Reporting Workflow in Radiology using DICOM SR integration

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Begin with the End in Mind

- Effective Communication
  - efficiency
  - uniform representation of observations
  - enhance understanding with other HCPs
  - content & feature extraction
  - “databaseable reporting”

Structured Reporting at all…

From the literature:

- „The ARRS (American Roentgen Ray Society) should recommend a standardized nomenclature to be used in writing roentgenological reports.“
- „..suggest to check 100 reports for those who are seeking membership in ARRS..“
- Dr. Hickey, AJR, 1922

Structured Reporting at all…

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Radiology

a monthly journal devoted to clinical radiology and allied sciences

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The Coding of Roentgen Images for Computer Analysis as Applied to Lung Cancer[1]

GWILYM S. LODWICK, M.D., THEODORE E. KEATS, M.D., and JOHN P. DORST, M.D.

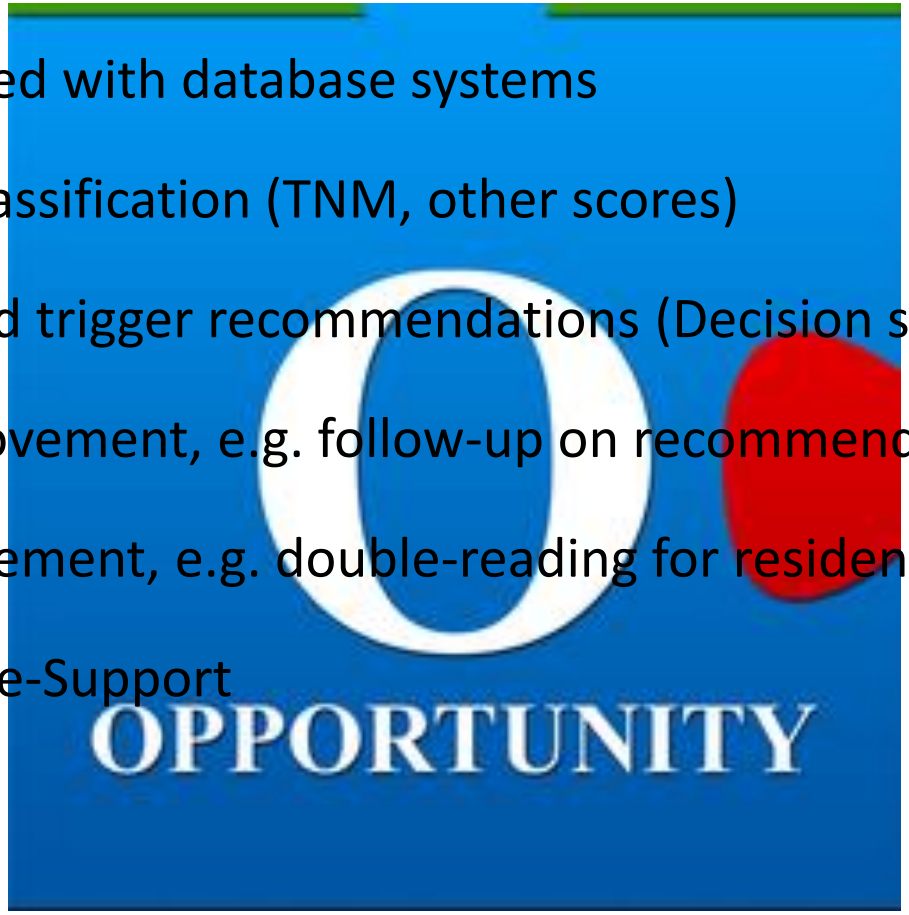
Structured Reporting and Radiologists

Strength

- Predefined structure of relevant topics
- Direct link with imaging and measurements (DICOM SR)
- Comprehensive presentation
- Useful for follow-up studies
- Improved integration into eHealth-Solutions

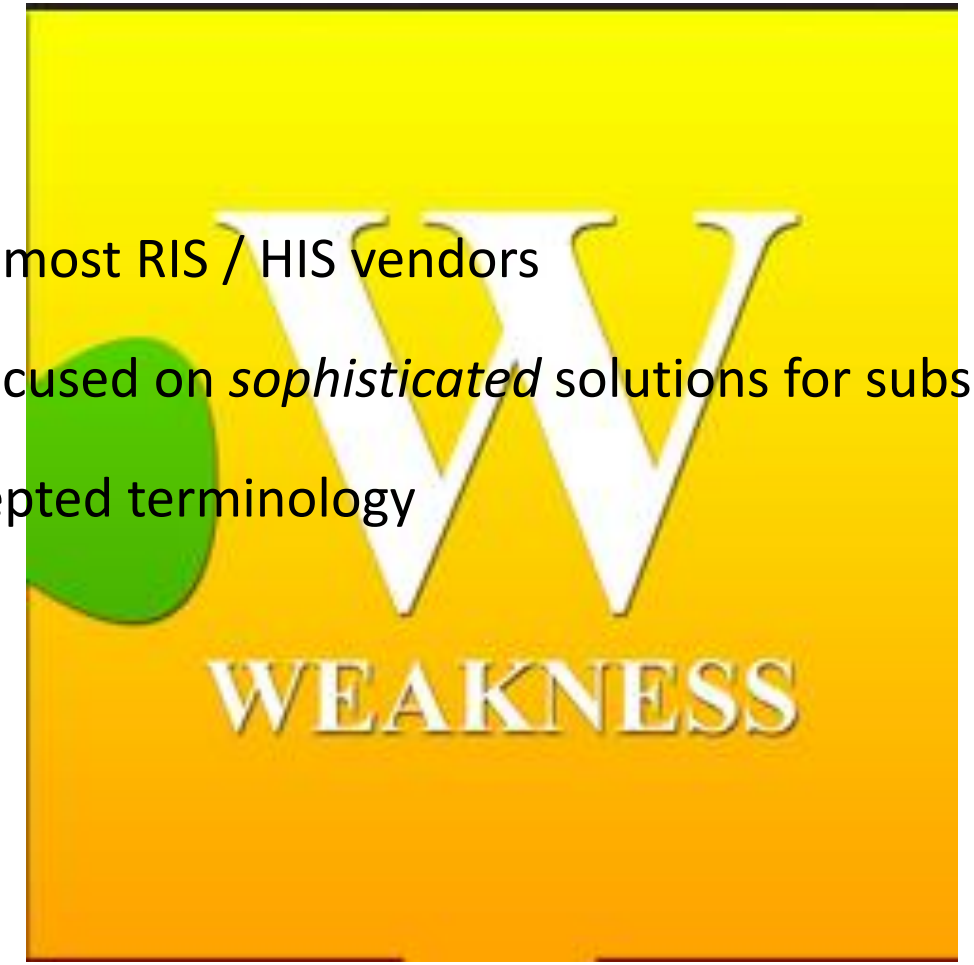
Opportunities

- Could be linked with database systems
- Support of classification (TNM, other scores)
- Findings could trigger recommendations (Decision support)
- Quality improvement, e.g. follow-up on recommendations
- Audit improvement, e.g. double-reading for residents
- Multilanguage-Support
- Research



Weaknesses

- Adoption by most RIS / HIS vendors
- Sometime focused on *sophisticated* solutions for subsets
- General accepted terminology

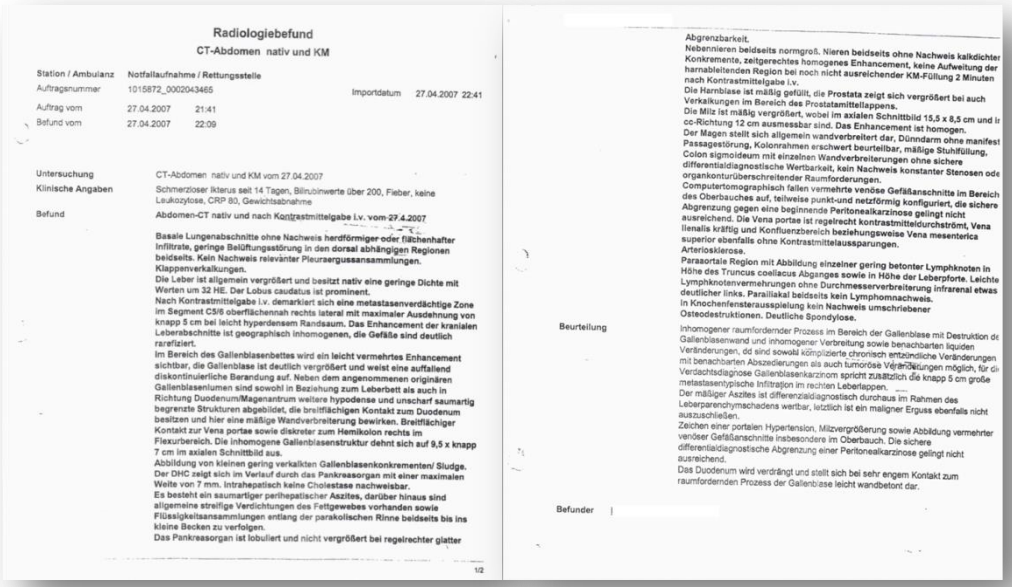


Threaths

- Limited interest by Radiology Community
- Implementations not supportive for workflow

