Patient's Imaging Journey

Dr. Judy Gichoya

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Emory University

EMORY
UNIVERSITY

Disclosures

- ACR
  - AI advisory council
- RSNA
  - Associate Editor - Radiology AI Trainee Editorial Board
  - CIRE & RIC Committee member
- SIIM
  - Co-chair – Research Committee
  - Board member
- HL7 and AHLI Board member
  - Association for Health Learning and Inference
- Softbrew LTD
  - Consulting on Global Health /Clinical informatics

- Funding
  - NIBIB MIDRC / COVID -19 Data repository
  - Clairity Consortium
  - NIH AIM AHEAD pilot grant
  - NIH AIM-AHEAD consortium development program
  - RSNA Health disparities grant
  - DeepLook grant for AI validation
  - Harold Amos Faculty Award to study AI bias
  - Lacuna fund for creating diverse medical datasets
  - LUNIT for breast DBT evaluation
  - R01 NHLBI Grant for opportunistic screening for ASCVD using multimodal AI
  - Winship invest cancer disparities pilot grant

Last updated May 29th ,2024

UCSF School of Medicine

Life-Cycle of an Imaging Exam

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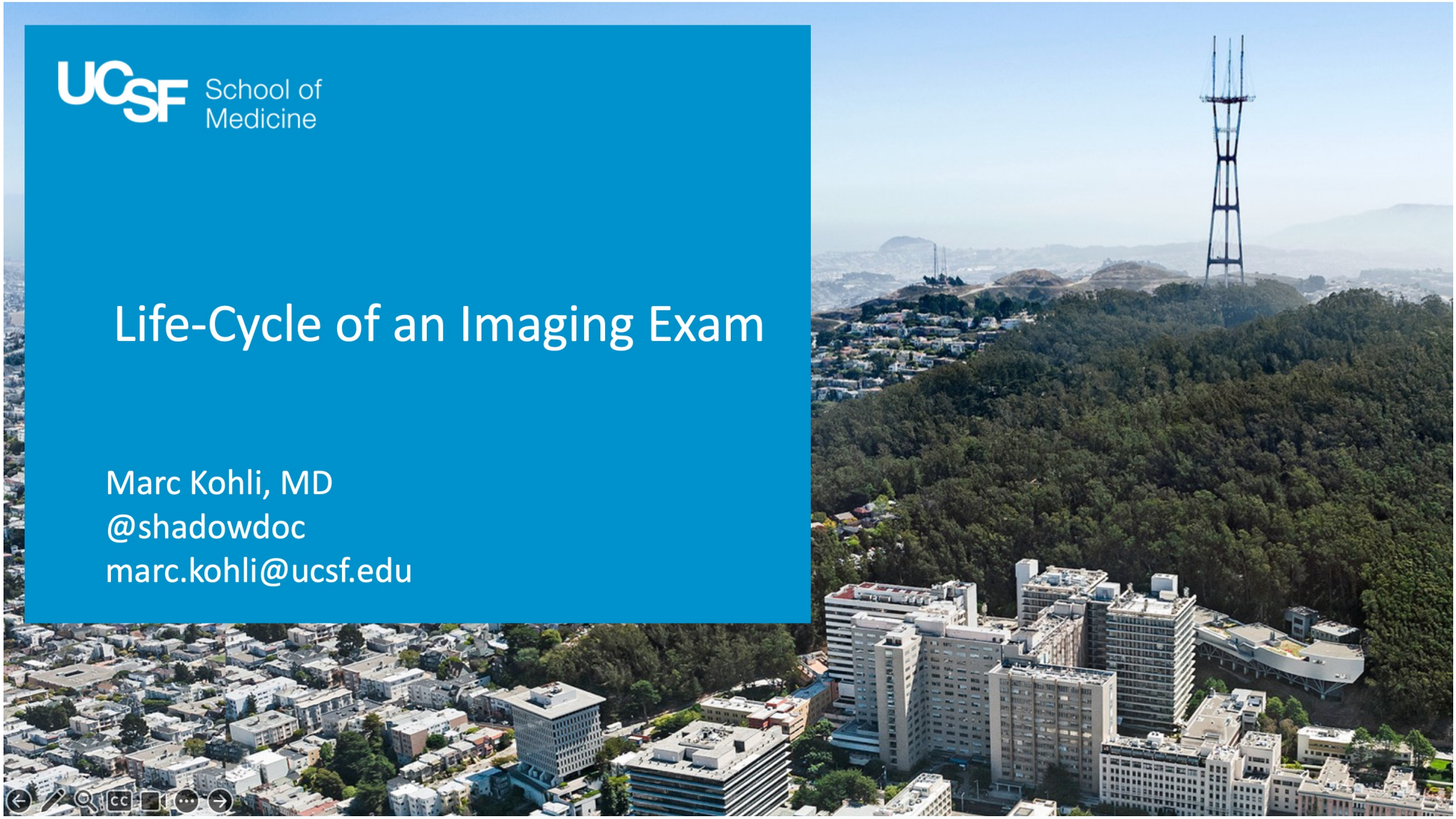
marc.kohli@ucsf.edu



