of Cardiology
© 2009 by the American College of Cardiology Foundation and the American Heart Association, Inc.
Published by Elsevier Inc.

Vol. 53, No. 1, 2009
ISSN 0735-1097/09/$36.00
doi:10.1016/j.jacc.2008.09.005

HEALTH POLICY STATEMENT

ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/ SAIP/SCAI/SCCT/SCMR 2008 Health Policy Statement on Structured Reporting in Cardiovascular Imaging

Writing Committee Members

Pamela S. Douglas, MD, MACC, FAHA, FASE, *Chair*
Robert C. Hendel, MD, FACC, FAHA, *Co-Chair*

Jennifer E. Cummings, MD, FACC*
John M. Dent, MD, FACC, FASE†
John McB. Hodgson, MD, FACC, FSCAI‡
Udo Hoffmann, MD, MPH§
Robert J. Horn, III‖
W. Gregory Hundley, MD, FACC, FAHA¶
Charles E. Kahn, JR, MD, MS#
Gerard R. Martin, MD, FACC
Frederick A. Masoudi, MD, MSPH, FACC
Eric D. Peterson, MD, MPH, FACC, FAHA
Geoffrey L. Rosenthal, MD, PHD, FACC
Harry Solomon**
Arthur E. Stillman, MD, PHD, FAHA††
Shawn D. Teague, MD‡‡
James D. Thomas, MD, FACC, FAHA§§
Peter L. Tilkemeier, MD, MMM, FACC, FAHA, FASNC‖‖
Wm. Guy Weigold, MD, FACC¶¶

*Heart Rhythm Society Official Representative; †American Society of Echocardiography Official Representative; ‡Society for Cardiovascular Angiography and Interventions Official Representative; §Society for Atherosclerotic Imaging and Prevention Official Representative; ‖Medical Imaging and Technology Alliance Official Representative; ¶Society for Cardiovascular Magnetic Resonance Official Representative; #Radiological Society of North America Official Representative; **Digital Imaging and Communications in Medicine Official Representative; ††North American Society for Cardiovascular Imaging Official Representative; ‡‡American College of Radiology Official Representative; §§American Heart Association Official Representative; ‖‖American Society of Nuclear Cardiology Official Representative; ¶¶Society of Cardiovascular Computed Tomography Official Representative

It's a RADIOLOGY best practice

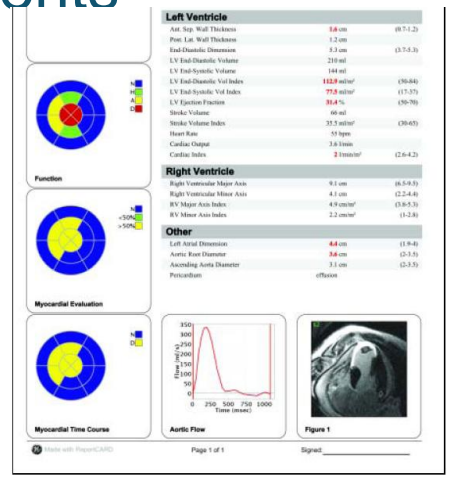
Goals of Electronic Reporting

Improved report quality

+ Completeness, clarity, consistency, reproducibility

Improved accuracy/evidentiary basis

+ Quantitative data, CAD and other measurements
+ Attached key images and graphical analysis (picture = 1000 words)



More timely communication

Improved secondary uses

Features facilitated by structured reporting

Report auto-population with image post-processing measurements

Patient longitudinal progress tracking

- Therapy decision support

Billing accuracy (avoid undercoding)

Data collection for research

- Evidence-based medicine
- Quality measures and quality improvement

Potential pitfalls of eReporting

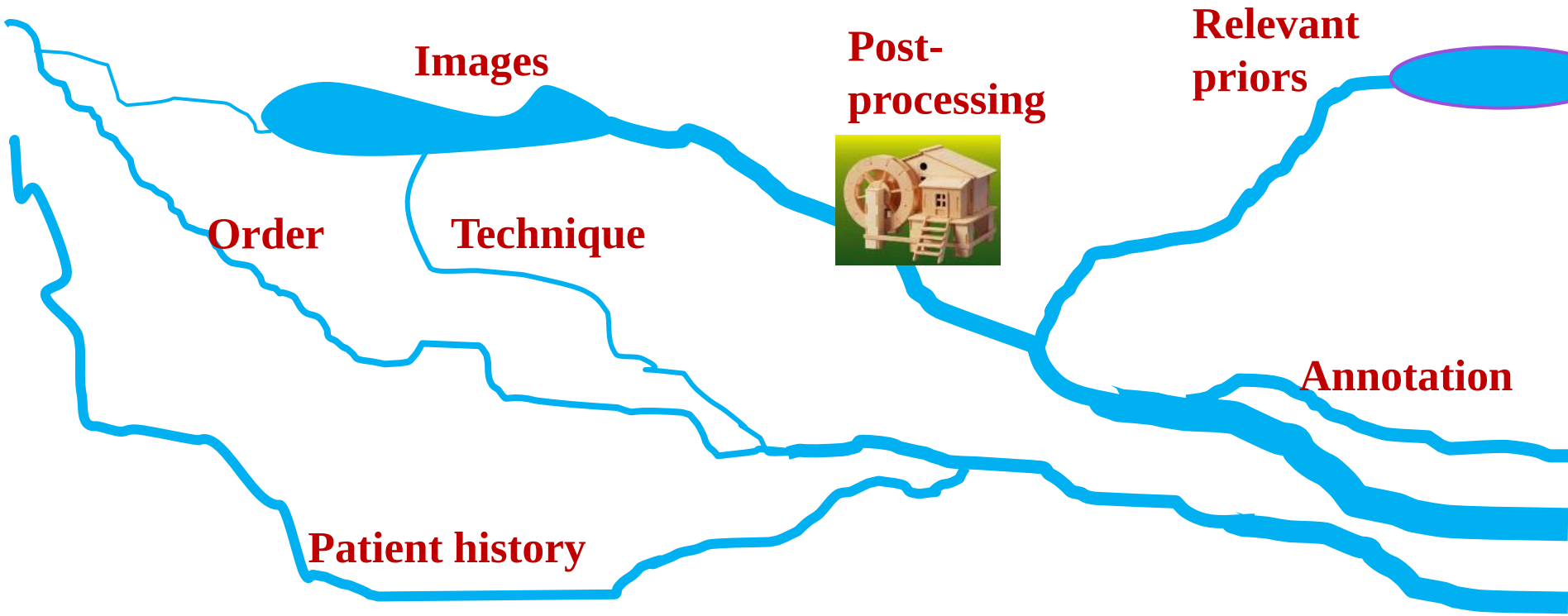
This is process re-engineering

- New systems
- New architectures
- New policies and procedures

Avoid placing the whole burden of transition on the radiologist

- Must not impact radiologist throughput, while still achieving improvement goals

The tributaries of eReporting



All these streams of data are in disjoint systems or data stores – how do we pull them together?

Interoperability & Standards

A conceptual framework

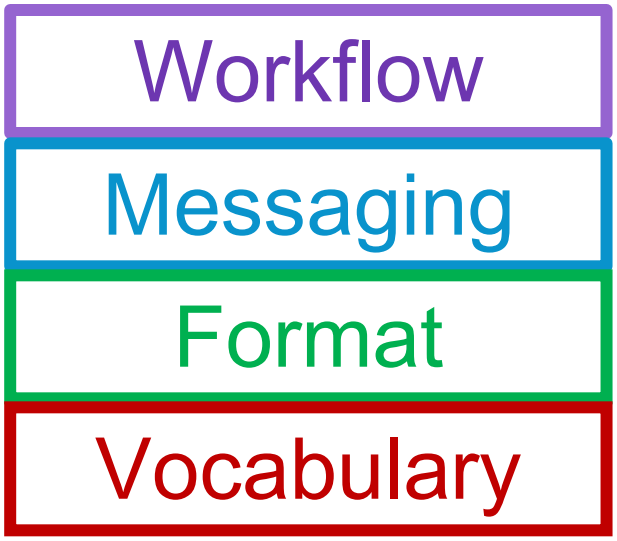
Interoperability

in·ter·op·er·a·bil·i·ty (n) The ability of two or more systems or components to exchange information and to **use** the information that has been exchanged.

- *IEEE Computer Dictionary*

"**Use**" has many connotations

Four level model of "use" in interoperability



business process : tasks

exchange : mail

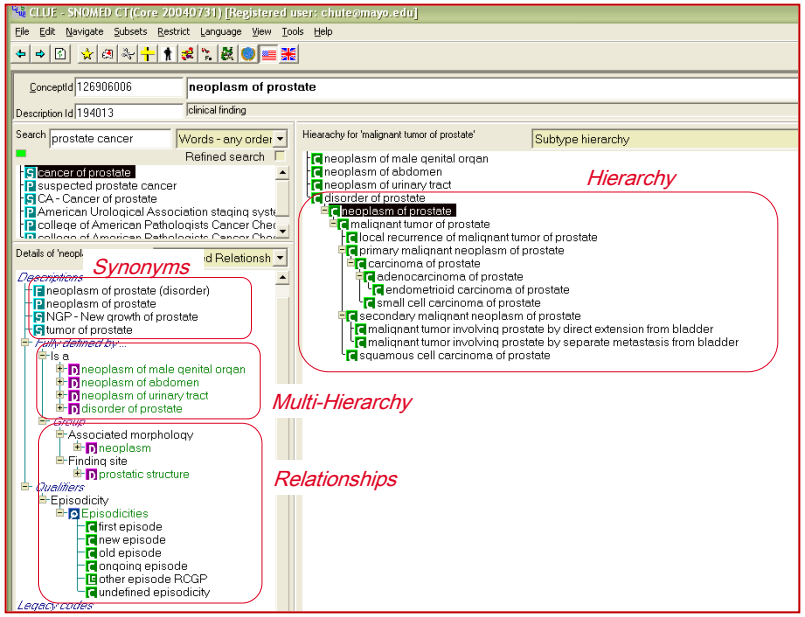
data record : document

terminology : words

Vocabulary

Controlled terminology representing semantic concepts

- Examples: RadLex, SNOMED-CT



Format

Format of a composed unit of exchanged information supporting a specific function

- Example: HL7v2 ORU message

ORU^R01^ORU_R01	Unsolicited Observation Message	Status	Chapter
MSH	Message Header		2
[{ SFT }]	Software Segment		2
[UAC]	User Authentication Credential		2
{	--- PATIENT_RESULT begin		
[	--- PATIENT begin		
PID	Patient Identification		3
[PD1]	Additional Demographics		3
[{NTE}]	Notes and Comments		2
[{NK1}]	Next of Kin/Associated Parties		3
[{OBX}]	Observation (for Patient ID)		7
[	--- VISIT begin		
PV1	Patient Visit		3
[PV2]	Patient Visit - Additional Info		3
]	--- VISIT end		
]	--- PATIENT end		
{	--- ORDER_OBSERVATION begin		
[ORC]	Order common		4
OBR	Observations Request		7
{[NTE]}	Notes and comments		2
[{ROL}]	Role (for observation)		15
[{	--- TIMING_QTY begin		
TQ1	Timing/Quantity		4
[{TQ2}]	Timing/Quantity Order Sequence		4
}]	--- TIMING_QTY end		
[CTD]	Contact Data		11
[{	--- OBSERVATION begin		
OBX	Observation related to OBR		7
{[NTE]}	Notes and comments		2
}]	--- OBSERVATION end		
[{FT1}]	Financial Transaction		6

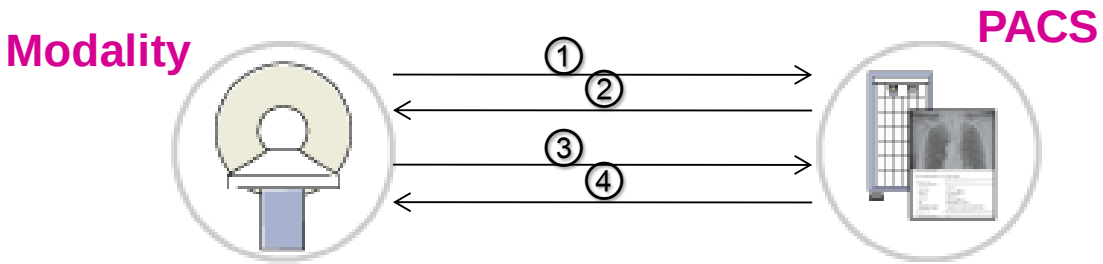
HL7 Attribute Table – OBR – Observation Request