Presentation of Reports

- For more than 100y, reports almost prose text
- Sometimes very „diplomatic“ (vague)
  - „cannot rule out“, „minimal“, „may represent“, „questionable“…
- SR could enable easier & better reception of facts / conclusions



Radiologiebefund

CT-Abdomen nativ und KM

Station / Ambulanz Notfallaufnahme / Rettungsstelle
Auftragsnummer 1015872_0002043465 Importdatum 27.04.2007 22:41
Auftrag vom 27.04.2007 21:41
Befund vom 27.04.2007 22:09

Untersuchung CT-Abdomen nativ und KM vom 27.04.2007
Klinische Angaben Schmerzloser Ikterus seit 14 Tagen, Bilirubinwerte über 200, Fieber, keine Leukozytose, CRP 80, Gewichtsabnahme
Befund Abdomen-CT nativ und nach Kontrastmittelgabe i.v. vom 27.4.2007

Basale Lungenabschnitte ohne Nachweis herdförmiger oder flächenhafter Infiltrate, geringe Belüftungsstörung in den dorsal abhängigen Regionen beidseits. Kein Nachweis relevanter Pleuraergussansammlungen.
Klappenverkalkungen.
Die Leber ist allgemein vergrößert und besitzt nativ eine geringe Dichte mit Werten um 32 HE. Der Lobus caudatus ist prominent.
Nach Kontrastmittelgabe i.v. demarkiert sich eine metastasenverdächtige Zone im Segment C5/6 oberflächennah rechts lateral mit maximaler Ausdehnung von knapp 5 cm bei leicht hyperdensem Randsaum. Das Enhancement der kranialen Leberabschnitte ist geographisch inhomogenen, die Gefäße sind deutlich rarefiziert.
Im Bereich des Gallenblasenbettes wird ein leicht vermehrtes Enhancement sichtbar, die Gallenblase ist deutlich vergrößert und weist eine auffallend diskontinuierliche Berandung auf. Neben dem angenommenen originären Gallenblasenlumen sind sowohl in Beziehung zum Leberbett als auch in Richtung Duodenum/Magenantrum weitere hypodense und unscharf saumartig begrenzte Strukturen abgebildet, die breitflächigen Kontakt zum Duodenum besitzen und hier eine mäßige Wandverbreiterung bewirken. Breitflächiger Kontakt zur Vena portae sowie diskreter zum Hemikolon rechts im Flexurbereich. Die inhomogene Gallenblasenstruktur dehnt sich auf 9,5 x knapp 7 cm im axialen Schnittbild aus.
Abbildung von kleinen gering verkalkten Gallenblasenkonkrementen/ Sludge.
Der DHC zeigt sich im Verlauf durch das Pankreasorgan mit einer maximalen Weite von 7 mm. Intrahepatisch keine Cholestase nachweisbar.
Es besteht ein saumartiger perihepatischer Aszites, darüber hinaus sind allgemeine streifige Verdichtungen des Fettgewebes vorhanden sowie Flüssigkeitsansammlungen entlang der parakolischen Rinne beidseits bis ins kleine Becken zu verfolgen.
Das Pankreasorgan ist lobuliert und nicht vergrößert bei regelrechter glatter

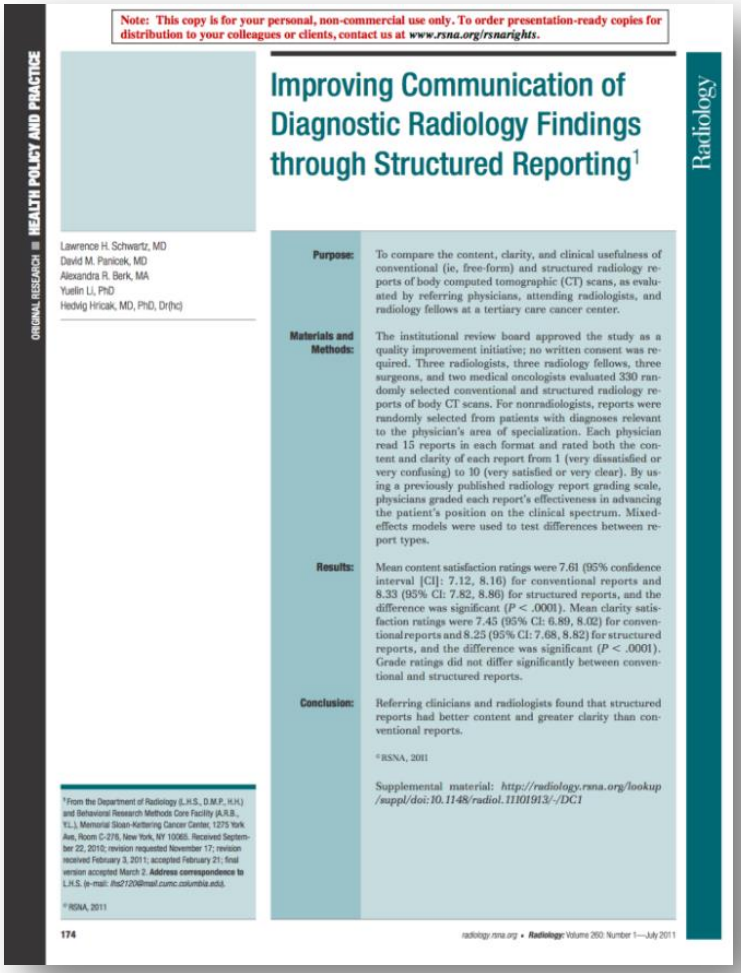
1/2

Abgrenzbarkeit.
Nebennieren beidseits normgroß. Nieren beidseits ohne Nachweis kalkdichter Konkremente, zeitgerechtes homogenes Enhancement, keine Aufweitung der harnableitenden Region bei noch nicht ausreichender KM-Füllung 2 Minuten nach Kontrastmittelgabe i.v.
Die Harnblase ist mäßig gefüllt, die Prostata zeigt sich vergrößert bei auch Verkalkungen im Bereich des Prostatamittellappens.
Die Milz ist mäßig vergrößert, wobei im axialen Schnittbild 15,5 x 8,5 cm und in cc-Richtung 12 cm ausmessbar sind. Das Enhancement ist homogen.
Der Magen stellt sich allgemein wandverbreitert dar, Dünndarm ohne manifest Passagestörung, Kolonrahmen erschwert beurteilbar, mäßige Stuhlfüllung.
Colon sigmoideum mit einzelnen Wandverbreiterungen ohne sichere differentialdiagnostische Wertbarkeit, kein Nachweis konstanter Stenosen oder organkonturüberschreitender Raumforderungen.
Computertomographisch fallen vermehrte venöse Gefäßanschnitte im Bereich des Oberbauches auf, teilweise punkt-und netzförmig konfiguriert, die sichere Abgrenzung gegen eine beginnende Peritonealkarzinose gelingt nicht ausreichend. Die Vena portae ist regelrecht kontrastmitteldurchströmt, Vena ilenalis kräftig und Konfluenzbereich beziehungsweise Vena mesenterica superior ebenfalls ohne Kontrastmittelaussparungen.
Arteriosklerose.
Paraaortale Region mit Abbildung einzelner gering betonter Lymphknoten in Höhe des Truncus coeliacus Abganges sowie in Höhe der Leberpforte. Leichte Lymphknotenvermehrungen ohne Durchmesserverbreiterung infrarenal etwas deutlicher links. Parailiakal beidseits kein Lymphomnachweis.
In Knochenfensterausspielung kein Nachweis umschriebener Osteodestruktionen. Deutliche Spondylose.

Beurteilung Inhomogener raumfordernder Prozess im Bereich der Gallenblase mit Destruktion der Gallenblasenwand und inhomogener Verbreitung sowie benachbarten liquiden Veränderungen, dd sind sowohl komplizierte chronisch entzündliche Veränderungen mit benachbarten Abszedierungen als auch tumoröse Veränderungen möglich, für die Verdachtsdiagnose Gallenblasenkarzinom spricht zusätzlich die knapp 5 cm große metastasentypische Infiltration im rechten Leberlappen.
Der mäßiger Aszites ist differenzialdiagnostisch durchaus im Rahmen des Leberparenchymschadens wertbar, letztlich ist ein maligner Erguss ebenfalls nicht auszuschließen.
Zeichen einer portalen Hypertension, Milzvergrößerung sowie Abbildung vermehrter venöser Gefäßanschnitte insbesondere im Oberbauch. Die sichere differentialdiagnostische Abgrenzung einer Peritonealkarzinose gelingt nicht ausreichend.
Das Duodenum wird verdrängt und stellt sich bei sehr engem Kontakt zum raumfordernden Prozess der Gallenblase leicht wandbetont dar.