Objectives

- Discuss standards relevant to imaging workflows
- Discuss imaging workflow
- Summarize imaging informatics workflow in the context of AI development and deployment

HL7 2.x

```
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VIEWS^WMHRAD|||200910052148|||PSC|||||^^^^L|||||||200910052215|||F||1^^^^^N^^Now|072801^SPACEMAN^
DR||||059980^AKISIK^M.^^^|
OBX|1|XCN|11780&SDR^KNEE 3 VIEWS^WMHRAD||059980^AKISIK^M.^|
OBX|2|TX|11780&GDT^KNEE 3 VIEWS^WMHRAD||Left knee and left lower extremity: 10/5/2009
Indication: Tenderness and pain.  Findings: There is no acute fracture or dislocation. There is
no other  bony abnormalities. The soft tissue is unremarkable.   ||||||F|
OBX|3|TX|11780&GDT^KNEE 3 VIEWS||~Transcribed by - PSC~Transcription Date - 200910052215||||||F|
OBX|4|TX|11780&IMP^KNEE 3 VIEWS                      ^WMHRAD|| Negative study.  ||||||F|
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HL7 3.0

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  </patientRole>
 </recordTarget>
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v2 + v3 :☺
FHIR
v2 + v3 =☹
HL7
INTERNATIONAL

FHIR