SEQ	LEN	DT	OPT	RP/#	TBL#	ITEM #	ELEMENT NAME
1	4	SI	O			00237	Set ID – OBR
2	427	EI	C			00216	Placer Order Number
3	427	EI	C			00217	Filler Order Number
4	705	CWE	R		9999	00238	Universal Service Identifier
5	2	ID	B			00239	Priority
6	24	DTM	B			00240	Requested Date/Time
7	24	DTM	C			00241	Observation Date/Time #
8	24	DTM	O			00242	Observation End Date/Time #
9	722	CQ	O			00243	Collection Volume *
10	3220	XCN	O	Y		00244	Collector Identifier *
11	1	ID	O		0065	00245	Specimen Action Code *
12	705	CWE	O		9999	00246	Danger Code
13	300	ST	O			00247	Relevant Clinical Information
14	24	DTM	B			00248	Specimen Received Date/Time *
15	300	SPS	B			00249	Specimen Source
16	3220	XCN	O	Y		00226	Ordering Provider
17	2743	XTN	O	Y/2		00250	Order Callback Phone Number
18	199	ST	O			00251	Placer Field 1

Messaging

Reliable transport of a composed unit of information from one system to another

- Example: DICOM Network Storage Service

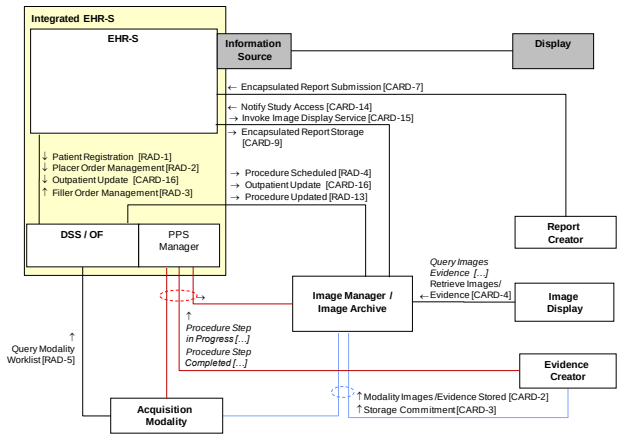


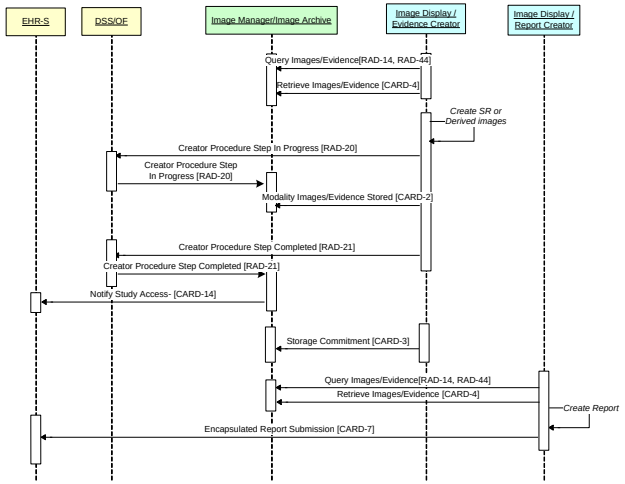
Workflow

Workflow
Messaging
Format
Vocabulary

Interaction among multiple users and systems (actors) to achieve a specific task

- Example: IHE Image Enabled Office Workflow





Implementing Interoperability

Prerequisite: Owners of systems need to agree to exchange information

Negotiate the details of the exchange

Implement the software (and communications hardware) in each system

Test the implementations against each other before field deployment

In the ~~good~~ *bad* old days we developed a new interface specification for each pair of systems

Standard Definition of "Standard"

Document, established by consensus and approved by a recognized body, that provides, **for common and repeated use**, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

ISO/IEC Guide 2:2004 *Standardization and related activities -- General vocabulary*

ISO International Organization for Standardization

IEC Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

The essence of standards – amortize the cost of design over many implementations

Standards and the Economics of Interoperability

Without standards, everything is a custom integration

- Custom jobs inherently expensive
- Must negotiate both financial *and technical* terms
- Non-expert consumers at competitive disadvantage

Standard "sockets" between components

- Allow user choice of component implementer
- Allow vendors to specialize in improving components

Standards allow "retail users" to leverage best practice

- Domain expertise codified into standard
- Expertise reproduced into each compliant system

Standards make a market

Use of standards is always an economic issue

Standards-based Interoperability

Negotiate the details of the exchange

- Standard specifies most, if not all, the technical details

Implement the software (and communications hardware) in each system

- Standards can be implemented in reusable toolkits

Test the implementations against each other before field deployment

- Standards allow significant independent validation

Interoperability

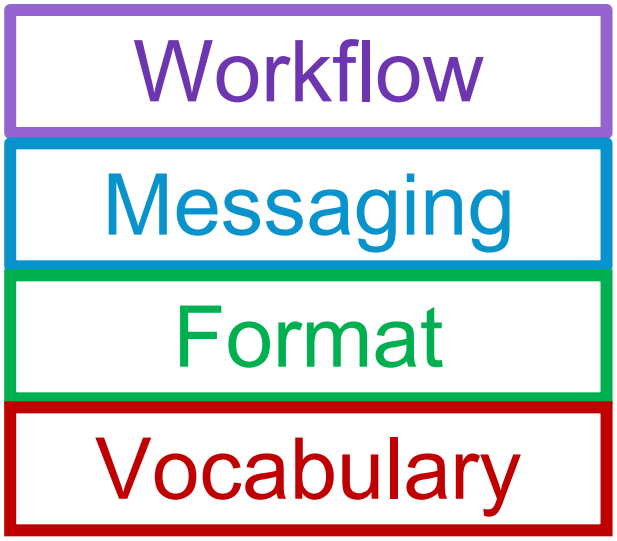
The ability of two or more systems or components to exchange information and to use the information that has been exchanged.

Standards

A consensus specification of rules for repeatable activities or uniform characteristics of products in a given context.

Interoperability is silent on the method used to achieve the result. **Standards** provide a method that is economically effective.

Four aspects of interoperability



business process : tasks

exchange : mail

data record : document

terminology : words

Reporting Workflow

well, actually several partial workflows …

Gathering Evidence

Post-imaging measurement or analytic results

- Computer aided detection
- Sonographer measurements
- Image Selection / Annotation

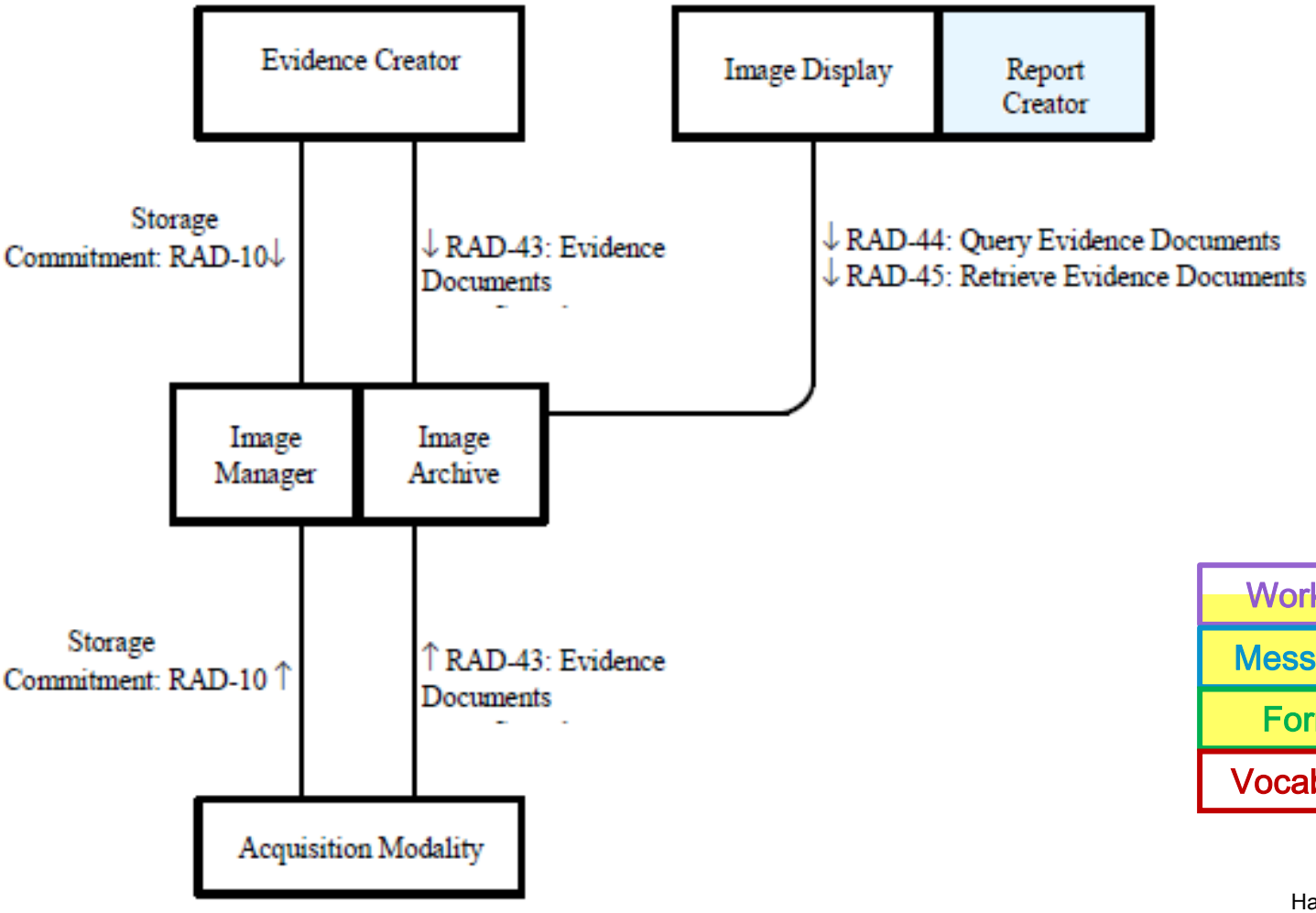
IHE Evidence Documents Profile

- Establishes DICOM Structured Reporting as principal format for intermediate imaging results

DICOM Dictation-Based Reporting with Image References

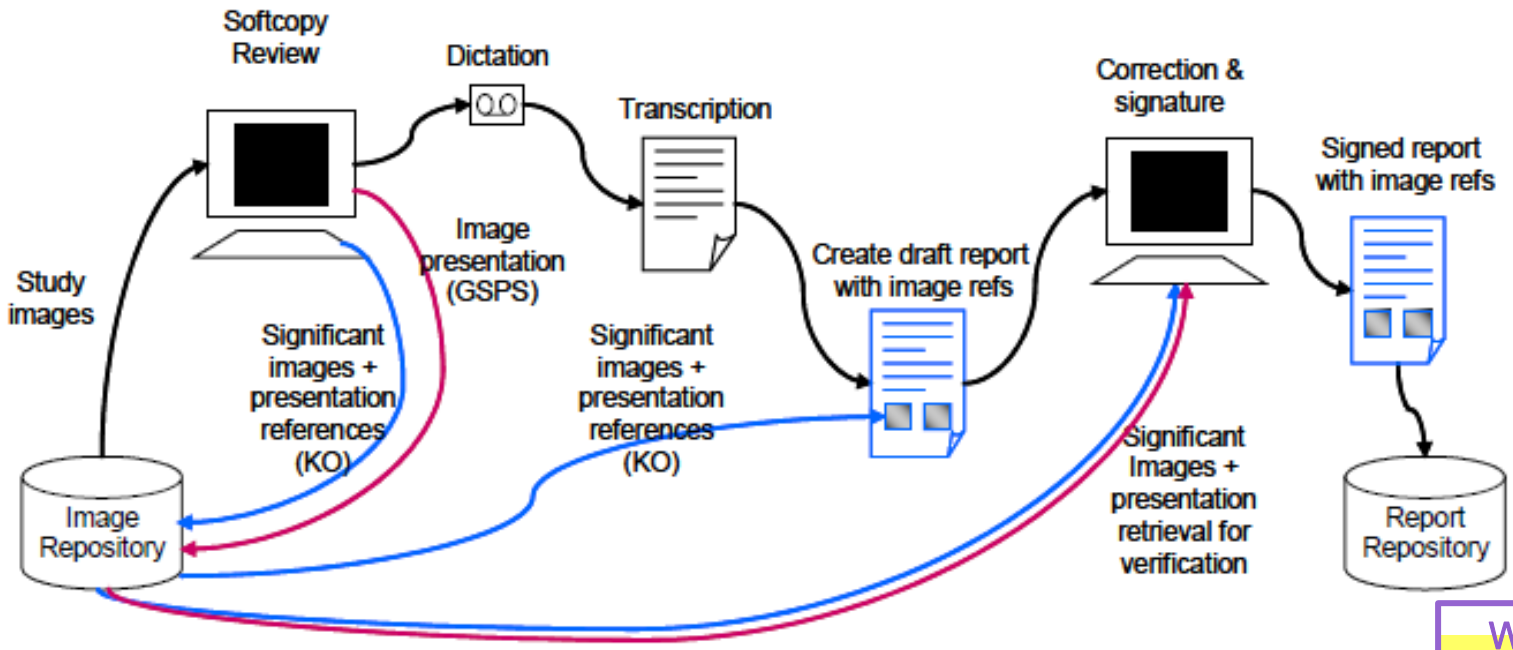
- Uses Key Object Selection and Softcopy Presentation State as means to add annotated images to report