Befunder

Structured Reports: Value



ORIGINAL RESEARCH ■ HEALTH POLICY AND PRACTICE

Improving Communication of Diagnostic Radiology Findings through Structured Reporting[1]

Lawrence H. Schwartz, MD
David M. Panicek, MD
Alexandra R. Berk, MA
Yuelin Li, PhD
Hedvig Hricak, MD, PhD, Dr(hc)

Purpose: To compare the content, clarity, and clinical usefulness of conventional (ie, free-form) and structured radiology reports of body computed tomographic (CT) scans, as evaluated by referring physicians, attending radiologists, and radiology fellows at a tertiary care cancer center.

Materials and Methods: The institutional review board approved the study as a quality improvement initiative; no written consent was required. Three radiologists, three radiology fellows, three surgeons, and two medical oncologists evaluated 330 randomly selected conventional and structured radiology reports of body CT scans. For nonradiologists, reports were randomly selected from patients with diagnoses relevant to the physician's area of specialization. Each physician read 15 reports in each format and rated both the content and clarity of each report from 1 (very dissatisfied or very confusing) to 10 (very satisfied or very clear). By using a previously published radiology report grading scale, physicians graded each report's effectiveness in advancing the patient's position on the clinical spectrum. Mixed-effects models were used to test differences between report types.

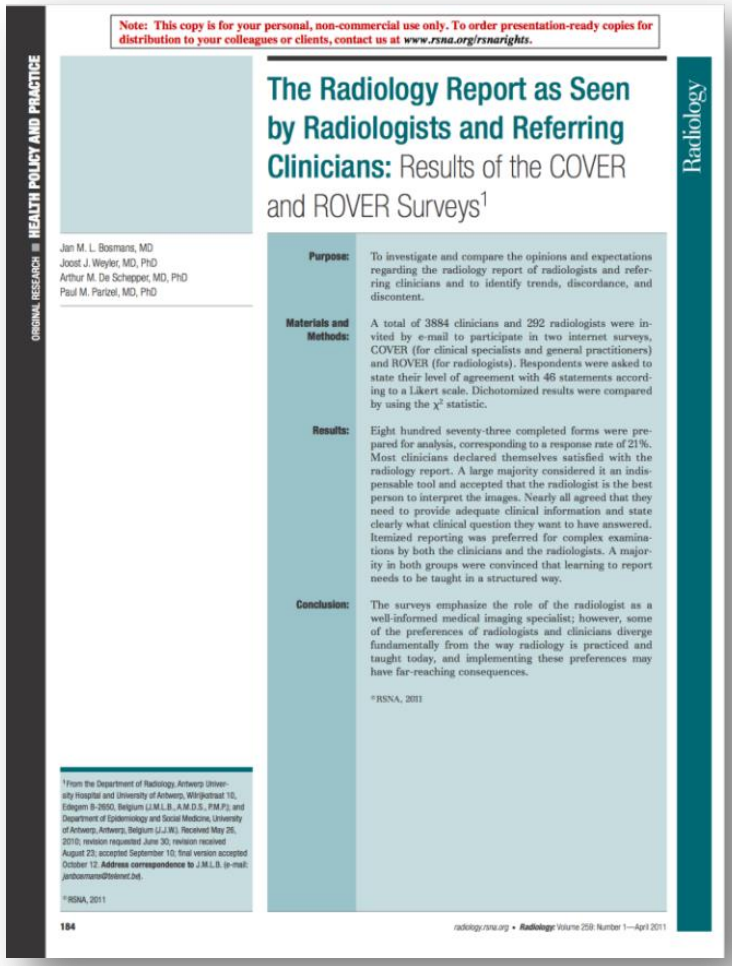
Results: Mean content satisfaction ratings were 7.61 (95% confidence interval [CI]: 7.12, 8.16) for conventional reports and 8.33 (95% CI: 7.82, 8.86) for structured reports, and the difference was significant ($P < .0001$). Mean clarity satisfaction ratings were 7.45 (95% CI: 6.89, 8.02) for conventional reports and 8.25 (95% CI: 7.68, 8.82) for structured reports, and the difference was significant ($P < .0001$). Grade ratings did not differ significantly between conventional and structured reports.

Conclusion: Referring clinicians and radiologists found that structured reports had better content and greater clarity than conventional reports.

Supplemental material: *http://radiology.rsna.org/lookup/suppl/doi:10.1148/radiol.11101913/-/DC1*

From the Department of Radiology (L.H.S., D.M.P., H.H.) and Behavioral Research Methods Core Facility (A.R.B., Y.L.), Memorial Sloan-Kettering Cancer Center, 1275 York Ave, Room C-276, New York, NY 10065. Received September 22, 2010; revision requested November 17; revision received February 3, 2011; accepted February 21; final version accepted March 2. **Address correspondence to** L.H.S. (e-mail: *lhs2120@mail.cumc.columbia.edu*).

Radiology



ORIGINAL RESEARCH ■ HEALTH POLICY AND PRACTICE

The Radiology Report as Seen by Radiologists and Referring Clinicians: Results of the COVER and ROVER Surveys[1]

Jan M. L. Bosmans, MD
Joost J. Weyler, MD, PhD
Arthur M. De Schepper, MD, PhD
Paul M. Parizel, MD, PhD

Purpose: To investigate and compare the opinions and expectations regarding the radiology report of radiologists and referring clinicians and to identify trends, discordance, and discontent.

Materials and Methods: A total of 3884 clinicians and 292 radiologists were invited by e-mail to participate in two internet surveys, COVER (for clinical specialists and general practitioners) and ROVER (for radiologists). Respondents were asked to state their level of agreement with 46 statements according to a Likert scale. Dichotomized results were compared by using the χ^2 statistic.

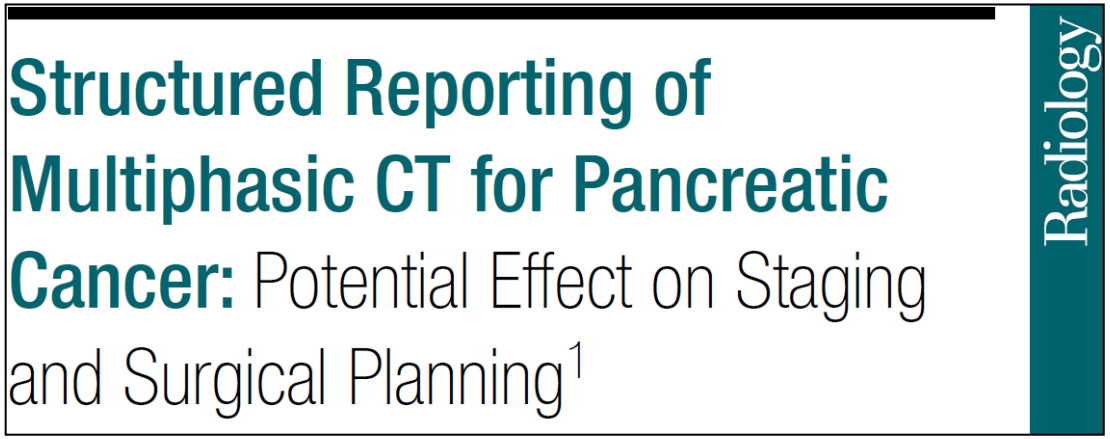
Results: Eight hundred seventy-three completed forms were prepared for analysis, corresponding to a response rate of 21%. Most clinicians declared themselves satisfied with the radiology report. A large majority considered it an indispensable tool and accepted that the radiologist is the best person to interpret the images. Nearly all agreed that they need to provide adequate clinical information and state clearly what clinical question they want to have answered. Itemized reporting was preferred for complex examinations by both the clinicians and the radiologists. A majority in both groups were convinced that learning to report needs to be taught in a structured way.

Conclusion: The surveys emphasize the role of the radiologist as a well-informed medical imaging specialist; however, some of the preferences of radiologists and clinicians diverge fundamentally from the way radiology is practiced and taught today, and implementing these preferences may have far-reaching consequences.

From the Department of Radiology, Antwerp University Hospital and University of Antwerp, Wilrijkstraat 10, Edegem B-2650, Belgium (J.M.L.B., A.M.D.S., P.M.P.); and Department of Epidemiology and Social Medicine, University of Antwerp, Antwerp, Belgium (J.J.W.). Received May 26, 2010; revision requested June 30; revision received August 23; accepted September 10; final version accepted October 12. **Address correspondence to** J.M.L.B. (e-mail: *janboemans@telenet.be*).