3.0 Resource Index

Categorized | Alphabetical

This page is provided to help find resources quickly. There is also a more detailed classification, ontology, and description.

Clinical

General:

- AllergyIntolerance 1
- Condition (Problem) 2
- Procedure 1
- ClinicalImpression 0
- FamilyMemberHistory 1
- RiskAssessment 0
- DetectedIssue 1

Care Provision:

- CarePlan 1
- Goal 1
- ReferralRequest 1
- ProcedureRequest 1
- NutritionOrder 1
- VisionPrescription 0

Medication & Immunization:

- Medication 1
- MedicationOrder 1
- MedicationAdministration 1
- MedicationDispense 1
- MedicationStatement 1
- Immunization 1
- ImmunizationRecommendation 1

Diagnostics:

- Observation 3
- DiagnosticReport 3
- DiagnosticOrder 1
- Specimen 1
- BodySite 0
- ImagingStudy 2
- ImagingObjectSelection 1

Identification

Individuals:

- Patient 3
- Practitioner 1
- RelatedPerson 1

Groups:

- Organization 1
- HealthcareService 1
- Group 1

Entities:

- Location 1
- Substance 1
- Person 1
- Contract 0

Devices:

- Device 1
- DeviceComponent 1
- DeviceMetric 1

Workflow

Patient Management:

- Encounter 1
- EpisodeOfCare 1

Scheduling:

- Appointment 1
- AppointmentResponse

Workflow #1:

- Order 0
- OrderResponse 0

Workflow #2:

- ProcessRequest 0
- ProcessResponse 0

HTTP

Server

Request

HTML Document

Response

Client

http://www.flickr.com/photos/laughingsquid/102689399/
http://www.flickr.com/photos/larskflem/95757299/

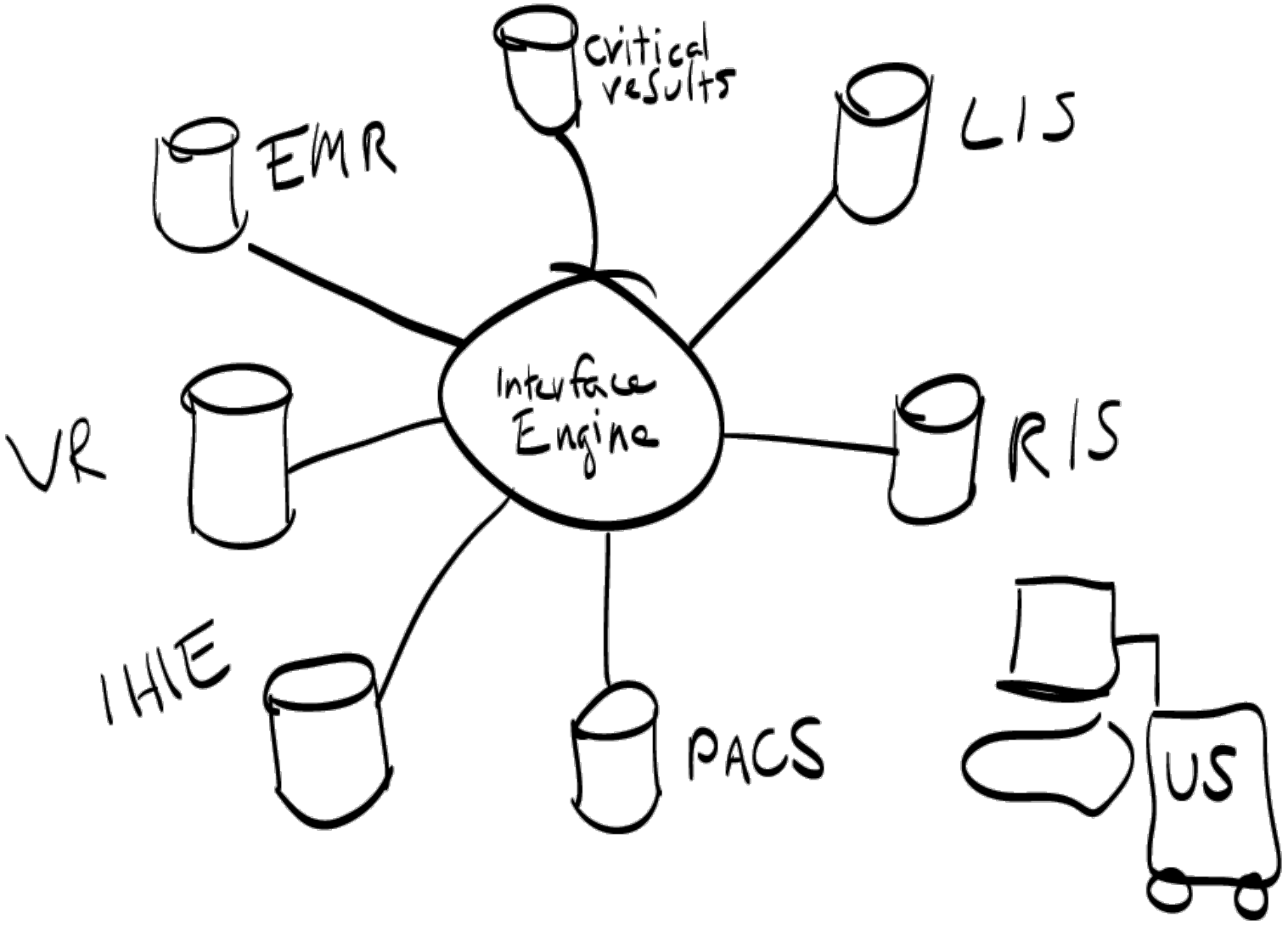
REST

http method	database method
get	select
put	update
post	insert
delete	delete

REST for DICOM

DICOMweb Services

SERVICE	DESCRIPTION	DETAILS	SPECS
QUERY	QIDO-RS (Query based on ID for DICOM Objects)	Link	DICOM PS3.18 6.7
RETRIEVE	WADO-RS (Web Access of DICOM Objects)	Link	DICOM PS3.18 6.5
STORE	STOW-RS (Store over the web)	Link	DICOM PS3.18 6.6
TASKS	UPS-RS (Worklist Service)	Link	DICOM PS3.18 6.9
CAPABILITIES	Service information	Link	DICOM PS3.18 6.8


critical results
EMR
LIS
Interface Engine
VR
RIS
IHIE
PACS
US

SAFETY FEATURES ON THIS DOCUMENT INCLUDE: ON FACE - COLORED VOID BACKGROUND - MICROPRINT LINES - ERASURE PROTECTION
REVERSE Rx DROPOUT - THERMOCHROMIC INK - ON BACK - ARTIFICIAL WATERMARK - COIN REACTIVE INK

Memorial Hospital
100 W. Main, Hometown, USA PH: 922-222-2222