IHE Evidence Documents Profile



Workflow
Messaging
Format
Vocabulary

DICOM Reporting with Image References



Core Reporting Process

Produce report document with content necessary to manage patient, bill properly, and support quality improvement

- Completeness, clarity, consistency, reproducibility
- Based on consensus templates

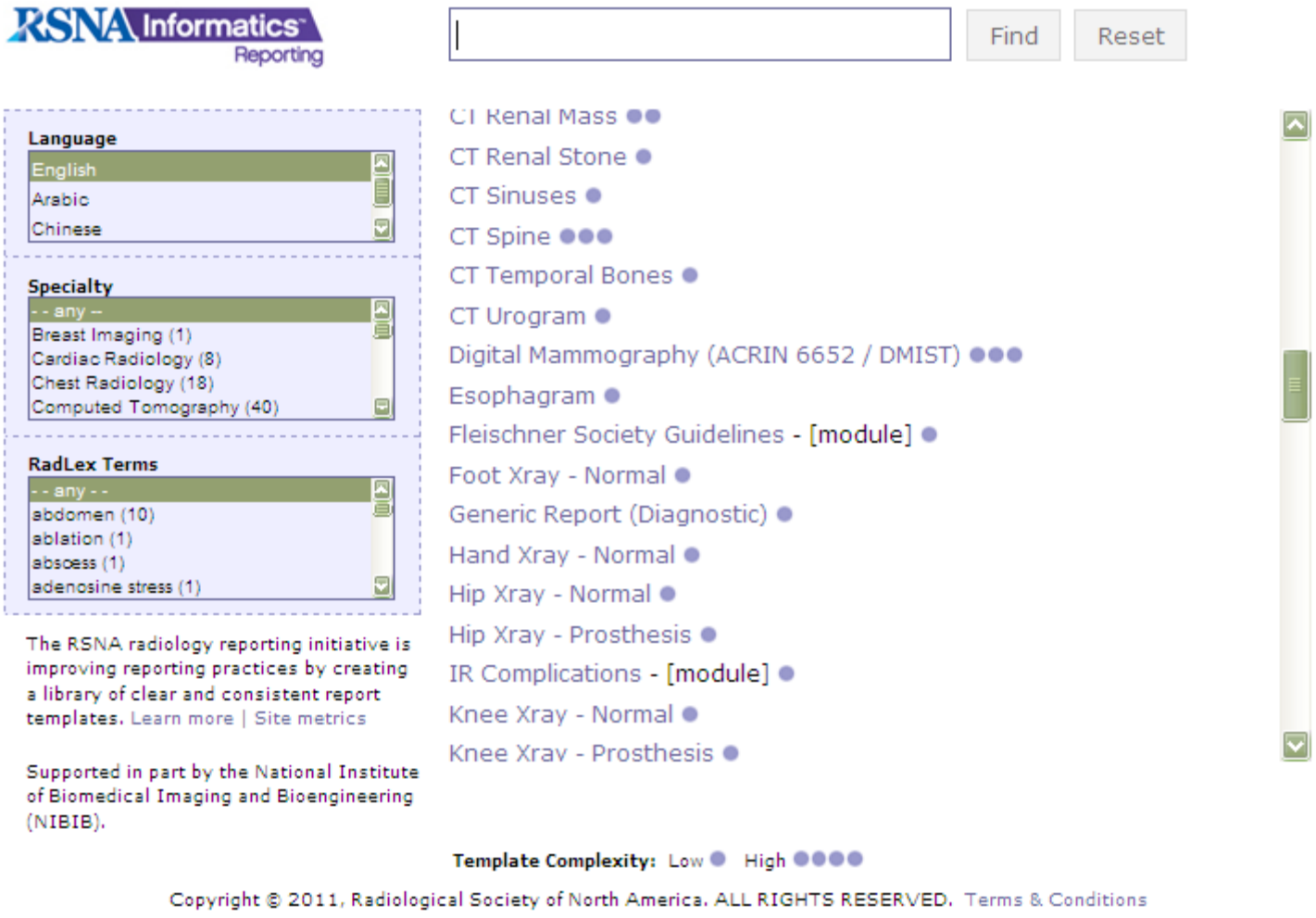
RSNA Reporting Templates

- 130+ procedure specific report formats linked to RadLex terminology

IHE Cardiac Imaging Report Content Template

- Implementation Guide for HL7 Clinical Document Architecture based on ACC/et al. Key Data Elements for Cardiac Imaging, linked to SNOMED/LOINC/DICOM

RSNA Reporting Templates



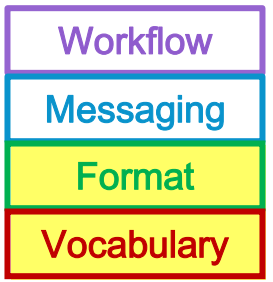
Workflow
Messaging
Format
Vocabulary

IHE Cardiac Imaging Report Content

Table 6.2.1.1.6-1 Cardiac Imaging Report Content Specification

Template ID	1.3.6.1.4.1.19376.1.4.1.1.1
Parent Template	Medical Document 1.3.6.1.4.1.19376.1.5.3.1.1.1 [PCC TF-2] Procedure Note 2.16.840.1.113883.10.20.18.1 [CDA-PN]
General Description	The Cardiac Imaging Report Content template specifies the content structure for a clinical report of a cardiology imaging exam, recorded in a DICOM Study. Such exams include: • Echocardiography (transthoracic – TTE, transesophageal – TEE, and TTE stress) • Cardiac computed tomography (angiography – CTA, and coronary artery calcium scoring – CACS) • Cardiac magnetic resonance (angiography – MRA, and MR stress) • Cardiovascular nuclear medicine (SPECT myocardial perfusion, positron emission tomography – PET) • Diagnostic coronary catheter based fluoroscopy (interventional coronary angiography – ICA, and left ventriculography – LVG) The template uses discrete data elements as described in the ACC/AHA/et al. 2008 Key Data Elements and Definitions for Cardiac Imaging.
Document Code	MAY be 18748-4, LOINC, "Diagnostic Imaging Study report"

Opt	Data Element or Section Name	Template ID	Specification Document	Constraint
	Header Elements			
M [1..1]	Encompassing Encounter	1.3.6.1.4.1.19376.1.4.1.3.1	CARD TF-2 6.2.3.1	
R [0..1]	Order	1.3.6.1.4.1.19376.1.4.1.3.2	CARD TF-2 6.2.3.2	
M [1..1]	Patient Demographics	1.3.6.1.4.1.19376.1.4.1.3.3	CARD TF-2 6.2.3.3	
M [1..1]	Service Event and Performer	1.3.6.1.4.1.19376.1.4.1.3.4	CARD TF-2 6.2.3.4	CARD TF-2 6.2.1.1.6.1
M [1..1]	Legal Authenticator	1.3.6.1.4.1.19376.1.4.1.3.5	CARD TF-2 6.2.3.5	
	Sections			
M [1..1]	Medical History (Cardiac)	1.3.6.1.4.1.19376.1.4.1.2.1	CARD TF-2 6.2.2.1	
M [1..1]	Medications	1.3.6.1.4.1.19376.1.5.3.1.3.19	PCC TF-2	CARD TF-2 6.2.1.1.6.2
M [1..1]	Allergies and Other Adverse Reactions	1.3.6.1.4.1.19376.1.5.3.1.3.13	PCC TF-2	CARD TF-2 6.2.1.1.6.3
R [1..1]	Coded Social History	1.3.6.1.4.1.19376.1.5.3.1.3.16.1	PCC TF-2	CARD TF-2



Publishing Report

Submit report from a reporting app to the EMR

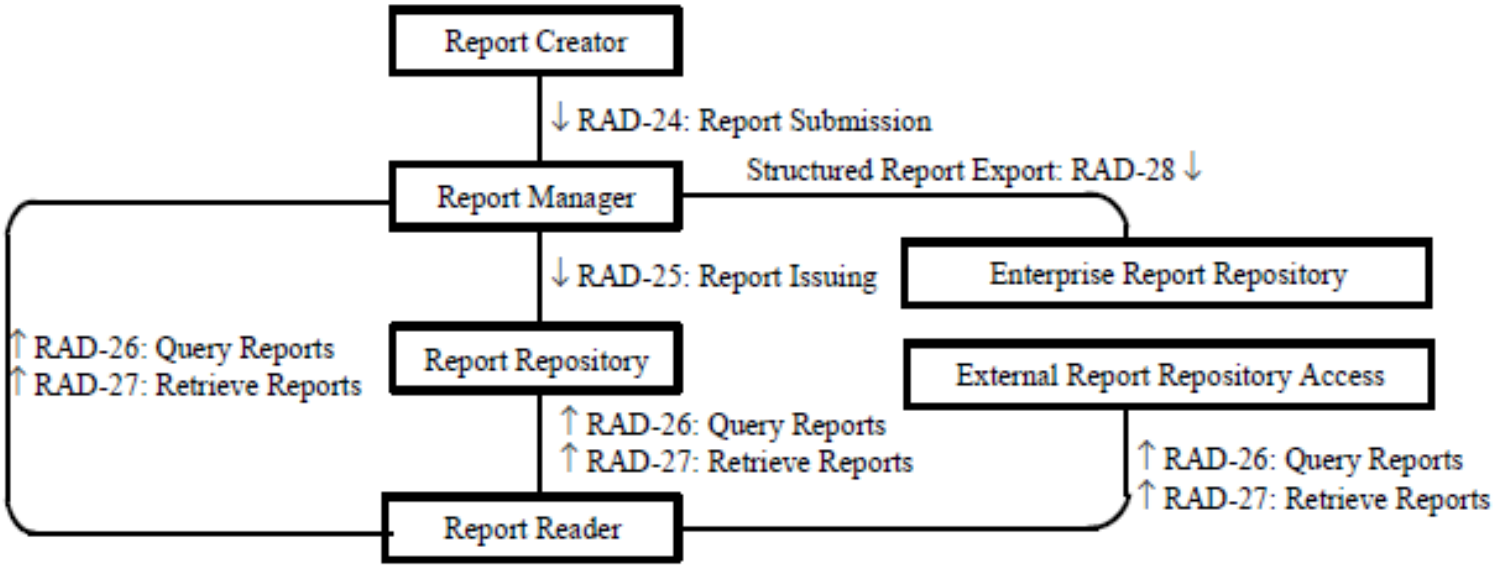
IHE Simple Image and Numeric Report Profile

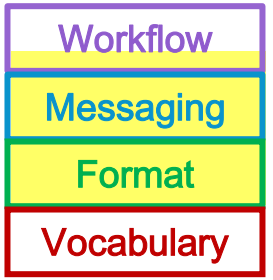
- Report created as DICOM SR using Template 2000
- Transcoded and submitted using HL7 v2 ORU