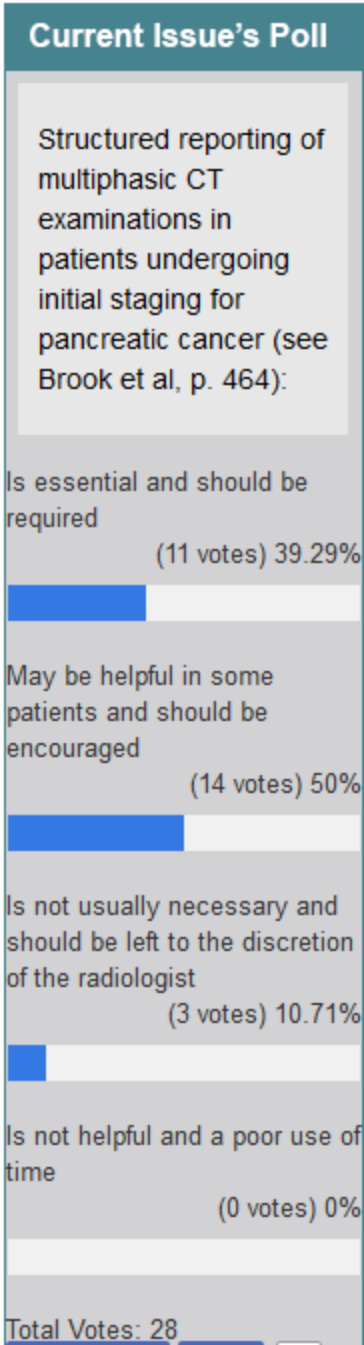
Radiology

Impact on Reporting and Decision Making



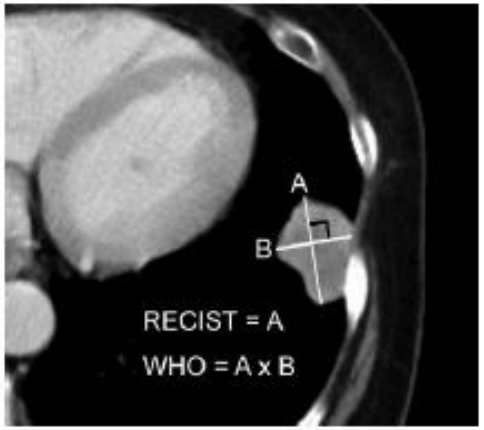
- Brook O et al. ***Radiology:*** Volume 274: February 2015

- 48 SRs vs 72 non-SRs
- 12 key features for surgical planning
- 7,3+-2,1 key features in non-SR vs 10,6+-0,9 in SR
- Significant difference for planning (84 vs 44%)



Value for Follow-Up Studies

- Measurements of lesions could be feeded into templates
- Linked with imaging location (using DICOM SR)
- Identification of corresponding lesions in follow-up study
  - Reduction of reading time by about 50% (René et al. ECR 2014)



Planning for electronic reporting

- What are *your* goals ?
  - Better capture of sonographer measurements into report
  - Add key images into reports
  - Ability to do research / data mining
- What kinds of reports do you need?
  - Text only
  - Text + image references
  - Structured text
  - Structured text + coded content
  - Multimedia

Impact on Reporting Workflow

- Full integration with existing reporting IT-solution important
- SR^2 : Structured Reporting & Speech Recognition
- Scores
- Recommendations
- Audits and Patient-Recalls could initiated by triggers

This is Process Re-engineering!

- Transition to electronic reports is hard
  - New systems
  - New architectures
  - New policies and procedures
  - Organizationally disjunct costs/benefits
- Minimize the risk and the effort
  - A standards-based approach
  - Incremental evolution from current workflow
  - Leverage the work of IHE (Integrating the Healthcare Enterprise)

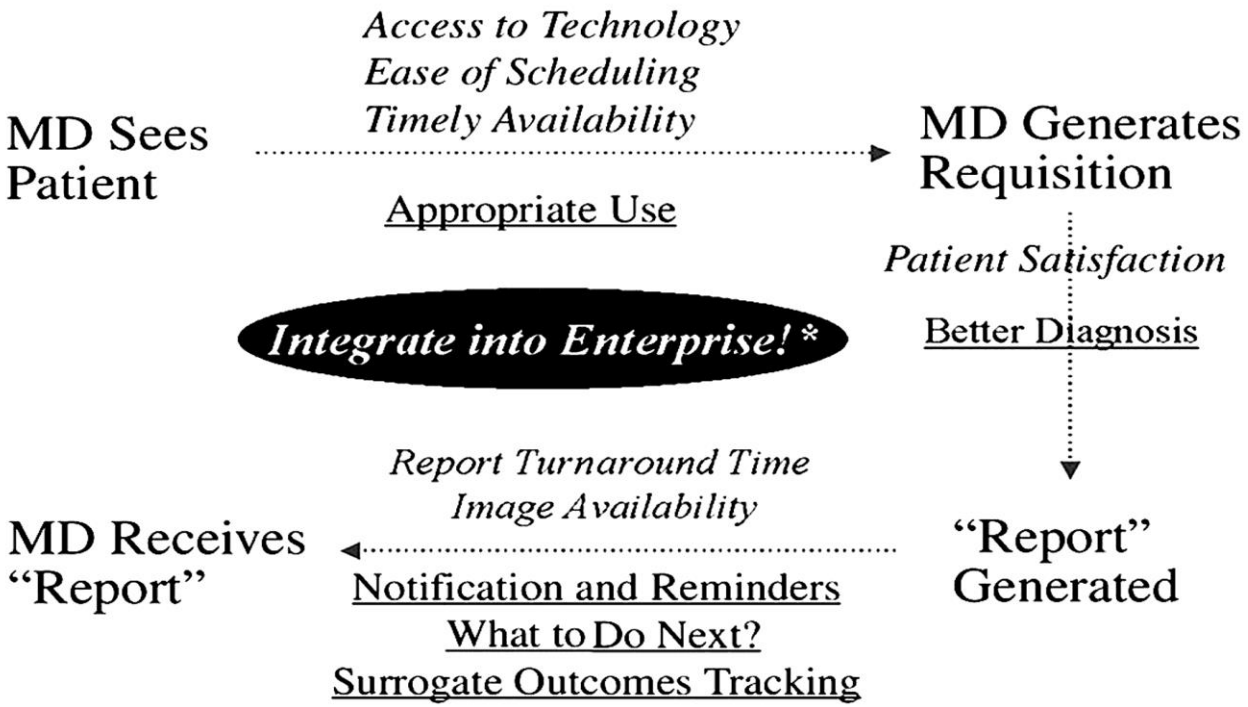
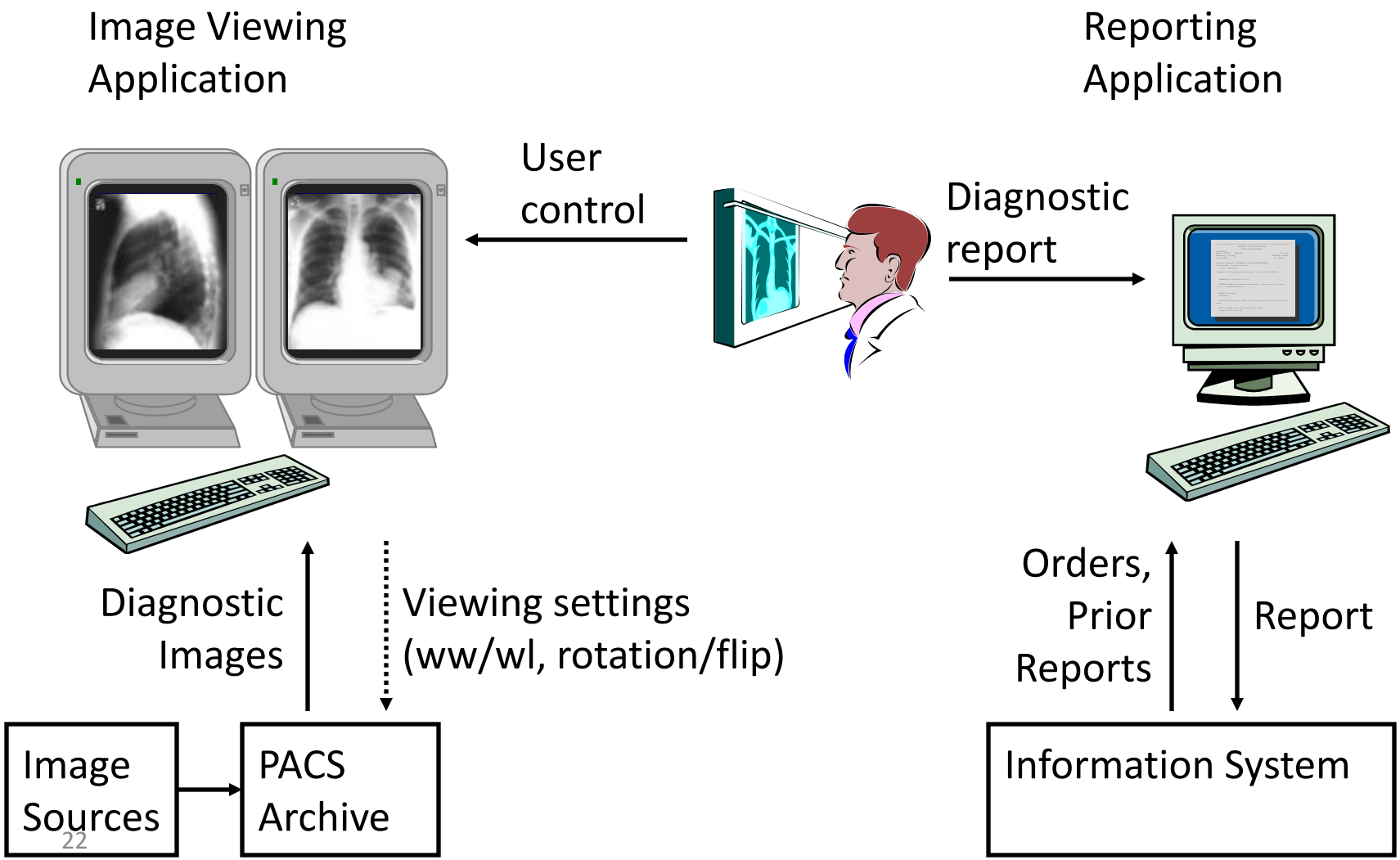