Name Rex Elephant Date 11/1/13

Address _____ DOB/Age 3/10/65

℞ GIVE FULL DIRECTIONS FOR USE

RUQ US

Indication: RUQ pain

Dr Bob

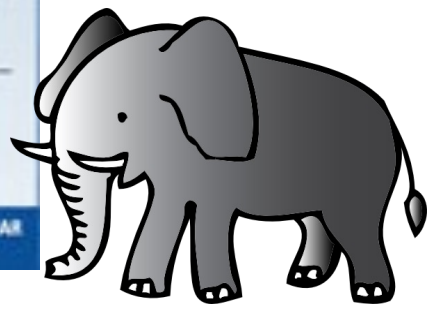
Refills 0-1-2-3-4-5- _____ Signature of prescriber

DEA # _____ Name (Printed)

Label unless checked here ☐
Generic substitution unless checked here ☐

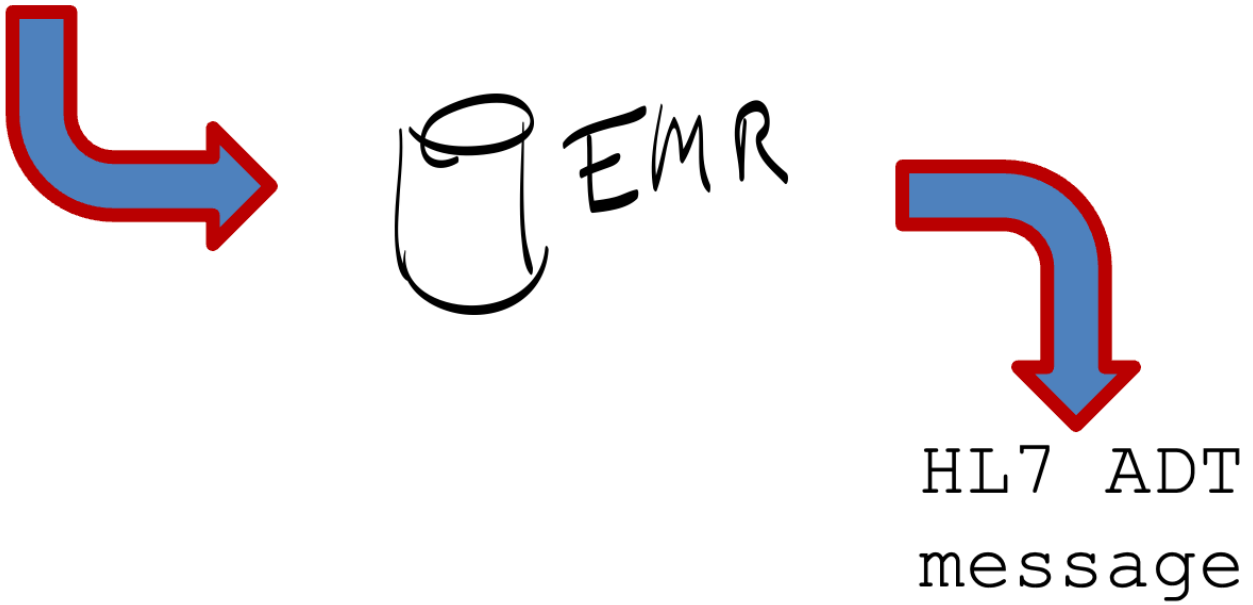
U.S. Department of Health & Human Services - Public Health Service - Indian Health Service

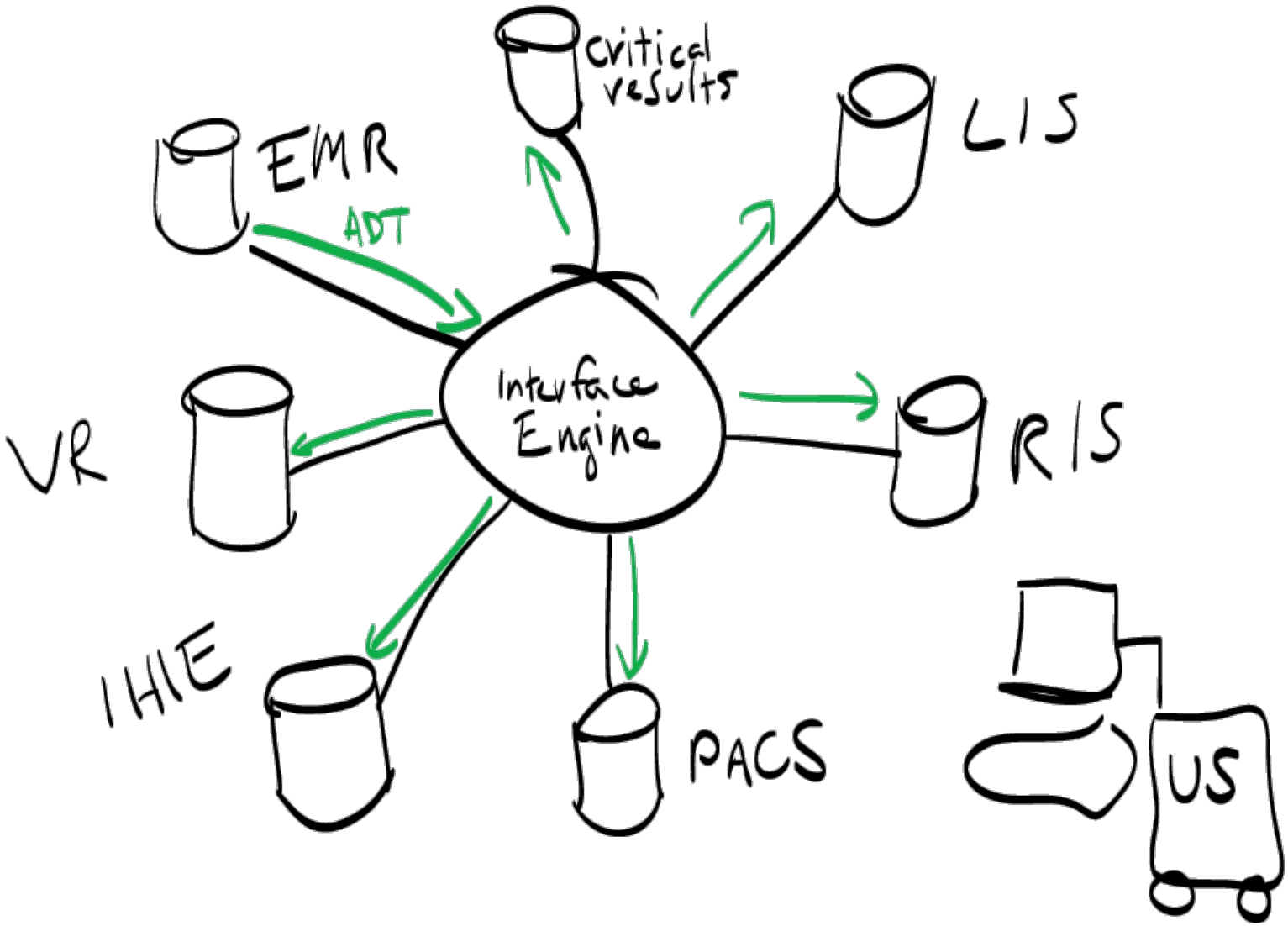
VERIFICATION BOX: HOLD BETWEEN THUMB AND FOREFINGER OR BREATHE ON IT. COLOR WILL DISAPPEAR, THEN REAPPEAR DURING THE ABSENCE OF COLOR THE WORD SECURE WILL SHOW IN THE WINDOW.



13
FERMÉ
14
FERMÉ
15
FERMÉ
16
FERMÉ

Demographics
Medical record number
Insurance info




critical results
EMR
ADT
LIS
Interface Engine
VR
RIS
IHIE
PACS
US

ADT Messages

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PID|1|9999999^^^ZOO HOSPTIAL MRN^MRN|||ELEPHANT^REX^^^^^||20111029|M||U|1234 MAIN^ANY^IN^^US^^^|
PD1||||92714^NONE^NONE
ZPI|1|||||||23051^NONE^NONE||23051^NONE^NONE
ZEI|1|3|NOT EMPLOYED|||||||594901