IHE Displayable Reports Profile

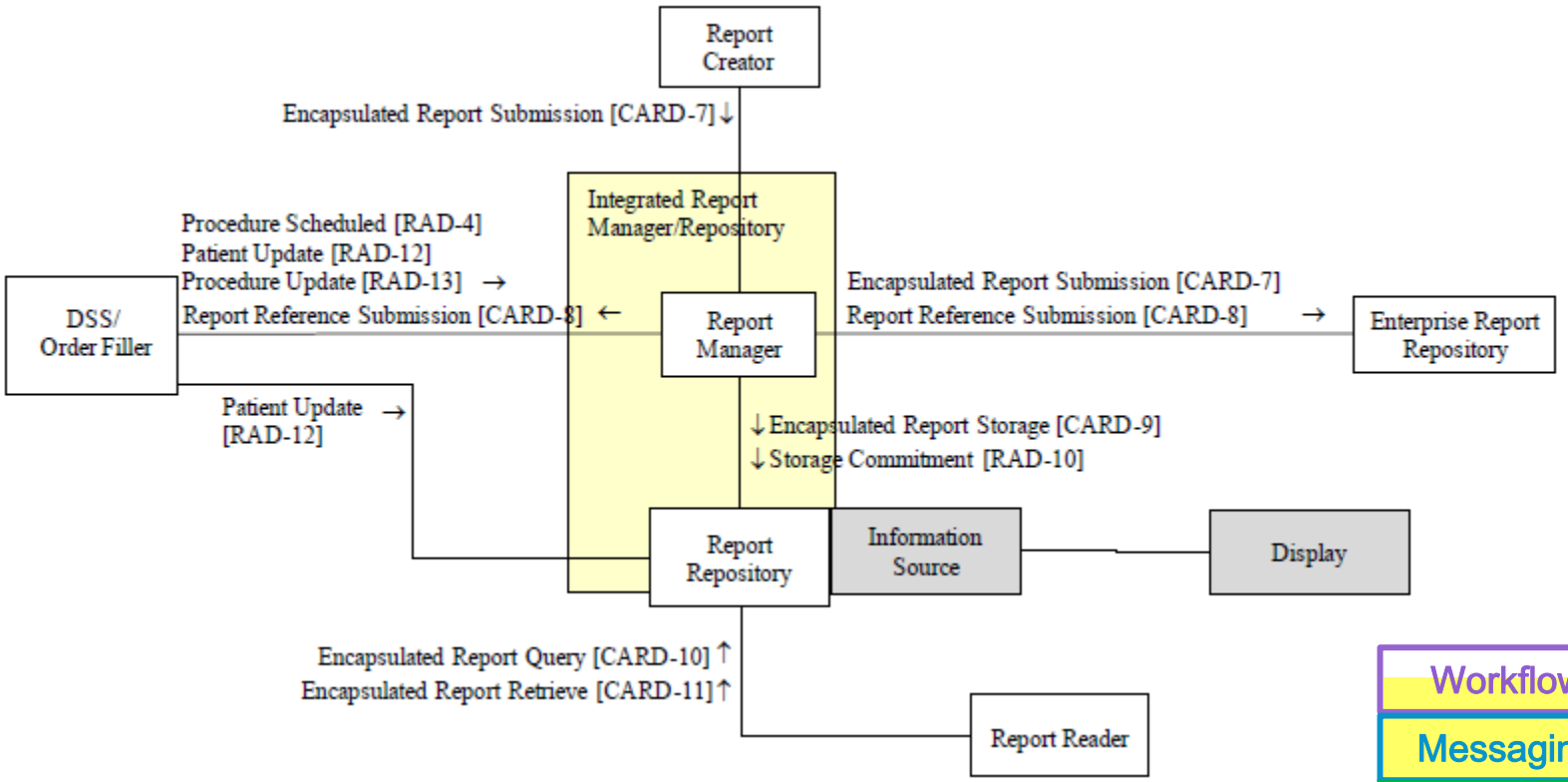
- Report created as PDF or CDA
- Encapsulated and submitted using HL7 v2 MDM
- May also be stored in PACS as DICOM Encapsulated Document

IHE Simple Image and Numeric Report





IHE Displayable Reports



Cross-institutional report exchange

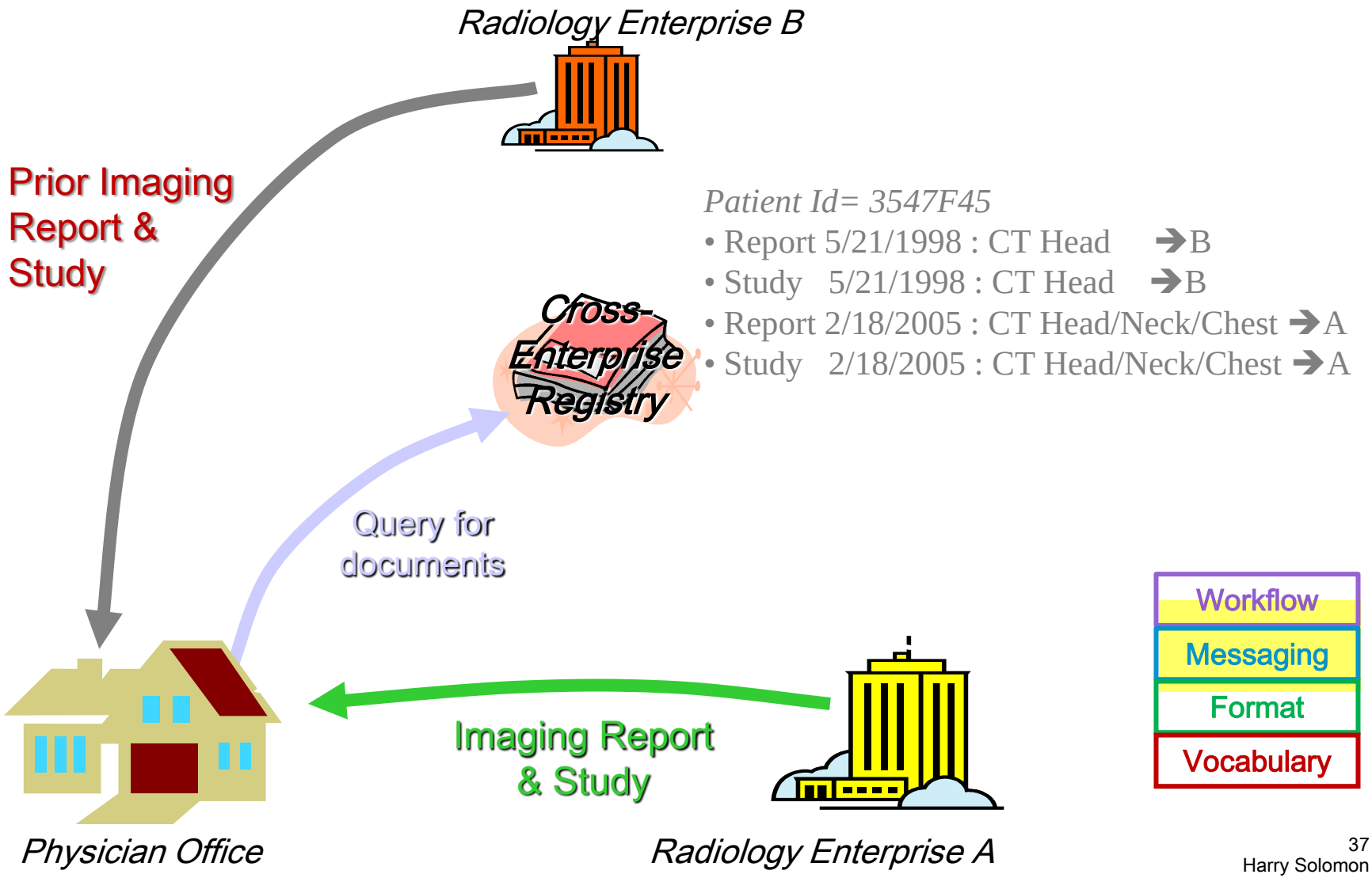
Send report to referring or other physician

IHE Cross-enterprise Document Sharing Profiles (XDS / XDR / XDM)

IHE XDS for Imaging (XDS-I), Portable Data for Imaging (PDI)

- Share report through Health Information Exchange, by direct network connection, or on media (CD/DVD)
- Share entire study (including images) through HIE or on media

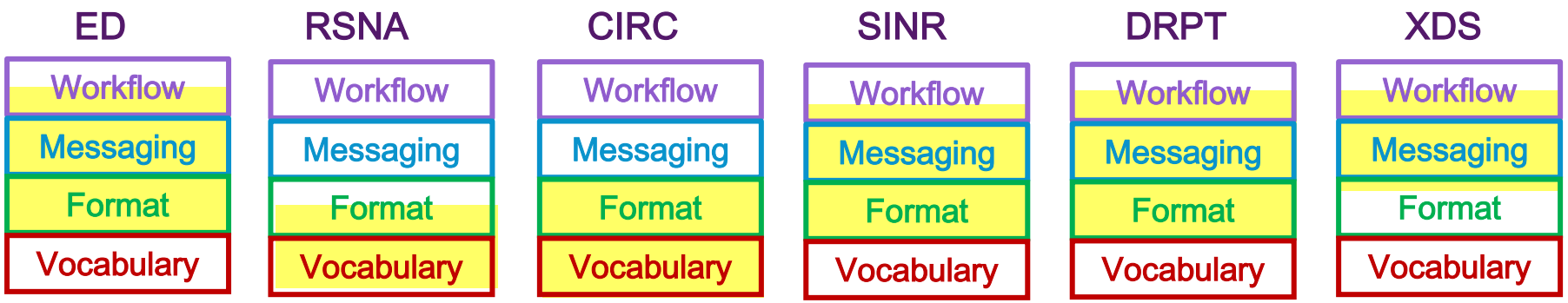
IHE XDS-I


Radiology Enterprise B
Prior Imaging Report & Study
Patient Id= 3547F45
• Report 5/21/1998 : CT Head ➔B
• Study 5/21/1998 : CT Head ➔B
• Report 2/18/2005 : CT Head/Neck/Chest ➔A
• Study 2/18/2005 : CT Head/Neck/Chest ➔A
Cross-Enterprise Registry
Query for documents
Imaging Report & Study
Workflow
Messaging
Format
Vocabulary
Physician Office
Radiology Enterprise A

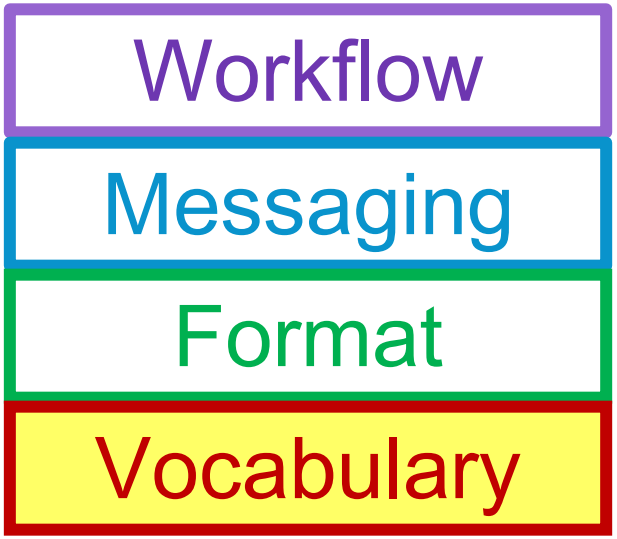
Reporting Workflow – are we there yet?

Many partial solutions

But perhaps that's all we can get, given the diversity of reporting targets, methods, and uses



Standards for Reporting Vocabulary



SNOMED
RadLex
LOINC
ICD

Systematized Nomenclature of Medicine - Clinical Terms

Most comprehensive clinical healthcare terminology

Primary external vocabulary system for HL7 and DICOM

Originally developed by the College of American Pathologists, now managed by an international consortium of governmental agencies (IHTSDO)

Australia	Lithuania	Spain
Canada	Malta	Sweden
Cyprus	New Zealand	The Netherlands
Denmark	Singapore	United Kingdom
Estonia	Slovak Republic	United States
Iceland	Slovenia	

SNOMED CT

>357,000 concepts; 19 Hierarchies

1.2M English language descriptions or synonyms

900,000 defining semantic relationships

Languages: English, Spanish, German

Cross Mappings:

- ICD-9-CM; ICD-O3; LOINC®; ICD-10 (UK Edition); OPCS-4 (UK Edition); NIC; NOC; NANDA; PNDS; Clinical Care Classification (CCC, formerly HHCC); The Omaha System