Figure. Diagram illustrates how information technology initiatives in radiology can add service value (italicized concepts) and content or knowledge value (underlined concepts) to the process of care. Integration into the information system infrastructure of the enterprise will be a prerequisite for success in most if not all cases.

RadioGraphics,
http://pubs.rsna.org/doi/abs/10.1148/radiographics.21.4.g01jl371015

Published in: Ramin Khorasani; *RadioGraphics* **2001,** 21, 1015-1018.
DOI: 10.1148/radiographics.21.4.g01jl371015

Diagnostic reporting



DICOM and Reporting

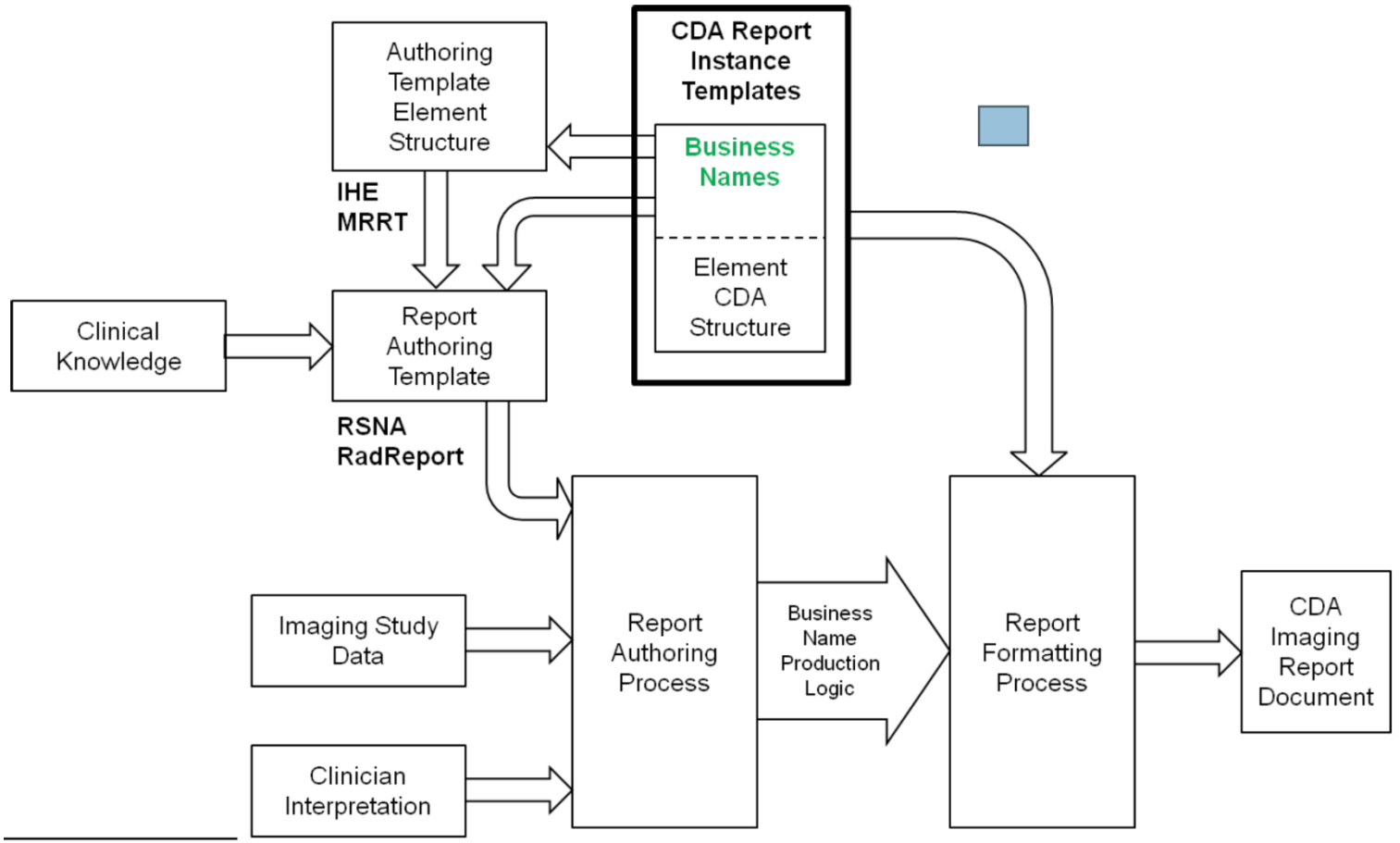
- Then
  - Supplement 23 Structured Reporting began in 1995
  - established place in the encoding of image analysis results, or “evidence documents”, it has seen only limited use for clinical reports
- Now
  - reporting based on CDA, an XML document format specified by HL7

SUPP 155: Introduction

- Nature of radiology reporting is evolving from purely text based reports to incorporate more discrete data elements

- New mechanism for specifying templates for imaging reports, as well as a set of specific templates for radiology diagnostic and screening reports

DICOM Supp 155:
Imaging Reports using HL7 Clinical Document Architecture



DICOM
Structured Reporting
Overview

DICOM is a Standards Development Organization
whose domain is biomedical imaging

DICOM Structured Reporting

- The scope of DICOM SR is the standardization of documents in the imaging environment

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

DICOM SR Use

- DICOM SR is used in key subspecialty areas that produce structured data in the course of image acquisition or post-processing, where:
  - Leveraging the DICOM infrastructure is easy and desirable
  - Results should be managed with other study evidence

- 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 Patient/Study/Series information model (header), plus hierarchical tree of "Content Items"
- Extensive mandatory use of coded content
  - Allows use of vocabulary/codes from non-DICOM sources
- Templates define content constraints for specific types of documents / reports