SNOMED CT Root Hierarchies

Clinical Finding
- Finding *(Swelling of arm)*
- Disease *(Pneumonia)*

Procedure/intervention *(Biopsy of lung)*

Observable entity *(Tumor stage)*

Body structure *(Structure of thyroid)*

Organism *(DNA virus)*

Substance *(Gastric acid)*

Pharmaceutical/biologic product *(Tamoxifen)*

Specimen (*Urine specimen)*

Situation with explicit context *(Family history observation)*

Physical object *(Suture needle)*

Physical force *(Friction)*

Events *(Flash flood)*

Environments/geographical locations *(Intensive care unit)*

Social context *(Organ donor)*

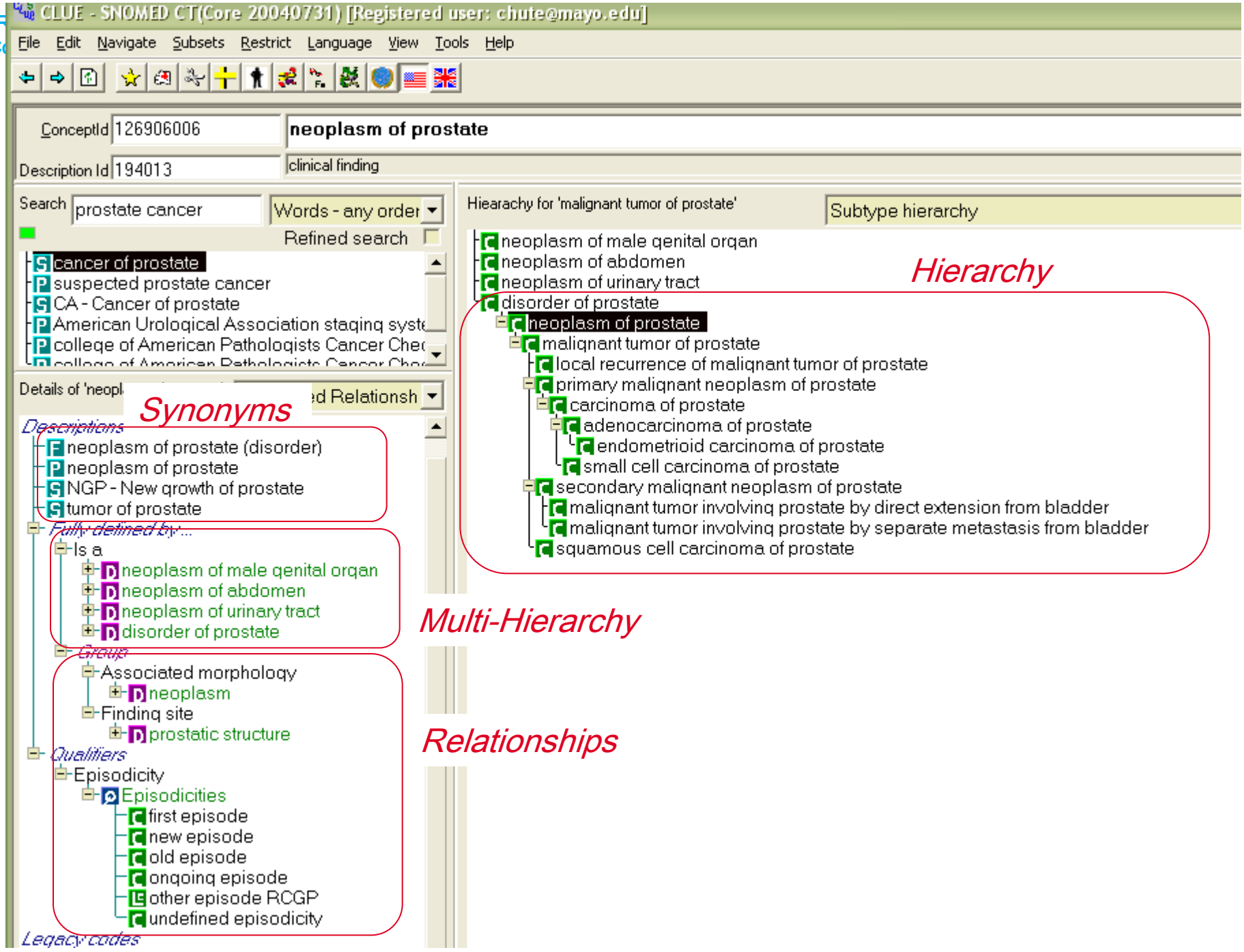
Context-dependent categories *(No nausea)*

Staging and scales *(Nottingham ten-point ADL index)*

Record artifact *(Relief notes)*

Qualifier value *(Bilateral)*

Special Concept *(Inactive concept)*


CLUE - SNOMED CT(Core 20040731) [Registered user: chute@mayo.edu]
File Edit Navigate Subsets Restrict Language View Tools Help
ConceptId 126906006
neoplasm of prostate
Description Id 194013
clinical finding
Search prostate cancer
Words - any order
Refined search
cancer of prostate
suspected prostate cancer
CA - Cancer of prostate
American Urological Association staging syste
college of American Pathologists Cancer Chec
Hiearachy for 'malignant tumor of prostate'
Subtype hierarchy
neoplasm of male genital organ
neoplasm of abdomen
neoplasm of urinary tract
disorder of prostate
neoplasm of prostate
malignant tumor of prostate
local recurrence of malignant tumor of prostate
primary malignant neoplasm of prostate
carcinoma of prostate
adenocarcinoma of prostate
endometrioid carcinoma of prostate
small cell carcinoma of prostate
secondary malignant neoplasm of prostate
malignant tumor involving prostate by direct extension from bladder
malignant tumor involving prostate by separate metastasis from bladder
squamous cell carcinoma of prostate
Hierarchy
Details of 'neopl
d Relationsh
Synonyms
Descriptions
neoplasm of prostate (disorder)
neoplasm of prostate
NGP - New growth of prostate
tumor of prostate
Fully defined by ...
Is a
neoplasm of male genital organ
neoplasm of abdomen
neoplasm of urinary tract
disorder of prostate
Group
Associated morphology
neoplasm
Finding site
prostatic structure
Qualifiers
Episodicity
Episodicities
first episode
new episode
old episode
ongoing episode
other episode RCGP
undefined episodicity
Legacy codes
Multi-Hierarchy
Relationships

RadLex®

Unified source of radiology terms for organizing and retrieving images and imaging reports

- Replacement for the ACR Index for Radiological Diagnoses

34,000 concept terms focused on Imaging Methods and Imaging Results

- Devices and acquisition parameters(“RadLex Playbook”)
- Imaging indications, findings, anatomy, diagnoses

Sponsored by the RSNA, collaboration with ACR

- Supported by National Institute of Biomedical Imaging and Bioengineering (NIBIB) and Cancer Biomedical Informatics Grid (caBIG)

RadLex Categories

Object *(collimator)*

Procedure *(colonography)*

Report component *(impression)*

Anatomical entity *(adrenal region)*

Imaging observation *(lace-like pattern of joint)*

Radlex non-anatomical set *(Set of bi-rads mammo terms)*

Non-anatomical substance *(radioisotope)*

Physiological condition *(neoplasm)*

Assessment *(Bi-rads 4c)*

Imaging modality *(fluoroscopy)*

Property *(Patient position)*

Imaging procedure attribute *(Late venous phase)*

Procedure step *(Treatment planning procedure step)*

Report

Logical Observation Identifier Names and Codes

Standard coding system for laboratory and clinical observations

- Hosted by Regenstrief Institute
- Supported by National Library of Medicine

Facilitates the exchange and pooling of clinical and laboratory results

- Supports clinical care, outcomes management, and research
- Specifically provides a universal ID for the OBX-3 (Observation ID) in HL7 v2.x messages, or the Observation.code value for HL7 v3

LOINC 2.36 (June 2011) has 65,004 codes (laboratory and clinical) and over 275,000 relationships

Laboratory LOINC Subject Areas

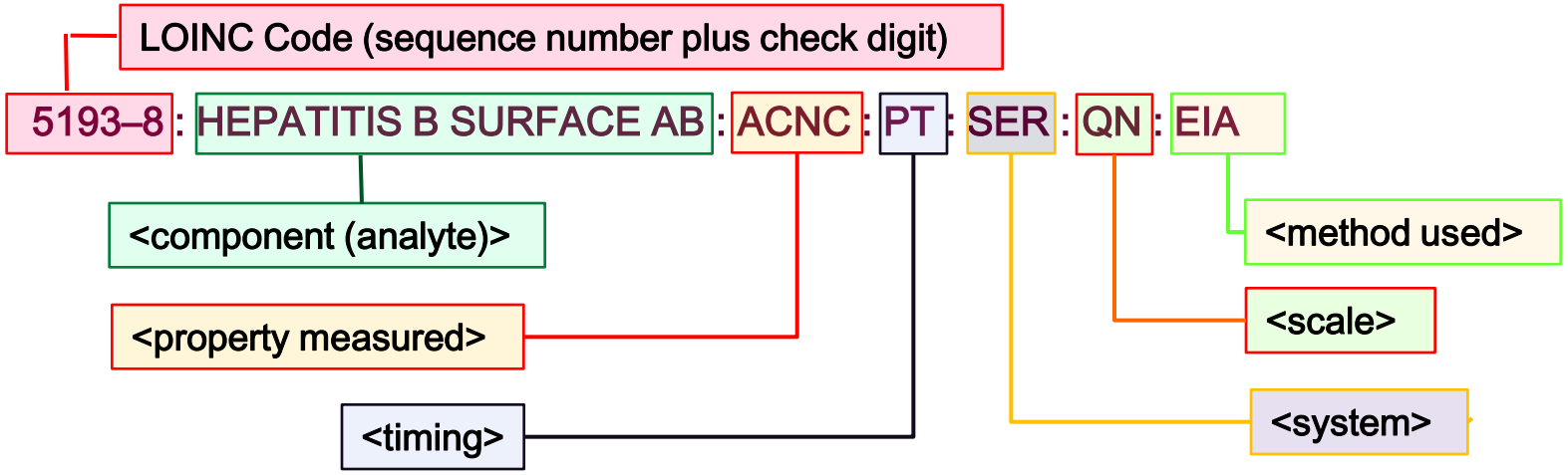
- Chemistry
- Urinalysis
- Toxicology
- Hematology
- Microbiology
- Antibiotic Susceptibilities
- Immunology/Serology
- Molecular Genetics
- Serology
- Cell counts
- Allergy testing
- Blood Bank
- Cell Markers
- Skin tests
- Coagulation
- Cytology
- Fertility Testing
- HLA antigens
- Microbiology
- Surgical Pathology

Clinical LOINC Subject Areas

- Vital Signs
- Hemodynamics
- Fluid Intake/Output
- Body Measurements
- Operative Notes
- Emergency Department
- History & Physical
- Standard survey instruments
- Respiratory Therapy
- Colonoscopy/Endoscopy
- EKG (ECG)
- Cardiac Ultrasound
- Obstetrical Ultrasound
- Radiology reports
- Discharge Summary
- Pathology Findings
- Tumor Registry
- Clinical Documents
- Document sections

Anatomy of a LOINC Term

Code : Component : Property : Timing : Sample : Scale : Method



**Six axes developed for labs,
applied (not totally successfully) to clinical observations**

International Classification of Disease (ICD)

1855 – International Statistical Congress adopts classification of causes of mortality based on work of Farr (1839)

1948 – List expanded to specify non-fatal diseases, and control passed to World Health Organization

Primary purpose to support vital and health statistics

Additional uses in classification of medical care

Adapted/extended for local use by national authorities

- US: ICD-9-CM; Australia: ICD-10-AM

Currently in 10th revision (ICD-10); planning underway for 11th revision

ICD-10 Structure

Three character basic classification (ANN), with 4th digit subdivision

- H90 Conductive and sensorineural hearing loss
- H90.4 Sensorineural hearing loss, unilateral with unrestricted hearing on the contralateral side

ICD-10-AM (Australia)

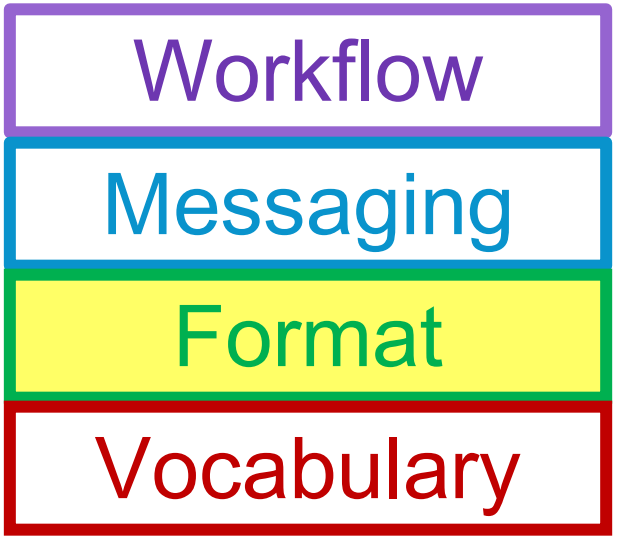
- Adds fifth and sixth digit for further subdivision of diseases
- Adds procedure coding based on Commonwealth Medicare Benefits Schedule
  - Example : 41542-00 Myringoplasty with ossicular chain reconstruction

ICD-10-CM (US)

- Up to seven characters for diseases + encounter
  - Example : T81.535A, Perforation due to foreign body accidently left in body following heart catheterization, Initial encounter
- ICD-10-PCS for procedures
  - Example : 0DNE2ZZ Release Large Intestine, Open Endoscopic Approach

Standards for Reporting Format

DICOM Structured Reporting
HL7 Clinical Document Architecture
RSNA Templates



DICOM
Structured Reporting
Overview

DICOM is a Standards Development Organization whose domain is biomedical imaging

DICOM Structured ~~Reporting~~ *Results*

The scope of DICOM SR is the standardization of structured data and clinical observations in the imaging environment.

SR objects record observations made for an imaging-based diagnostic or interventional procedure, particularly those that describe or reference images, waveforms, or specific regions of interest.

Most important in the stages before report creation

What's important about DICOM SR?