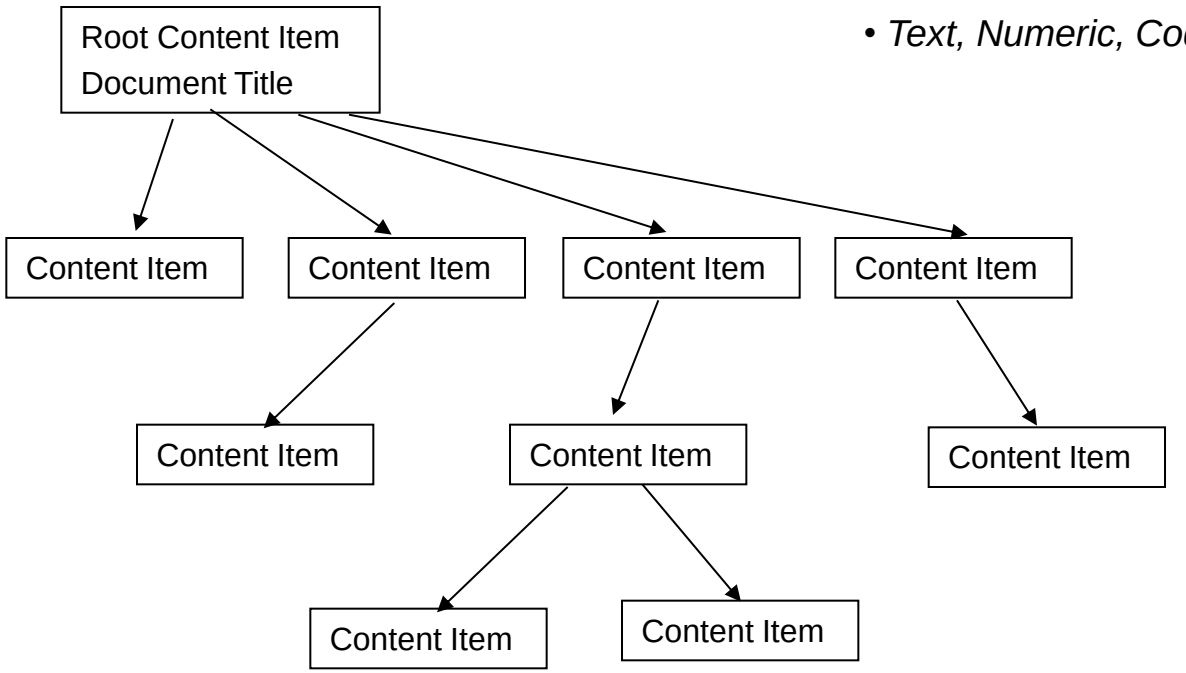
SR Content Item Tree

Arrows are parent-child relationships

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

Content Items are units of meaning

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



DICOM SR Object Classes

- Enhanced and Comprehensive - Text, coded content, numeric measurements, spatial and temporal ROI references
  - Templates for ultrasound, cardiac imaging
- 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

Optimizing Radiation Use During Fluoroscopic Procedures: A Quality and Safety Improvement Project

James R. Duncan, MD, PhD, Mandie Street, RT, Marshall Strother, BS, Daniel Picus, MD

Journal of the American College of Radiology
Volume 10, Issue 11, Pages 847-853 (November 2013)
DOI: 10.1016/j.jacr.2013.05.008

HL7
Clinical Document Architecture Overview

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

Clinical Document Characteristics

- Persistence
  - Documents exist over time and can be used in many contexts
- Stewardship
  - Documents must be managed, shared by the steward
- Potential for authentication
  - Intended use as medico-legal documentation
- Wholeness
  - Document includes its relevant context
- Human readability
  - Essential for human authentication

CDA Use Cases

- Diagnostic and therapeutic procedure reports
- Encounter / discharge summaries
- Patient history & physical
- Referrals
- Claims attachments

- Consistent format for all clinical documents

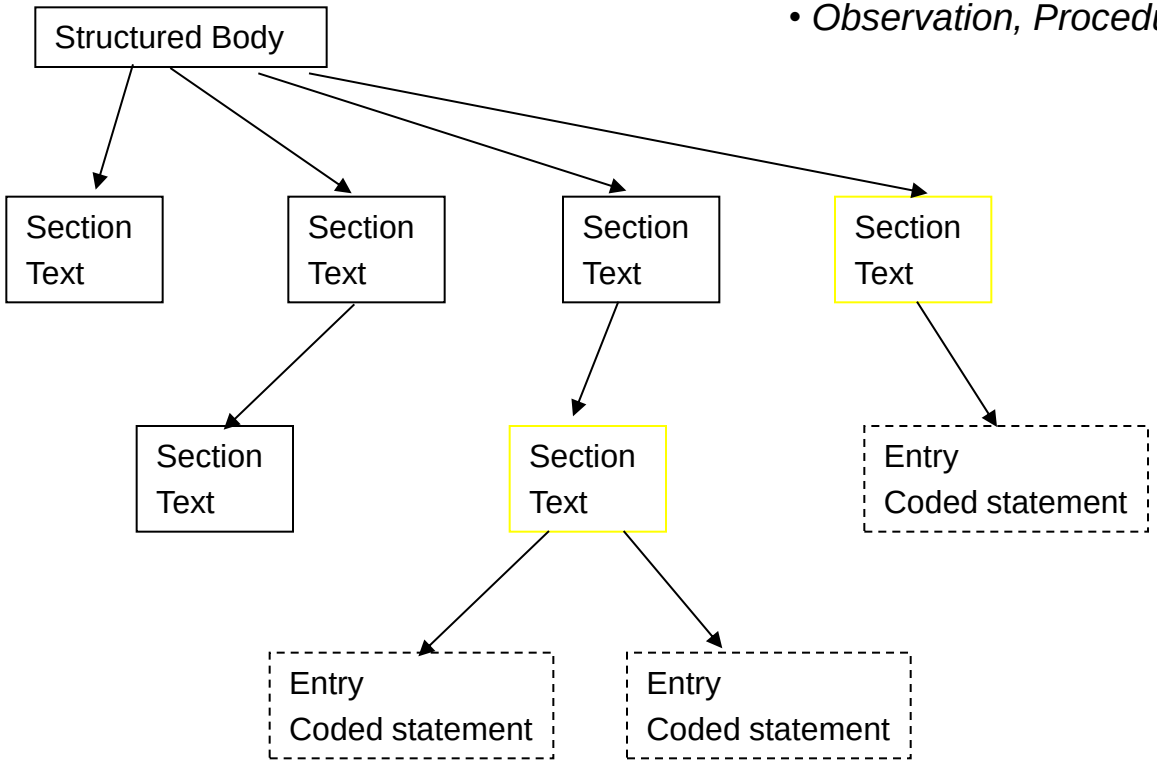
Key Aspects of the CDA

- 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
- A CDA document consists 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 Structured Body

Arrows are Act Relationships
- *Has component, Derived from, etc.*

Entries are coded clinical statements
- *Observation, Procedure, Substance administration, etc.*



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

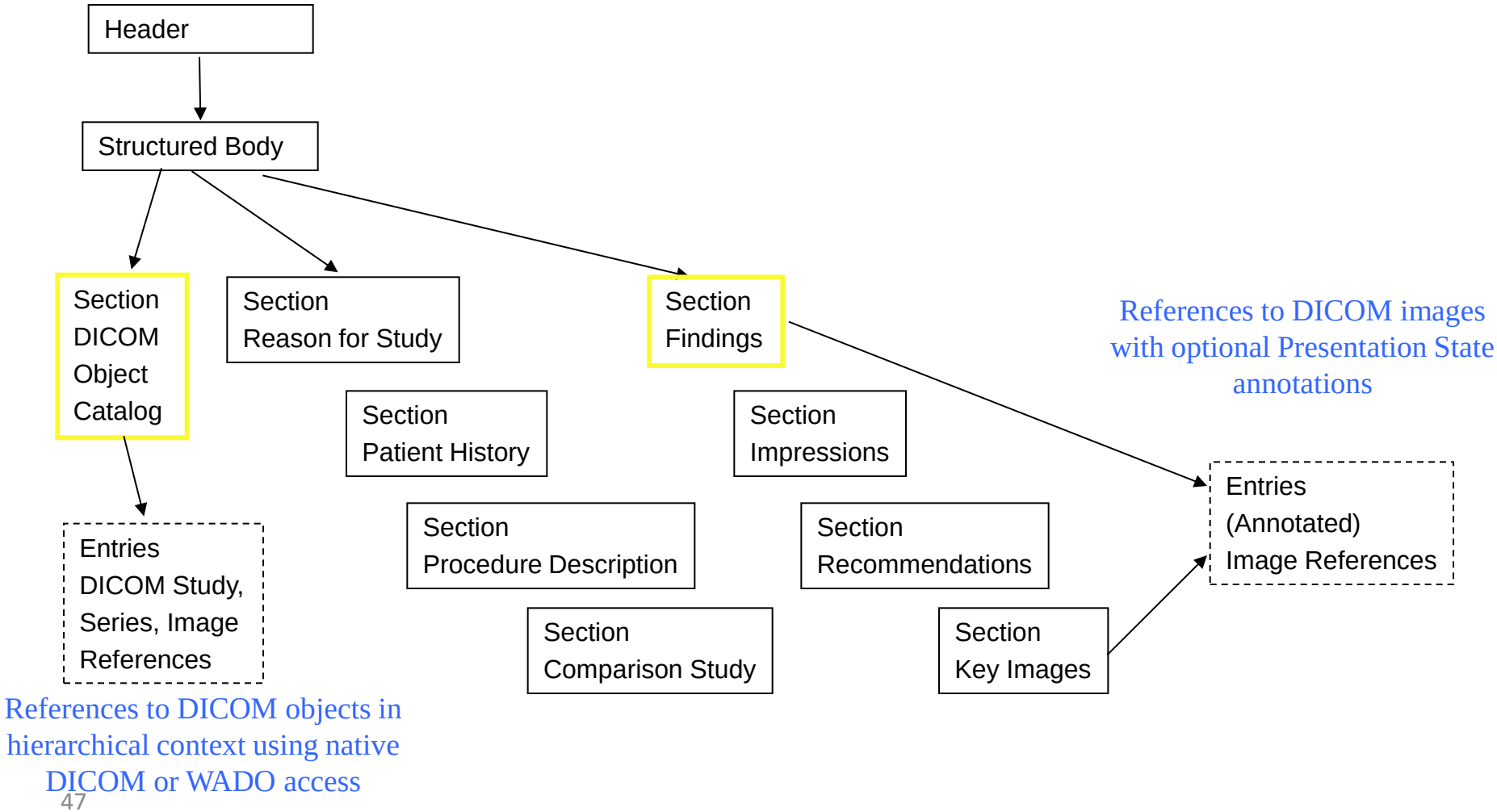
- CDA allows ***optional*** machine-readable coded "Entries", which drive automated processes

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

CDA Structures defined by Templates in Supplement 155

- The header contains structured data that allows management and exchange of clinical documents by generic document handling systems and interfaces, e.g., as specified in the IHE Cross-Enterprise Document Sharing (XDS) Profile
- RSNA RadReport initiative has specified five canonical top level narrative sections, which are supported by specific templates: Procedure Description, Clinical Information, Comparison Study, Findings, and Impression

Diagnostic Imaging Report Implementation Guide



“Evidence” and “Reports”

- Evidence Documents
  - Includes measurements, procedure logs, CAD results, etc., created in the imaging context, and together with images are interpreted by a radiologist to produce a report
  - The radiologist may quote or copy parts of Evidence Documents into the report, but doing so is part of the interpretation process at his discretion
  - Appropriate to be stored in PACS as **DICOM SR** objects, with same (legal/distribution) status as images
- Reports
  - Become part of the patient’s medical record, with potentially wide distribution
  - Good match to **HL7 CDA**

CDA and Implementation Guides

- Industry consensus standard for the formatting of clinical reports across all medical disciplines
- Native (unecapsulated) and encapsulated CDA documents may be managed on DICOM exchange media
- Generic CDA format is typically constrained for specific document types by implementation guides in support of specific use cases

CDA and Implementation Guides

- Multiple layers of constraint and implementation guidance that go into a CDA imaging report
- Supplement 155 defines several report document structures that further constrain CDA
- Professional societies or healthcare providers may define even more detailed constraints and guidance for use in reporting on specific sub-specialty procedures

Report Section	Content
Administrative information	Imaging facility
	Referring provider
	Date of service
	Time of service
Patient identification	Name
	Identifier (eg, medical record number or Social Security number)
	Date of birth
	Sex
Clinical history	Medical history
	Risk factors
	Allergies, if relevant
	Reason for examination, including medical necessity
Imaging technique	Time of image acquisition
	Imaging device
	Image acquisition parameters, such as device settings, patient positioning, interventions (eg, Valsalva maneuver)
	Contrast materials and other medications administered (including name, dose, route, and time of administration)
	Radiation dose
Comparison	Date and type of previous examinations reviewed, if applicable
Observations	Narrative description or itemization of findings, including measurements, image annotations, and identification of key images
Summary or impression	Key observations, inferences, and conclusions, including any recommendations
Signature	The date and time of electronic signature for each responsible provider, including attestation statement for physicians supervising trainees, if applicable

Kahn CE Jr, Langlotz CP, Burnside ES, Carrino JA, Channin DS, Hovsepian DM, Rubin DL. Toward best practices in radiology reporting. Radiology. 2009 Sep;252(3):852-6. doi: 10.1148/radiol.2523081992. PubMed PMID: 19717755.

Templates

- Constraints specified in implementation guides
- Describe patterns that specify the structure and content of a document
  - *Structure* → relationships among portions of the document
  - *Content* → concepts and vocabularies used for a particular application
- *mandatory* or *optional*

Template: Purposes

- improve interoperability by limiting the variability of unconstrained (idiosyncratic or arbitrary) structures and content
- allows a professional society or healthcare provider to normalize best practice for reports with content appropriate for their use cases, including foreseeable secondary uses such as research or quality improvement
- may be used operationally in the creation of reports
  - an application may use the template to guide authoring of the report, ensuring the entry or composition of essential reporting elements, and structuring that data into the target encoded format
- provide a conformance validation for instances of reports against the purposes (use case) of the template

Medical Terminologies

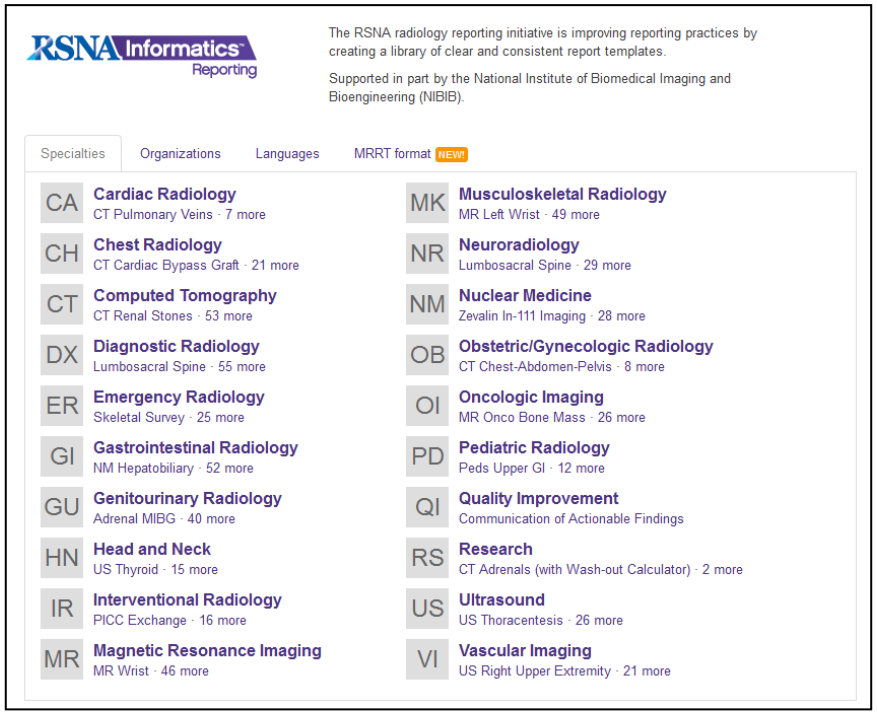
- ACR Index
  - Anatomic Taxonomy + Pathologic Taxonomy
  - Several thousand codes

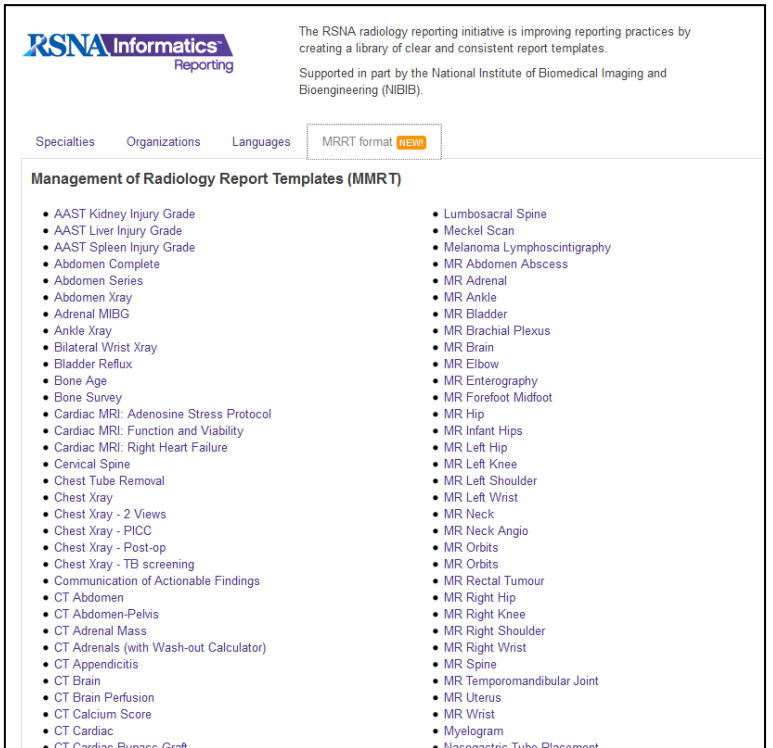
- SNOMED (Systematized Nomenclature of Medicine)
  - As SNOP 1974 by CAP published, als SNOMED 1982
  - International Healthcare Terminology Standards Development Organization (IHTSDO)
    - Constitution of 14 countries (US, CA, AU, NZ, SG, UK, DK, NL, SE, LT, EE, CY, SK, ES)
  - 350.000 terms

- RadLex by RSNA

Library of Templates

- RSNA Reporting Initiative startet about 2009
- IHE MRRT Template July 2014 published
- ESR has joined this effort through eHealth SC (O Ratib et al.)