DICOM SR is the standard to exchange structured data produced with image acquisition or post-processing, where:

- Leveraging the DICOM infrastructure is easy and desirable
- Results should be managed with other study evidence

Replaces legacy kludges

- Manually transcribed worksheets, screen scrapes from analysis apps, one-off integrations

Examples

- Sonographer measurements
- Computer-aided detection results
- QC notes about images
- Radiation dose reports
- Image exchange manifests

Key Aspects of DICOM SR

SR documents are encoded using DICOM standard data elements and leverage DICOM network services (storage, query/retrieve)

SR uses DICOM Composite Object model

- Patient/Study/Series information model (header)
- Hierarchical tree of “Content Items” (instead of image)

Extensive use of coded nomenclature

- Allows use of vocabulary/codes from non-DICOM sources (SNOMED, LOINC, RadLex)

Templates define content constraints for specific types of documents / reports

SR Content Item Tree

Content Items are units of meaning …

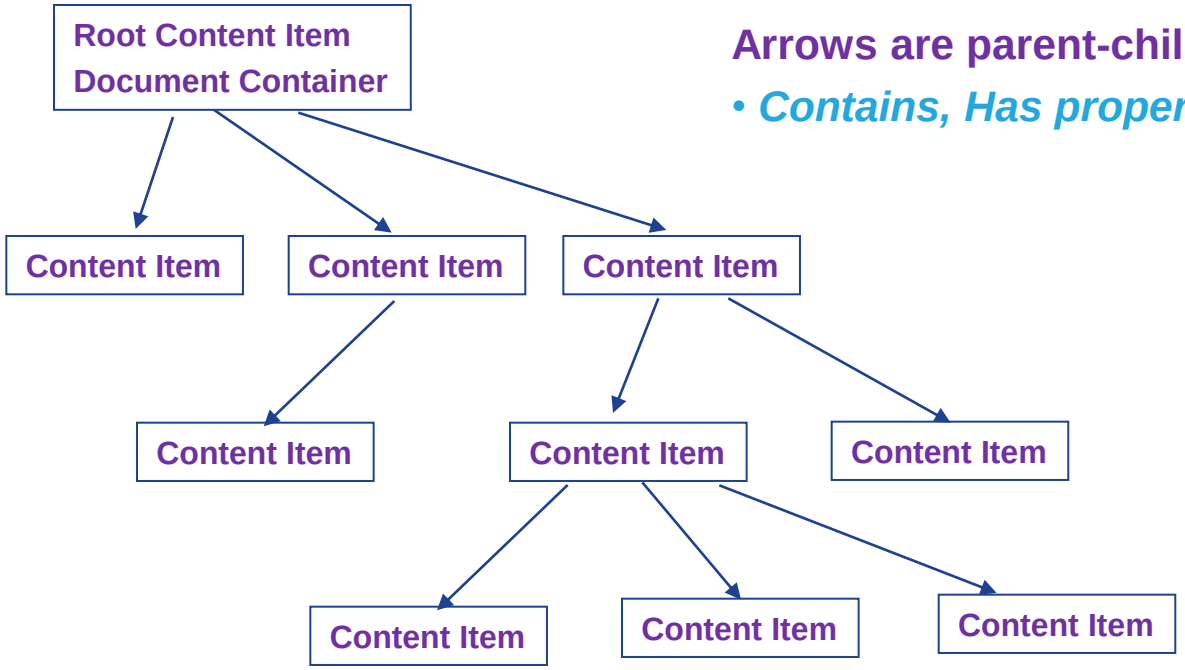
- ***Text, Numeric, Code, Image, Spatial coordinates, etc.***

… or units of structure

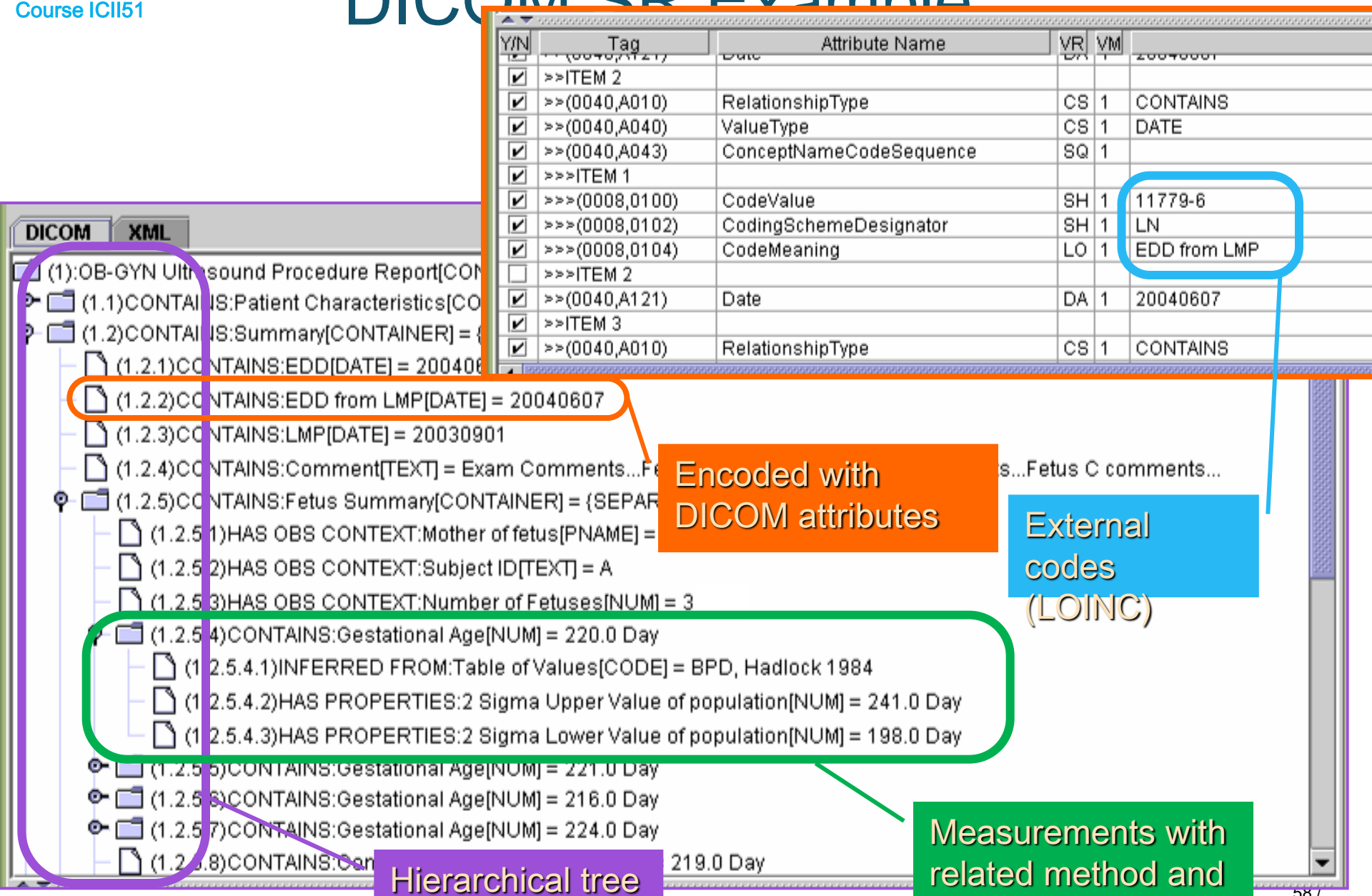
- ***Container***

Arrows are parent-child relationships

- ***Contains, Has properties, Inferred from, etc.***



DICOM SR Example



Example : SR Rendering

X-Ray Radiation Dose Report

Patient ID:	ALL_TAGS_ONE	**Name:**	TAGS ONE ALL
Birth date:	1999-06-16	**Age:**	10 (10)
Sex:	Male	**Ethnic Group:**	
Exam Date:	2009-09-25, 07:46:15	**Exam No.:**	10
Accession Number:	10000003	**Content Date:**	2009-09-25, 07:46:15

Weight:	**Body Surface Area:**
Height:	**Body Mass Index:**

Cardiologist:	**Referring Physician:**

Completion flag: COMPLETE **Verification flag:** UNVERIFIED

Procedure reported	Computed Tomography X-Ray
Observer Type	Device
Device Observer UID	1.2.840.113619.6.267
Device Observer Name	ctbay57
Device Observer Manufacturer	GE Medical Systems
Device Observer Model Name	Discovery CT750 HD
Start of X-ray Irradiation	2009-09-25, 07:46:15
End of X-ray Irradiation	2009-09-25, 07:52:31
Scope of Accumulation	Study
Study Instance UID	1.2.276.0.7230010.442.408.1371999

CT Accumulated Dose Data

Total Number of Irradiation Events	10.0 {events}
CT Dose Length Product Total	1,473.5 mGycm

CT Acquisition

Target Region	Head
CT Acquisition Type	Constant Angle Acquisition
Irradiation Event UID	1.2.840.113619.2.267.1.2654289.1253883151.806.124
CT Acquisition Parameters	
Exposure Time	2.0 s
Scanning Length	200.0 mm
Nominal Single Collimation Width	1.2 mm
Nominal Total Collimation Width	200.0 mm
Number of X-ray Sources	1.0 X-ray sources
CT X-ray Source Parameters	
Identification of the X-ray Source	1
KVP	120.0 kV
Maximum X-ray Tube Current	10.0 mA
X-Ray Tube Current	10.0 mA

Format and Content

The basic DICOM SR standard is about format or structure

- The grammar for constructing sentences and paragraphs and documents

That structure needs to be filled in with content to enable meaningful receiving applications

- Specific words put together to convey meaning

Certain classes of documents have consistent patterns of content

- This is purpose of ***Templates***

SR Templates

Documentation patterns for SR content

- Define attributes (concepts), required/optional, and allowed values
- Specify hierarchical structure of sections and subsections (containers)

Specified for a variety of uses, often in conjunction with specialty societies

- OB/GYN, vascular, echo, and IVUS ultrasound
- X-ray, CT, and MR angiography
- Mammo, chest, and colon computer-aided detection
- Radiation dose

DICOM Standard Part 16 has over 250 defined Templates, and over 800 associated value sets (Context Groups)

SR Template Example – Document with sections

TID 5000
OB-GYN Ultrasound Procedure Report
Type: Extensible Order: Significant

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (125000, DCM, "OB-GYN Ultrasound Procedure Report")	1	M		
9	>	CONTAINS	INCLUDE	DTID (5005) Fetal Biometry Section	1-n	U		
10	>	CONTAINS	INCLUDE	DTID (5006) Long Bones Section	1-n	U		
11	>	CONTAINS	INCLUDE	DTID (5007) Fetal Cranium Section	1-n	U		
12	>	CONTAINS	INCLUDE	DTID (5009) Fetal Biophysical Profile Section	1-n	U		
13	>	CONTAINS	INCLUDE	DTID (5011) Early Gestation Section	1-n	U		
14	>	CONTAINS	INCLUDE	DTID (5010) Amniotic Sac Section	1	U		

SR Template Example – Section with numeric data

TID 5001
OB-GYN PATIENT CHARACTERISTICS
Type: Extensible

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (121118, DCM, "Patient Characteristics")	1	M		
2	>	CONTAINS	TEXT	EV (121106, DCM, "Comment")	1	U		
3	>	CONTAINS	NUM	EV (8302-2, LN, "Patient Height")	1	U		
4	>	CONTAINS	NUM	EV (29463-7, LN, "Patient Weight")	1	U		
5	>	CONTAINS	NUM	EV (11996-6, LN, "Gravida")	1	U		
6	>	CONTAINS	NUM	EV (11977-6, LN, "Para")	1	U		
7	>	CONTAINS	NUM	EV (11612-9, LN, "Aborta")	1	U		
8	>	CONTAINS	NUM	EV (33065-4, LN, "Ectopic Pregnancies")	1	U		

DICOM SR Object Classes

General use Enhanced and Comprehensive - Text, coded content, numeric measurements, spatial and temporal ROI references (any template)

CAD - Automated analysis results (Mammo, Chest, Colon)

Key Object Selection (KO) - Flags one or more images

- Purpose ("for referring physician", "for surgery", …) and textual note
- Used for key image notes and image manifests (in IHE profiles)

Procedure Log - For extended duration procedures (e.g., cath)

Radiation Dose Report - Projection X-ray; CT

(in development) Contrast Agent Use Report - From smart injectors

IHE SR-related Profiles

IHE Evidence Documents Integration Profile specifies use of DICOM SR

- Specific options (defined by IHE Cardiology) for CTA/MRA (Template 3900), echocardiography (Template 5200), etc.

Key Image Notes Integration Profile allows tagging of images for further use

- Particularly key image to attach to report

Radiation Exposure Monitoring Profile captures interoperable dose measurements

- Aligned with international dose standards

HL7
Clinical Document Architecture
Overview

HL7 is a Standards Development Organization whose domain is clinical and administrative data

HL7 Clinical Document Architecture

The scope of the CDA is the standardization of clinical documents for exchange.

A clinical document is a record of observations and other services with the following characteristics:

- Persistence
- Stewardship
- Potential for authentication
- Wholeness
- Human readability

A CDA document is a defined and complete information object that can exist outside of a message, and can include text, images, sounds, and other multimedia content.

Clinical Document Characteristics

Persistence
- Documents exist over time and can be used in many contexts

Stewardship
- Documents must be managed, shared by the steward organization

Potential for authentication
- Intended use as medico-legal documentation

Wholeness
- Document includes its relevant context
- Findings are presented within that context

Human readability
- Attested content is human readable narrative (see authentication)
- Additional computer processable markup allowed/encouraged

CDA Use Cases

Diagnostic and therapeutic procedure reports

Encounter / discharge summaries

Patient history & physical

Referrals

Claims attachments

Consistent format for all clinical documents

Key Aspects of the CDA

CDA documents are encoded in Extensible Markup Language (XML)

CDA documents derive their meaning from the HL7 v3 Reference Information Model (RIM) and use HL7 v3 Data Types

CDA documents consist of a header and a body

- *Header* is consistent across all clinical documents - identifies and classifies the document, provides information on patient, provider, encounter, and authentication
- *Body* contains narrative text / multimedia content (level 1), optionally augmented by coded equivalents (levels 2 & 3)

CDA documents may be constrained by a Template

eXtensible Markup Language (XML)

A standard of the World Wide Web Consortium (www.w3c.org)

In XML, structure & format are conveyed by *markup* that is embedded into the information

XML markup is application independent, makes information processable across applications, over time

- information + <markup> = asset

```
- <section>
  - <caption>
      <caption_cd V="10164-2" S="2.16.840.1.113883.6.1" />
      History of Present Illness
    </caption>
  - <paragraph>
      <content>Henry Levin, the 7th is a 67 year old male referred for further
      asthma management. Onset of asthma in his teens. He was
      hospitalized twice last year, and already twice this year. He has not
      been able to be weaned off steroids for the past several
      months.</content>
    </paragraph>
```

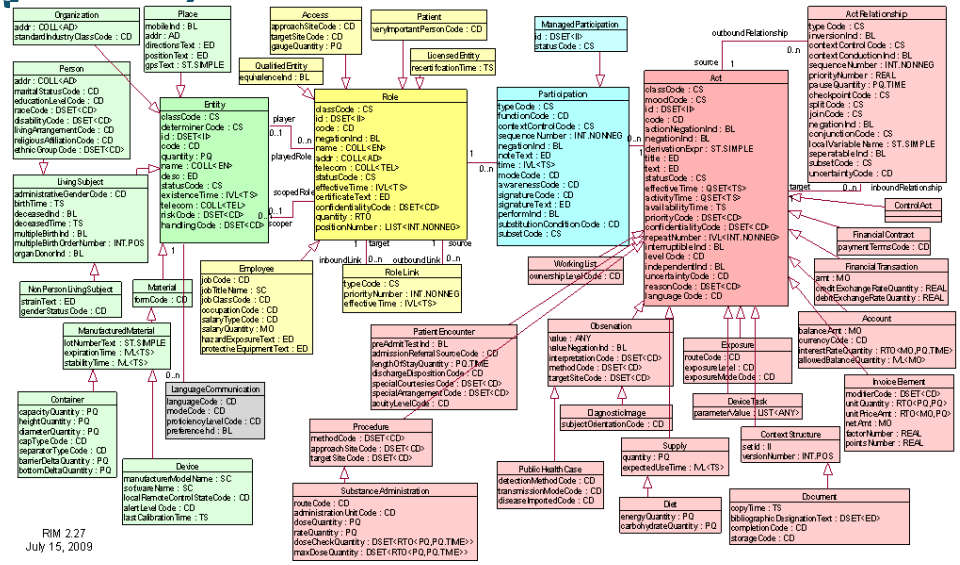
HL7 v3 Reference Information Model (RIM)

Intended as a universal conceptual structure for healthcare information

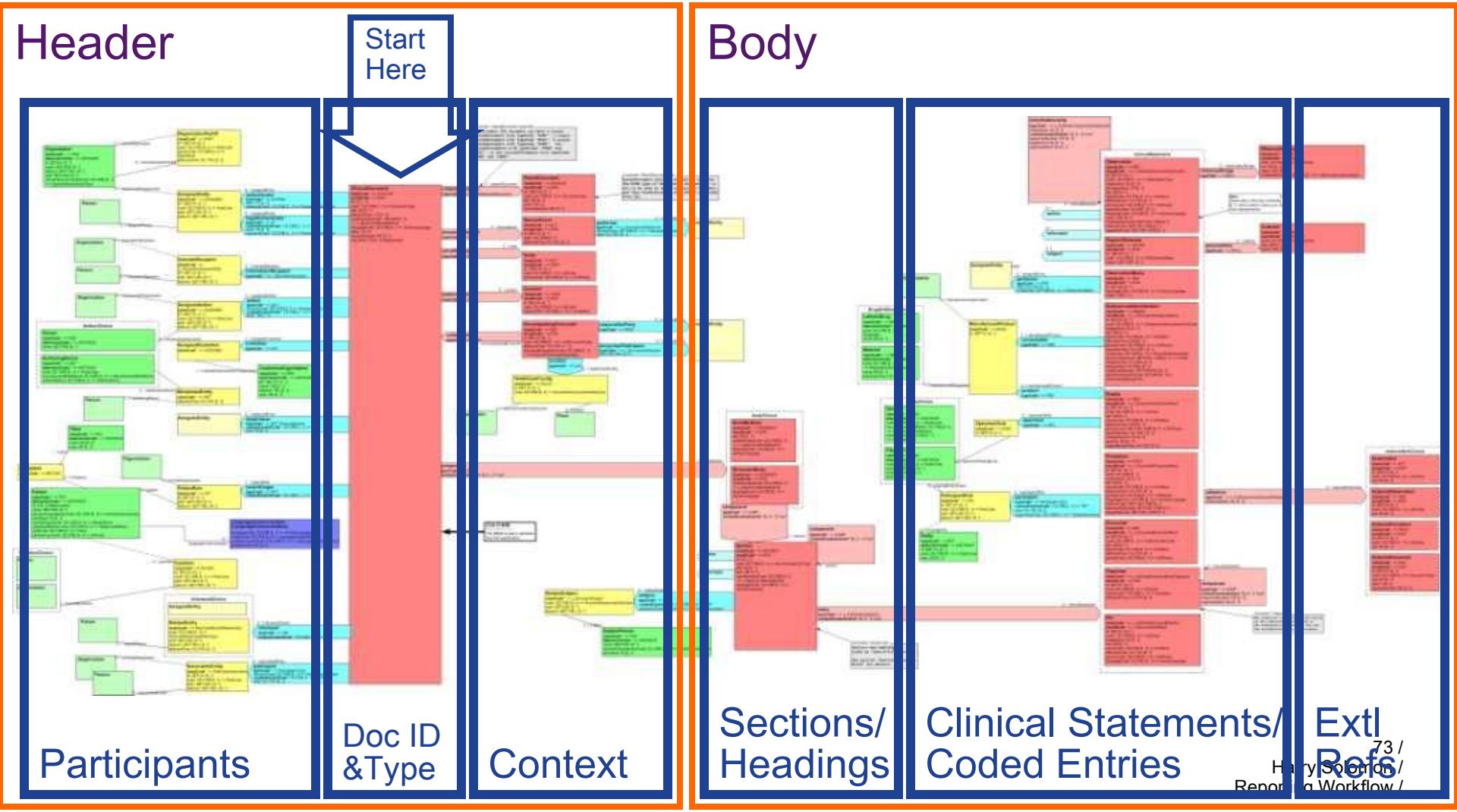
Allows information modeling: *explicit representation of the semantic and lexical connections between units of information*

Allows transformation of models into structures of a particular computer language (especially XML)

ISO Standard for international work in health informatics (ISO 21731)



CDA Release 2 Information Model



CDA Structured Body

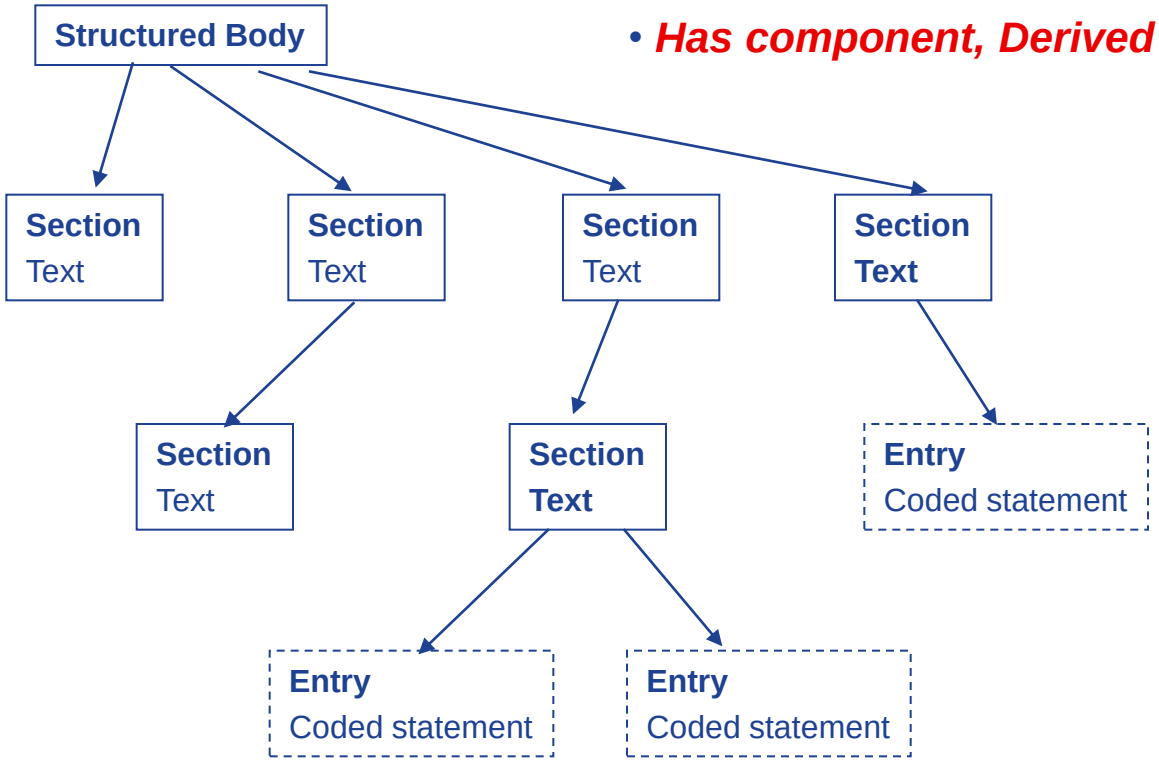
Sections are structures with attested narrative

Entries are coded clinical statements

- ***Observation, Procedure, Substance administration, etc.***

Arrows are Act Relationships

- ***Has component, Derived from, etc.***



Good Health Clinic Consultation Note - M

File Edit View Go Bookmarks Tools Help

Subscribe with Blogli...