Imaging Report Templates for CDA

- Supplement 155 defines the CDA format structures and technical constraints
- High level structures that can belie the details of implementation
- Facilitate report authoring templates

Schematics and Blue Prints

- IHE MRRT profile
- RSNA Reporting Initiative
  - radreport.org
- Literature
  - and many more…

RSNA RadReport and IHE MRRT

- RadReport is focused on developing best practice clinical content templates for authoring radiology reports
- Management of Radiology Report Templates (MRRT) Profile specifies an XML-based encoding for those report authoring templates that can be used by a report authoring application

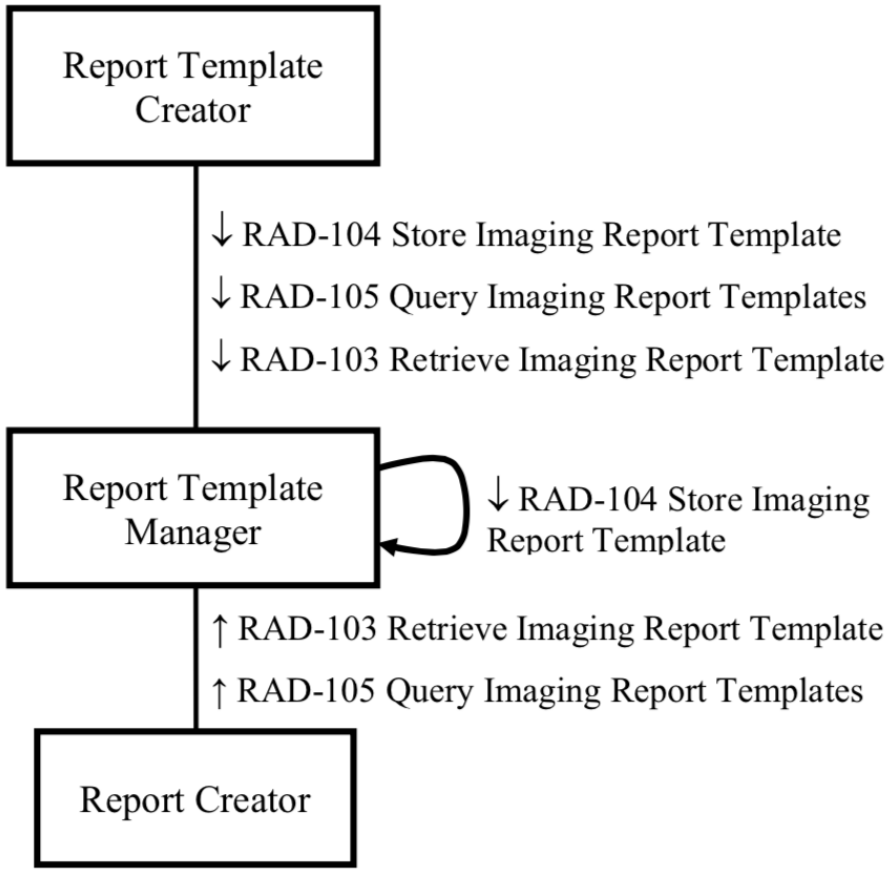


Figure 33.1-1: MRRT Actor Diagram

Supp 155 Summary

This standard forms the basis for encoding radiology reports as CDA documents, including the following features

- Standard header allowing management using any CDA-based document management or exchange system, e.g., as used for meaningful use
- Narrative reporting in canonical report sections (Clinical Information, Procedure, Comparison, Findings, Impressions, Addendum)
- Available structures for lists or tabular report content
- Optional discrete data elements for numeric or qualitative observations, including flags for critical/actionable findings
- Computer-processable documentation for communication of actionable findings, for follow-up recommendations, and for radiation dose summary
- Linkage to key images and to complete DICOM study imaging evidence
- Support for subspecialty report content templates, e.g., RSNA RadReport
- Transcoding from DICOM SR imaging report instances

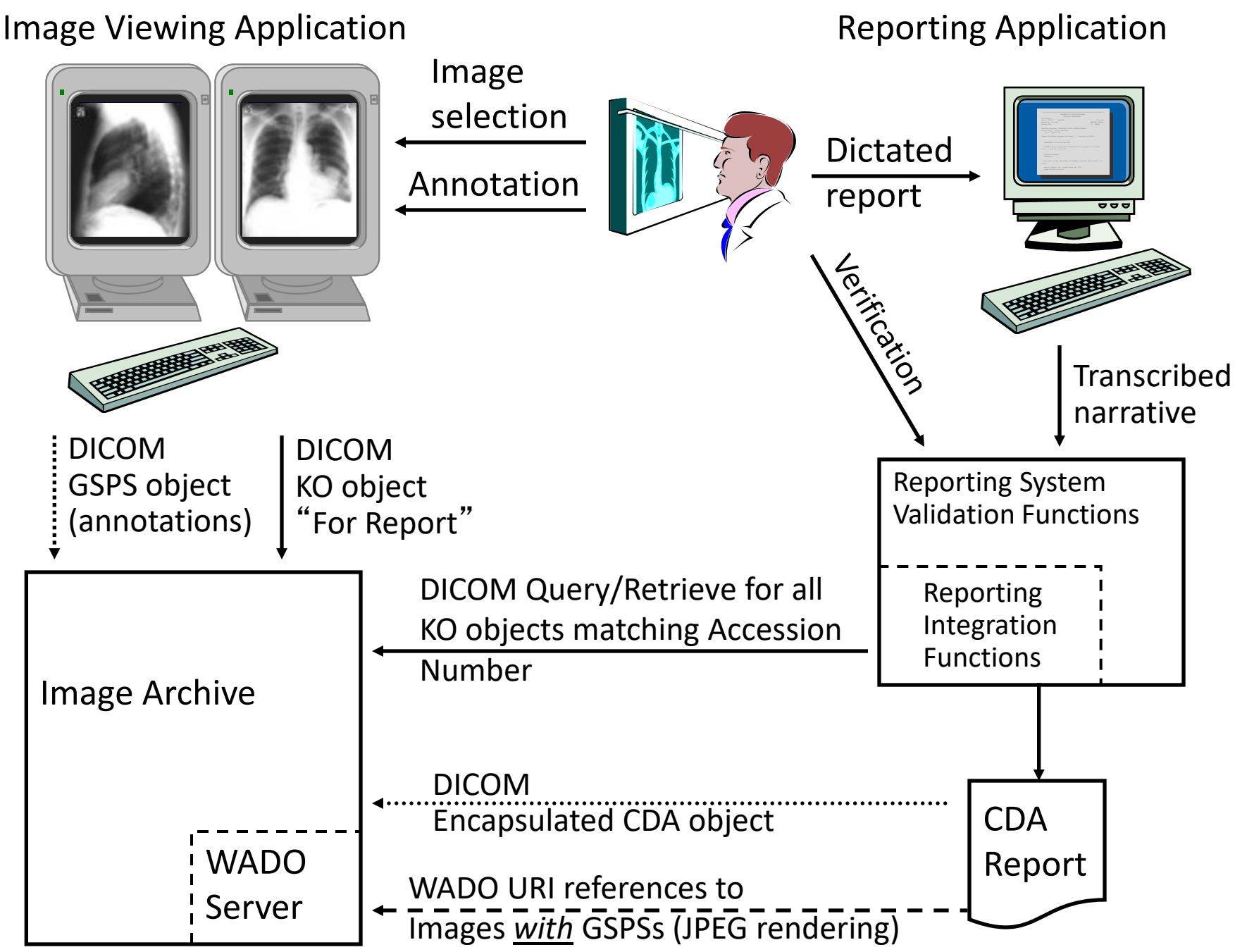


Image Viewing Application
Reporting Application
Image selection
Annotation
Dictated report
Verification
Transcribed narrative
DICOM GSPS object (annotations)
DICOM KO object "For Report"
Reporting System Validation Functions
Reporting Integration Functions
DICOM Query/Retrieve for all KO objects matching Accession Number
Image Archive
DICOM Encapsulated CDA object
CDA Report
WADO Server
WADO URI references to Images *with* GSPSs (JPEG rendering)

Open-Source Tools

- RadLex
- DICOM
  - Supplements 23, 76, 77, 86, 101, 128, 155
- IHE MRRT Library
- Web-based implementation with HTML5
- PHP / MySQL…

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