Good Health C

Patient: Henry Levin , the 7th

Birthdate: September 24, 1932

Consultant: Robert Dolin , MD

History of Present Illness

Henry Levin, the 7th is a 67 year o
asthma in his teens. He was hospitali
been able to be weaned off steroids

Past Medical History

- Asthma
- Hypertension (see HTN.cda for deta
- Osteoarthritis, right knee

Medications

- Theodur 200mg BID
- Proventil inhaler 2puffs QID PRN
- Prednisone 20mg qd

Back Search Favorites

```
+ <custodian>
- <recordTarget>
  - <patient>
      <id extension="12345" root="2.16.840.1.113883.3.933" />
    - <patientPatient>
      - <name>
          <given>Henry</given>
          <family>Levin</family>
          <suffix>the 7th</suffix>
        </name>
        <administrativeGenderCode code="M" codeSystem="2.16.840.1.113883.5.1" />
        <birthTime value="19320924" />
      </patientPatient>
    + <providerOrganization>
    </patient>
  </recordTarget>
+ <relatedDocument typeCode="RPLC">
+ <componentOf>
- <!--

    ************************************************************
      CDA Body
    ************************************************************
  -->
- <component>
  - <structuredBody>
    - <!--

        ************************************************************
          History of Present Illness section
        ************************************************************
      -->
    - <component>
      - <section>
          <code code="10164-2" codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC" />
          <title>History of Present Illness</title>
        - <text>
          - <content styleCode="Bold">
              Henry Levin, the 7
              <sup>th</sup>
```

Principle of *Human Readability*: Narrative and Coded Information

CDA structured body ***requires*** human-readable "Narrative Block", all that is needed to reproduce the legally attested clinical content

CDA allows ***optional*** machine-readable coded "Entries", which drive automated processes

By starting with a base of text, CDA allows incremental improvement to amount of coded data without breaking the model

Narrative and Coded Entry Example

History of Present Illness

Henry Levin, the 7th is a 67 year old male referred for
asthma in his teens. He was hospitalized twic
been able to be weaned off steroids for the p

Past Medical History

- Asthma
- Hypertension (see HTN.cda for details)
- Osteoarthritis, right knee

Medications

```
<title>Past Medical History</title>
- <text>
  - <list>
    - <item>
        <content ID="a1">Asthma</content>
      </item>
    + <item>
    + <item>
    </list>
  </text>
```

Implementation Guides and Templates

CDA is a very generic structure focused on human-readable content

- Great for minimally marked-up documents
- Very simple to render narrative content

Machine processing (more powerful apps) requires standardization of CDA structures and entries

- Implementation guides for specific clinical uses
- Templates define structure and content constraints

CDA Implementation Guides

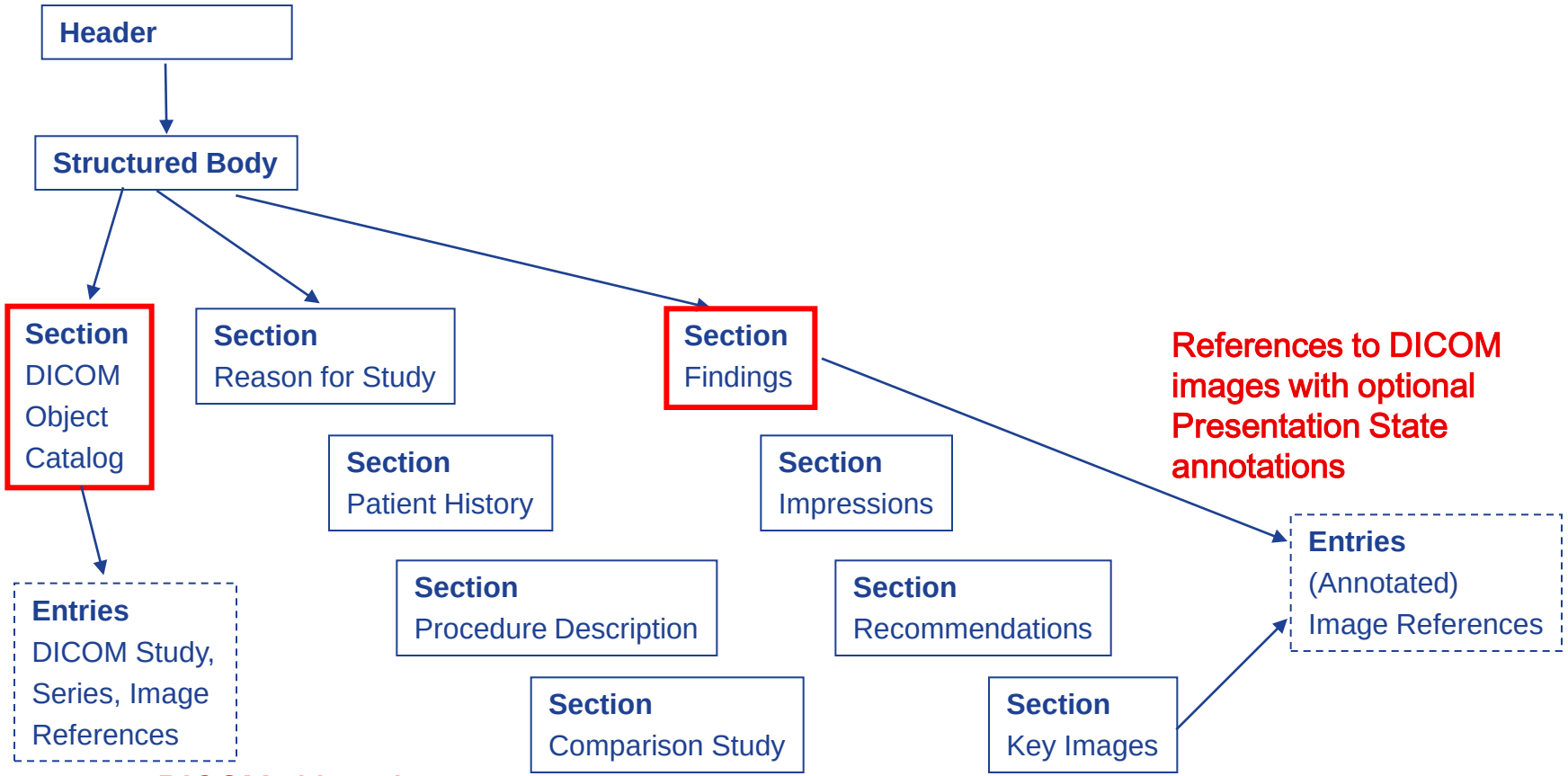
Published by HL7

- Care Record Summary – encounter notes, discharge summary
- Continuity of Care Document – transfer of care (harmonized with ASTM Continuity of Care Record)
- Healthcare Acquired Infections Report
- Diagnostic Imaging Report – with robust references to DICOM objects

Published by IHE Patient Care Coordination

- Emergency Department Referral
- Pre-procedure History and Physical
- Scanned Documents
- Personal Health Record Extract
- Basic Patient Privacy Consents
- Antepartum Summary
- Emergency Department Encounter Summary

Diagnostic Imaging Report CDA Implementation Guide



RSNA Informatics Reporting

RSNA
Reporting Templates
Overview

RSNA Reporting Templates

Expert consensus for content of procedure-specific reports

130+ templates linked to RadLex terminology

- ~2/3 concepts mapped (Hong, et al.)
- Much work still to be done !

Independent of output report encoding

- Text now
- CDA future

RSNA Template Example

US Abdomen Complete (generic)
Clinical History: [abdominal pain, fever, mass, etc]
Study: [complete ultrasound of abdomen]
Prior study: [none]
[ultrasound dated …….]
[CT abdomen dated ….]
[MR abdomen dated …]
Liver: size- [normal]
[enlarged]
[small]
echogenicity- [normal]
[hyperechoic consistent with hepatic steatosis]
[heterogenous]
contour- [smooth]
[nodular consistent with cirrhosis]
mass- [none]
[cyst measuring L x AP x W cm]
[solid mass measuring L x AP x W cm]]
bile ducts- [intrahepatic and extrahepatic bile ducts not dilated with common duct measuring _mm]
[intrahepatic bile ducts dilated]
[extrahepatic bile duct dilated with common bile duct measuring _mm]
Gallbladder: [normal]
[cholelithiasis]
[gallbladder wall thickened]
[no pain over gallbladder]
Pancreas: [head, body, and tail appeared normal]
[head and body appear normal; tail obscured by bowel gas]
. . .

RSNA Template XML definition

```
- <element name="Report" radlex:id="RID28487" radlex:match="Exact">
  - <attribute name="template">
      <value>US_First_Trimester.2010-06-19</value>
    </attribute>
  - <interleave>
      <ref name="Procedure" />
      <ref name="Clinical_information" />
      <ref name="Comparison" />
      <ref name="Findings" />
      <ref name="Impression" />
    </interleave>
  </element>
</start>
- <define name="Procedure">
  - <element name="Procedure" radlex:id="RID1559" radlex:match="Exact">
    - <interleave>
      - <element name="Modality" radlex:id="" radlex:match="">
        + <element name="US" radlex:id="RID10326" radlex:match="Exact">
        </element>
      - <element name="Site" radlex:id="" radlex:match="">
        + <element name="Pelvis" radlex:id="RID2507" radlex:match="">
        </element>
      - <element name="Technique" radlex:id="RID28482" radlex:match="Exact">
        - <choice>
          + <element name="Transabdominal" radlex:id="RID6427" radlex:match="Exact">
          + <element name="Transvaginal" radlex:id="RID6426" radlex:match="Exact">
          + <element name="Transabdominal_and_transvaginal" radlex:id="RID6427 RID6426" radlex:match="Exact">
          </choice>
```

"Structured Reports" vs. "Structured Data Entry" vs. "Structured Results"

Structured report is the output side from report creation

- Coded findings in a defined structure
- Appropriate for **HL7 Clinical Document Architecture**

Structured data entry is the input side of report creation

- Defined structure
- Context-sensitive voice recognition or pull-down menus
- May be supported by **RSNA Templates**

Structured results are the output of image analysis tasks that become an input to the report

- Measurements, CAD results, etc., that together with images are interpreted by a radiologist
- Appropriate for **DICOM Structured Reports**

Current Activities in Reporting Standardization

HL7 / IHE CDA Consolidation
RadLex
RSNA Templates
DICOM CDA Implementation Guide
IHE Radiology Template Management

HL7 / IHE CDA Consolidation

The Office of the National Coordinator for Health Information Technology

Effort funded by the Office of the National Coordinator for Health IT to consolidate the seven initial HL7 and IHE CDA Implementation Guides

The Consolidated IG will be the basis for Stage 2 Meaningful Use interoperability requirements in patient care coordination

Currently in final publication clean up – should be released in January

Includes Basic Imaging Report and Procedure Report (for interventional radiology)

- Minimal discrete data elements

RadLex

A continuing work-in-progress

- New terms
- Ontology model tweaking

Recent addition of the RadLex Paybook

- Radiology orderables and procedure step names
- Currently 342 CT procedure names

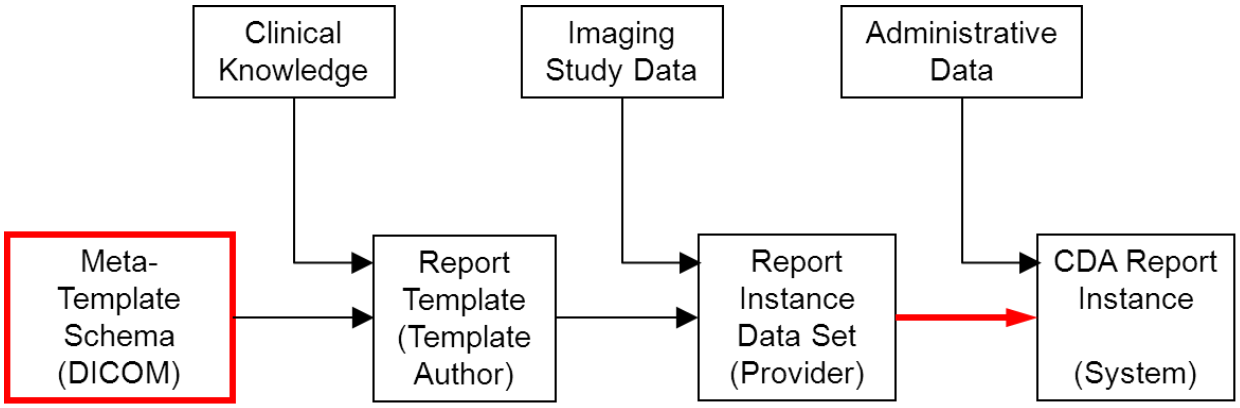
RPID	Short Name	Long Name	Long Description
RPID1	CT ABD PELVIS LE ANGIO WO & W IVCON	CT ABDOMEN PELVIS LOWER EXTREMITY ANGIOGRAPHY WITHOUT THEN WITH IV CONTRAST	A computed tomography ANGIOGRAPHY procedure focused on the ABDOMEN and PELVIS and LOWER EXTREMITY WITHOUT THEN WITH IV CONTRAST
RPID2	CT ABD ANGIO WO & W IVCON	CT ABDOMEN ANGIOGRAPHY WITHOUT THEN WITH IV CONTRAST	A computed tomography ANGIOGRAPHY procedure focused on the ABDOMEN WITHOUT THEN WITH IV CONTRAST
RPID3	CT ABD WO IVCON	CT ABDOMEN WITHOUT IV CONTRAST	A computed tomography imaging procedure focused on the ABDOMEN WITHOUT IV CONTRAST
		CT ABDOMEN WITHOUT THEN WITH IV	A computed tomography imaging procedure focused on the

RSNA Templates
DICOM CDA Implementation Guide

Creating a standard transform to facilitate creation of CDA structured reports from the RSNA Templates

Work to be part of DICOM Standard

- Will link DICOM SR to RSNA Templates for automated pre-population of appropriate fields
- Will necessitate some rework of the templates encoding



IHE Radiology Template Management

Develop industry-consensus workflow for managing and accessing reporting templates

- Initial use case for RSNA Templates

Work just starting