NK1|1|ELEPHANT^MOM^^^^^|AD|1234 MAIN ST^5^ANY^IN^^US^^^|867-5309||NEXT OF KIN|||||||||19010101
ZKI||DA|0
ZKI|||0
PV1|1|O|^^^MH^^AMBULATORY(S)^ATHEIST|3|||^^MEDICINE^^^^^^ZOO DOCTOR NUMBER^^^
PV2|||^RUQ PAIN|||||||0|||||||||||GI||^^589743
ZVI|||||||||LH
OBX|1|CD|PRINIC||NO
GT1|1||ELEPHANT^REX^^^^^CURRENT||123 MAIN^^ANY^IN^^^^^|867-5309^HOME||19010101|M|DEFAULT
ZGI|||DA
IN1|1|P10^SELF PAY^^^SPRINGFIELD HEALTH PARTNERS|1972167||250 North ROAD .^^ANY^IN^^US^BUS^^49
IN2||999999999|^NOT EMPLOYED|||||||||||||||||||||||||||||||||||||||||||||||||||||
ZNI|||PT
IN3|1|NONE ENTERED||||||20111031205800|21001231000000
UB2|||||||11 ONSET OF SYMPTOMS/ILLNESS
```

```
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708617362T12988|P|2.3


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MRN^COMMUNITY MEDICAL RECORD
NUMBER~||ELEPHANT^REX^^^^^CURRENT||20111029|F||U|1234 MAIN
ST^5^ANYTOWN^IN^46016^US^HOME^^48||(555)867-
5309^HOME^TEL||EN|S||000888888888^^^SPRINGFIELD FIN NUMBER^FIN

PV1|1|O|^^^MH^^AMBULATORY(S)^ATHEIST|3|||99999^EMERGENCY
SERVICES^MEDICINE^^^^^^SPRINGFIELD ORGANIZATION DOCTOR
NUMBER^PERSONNEL^^^ORGANIZATION DOCTOR~ADDRESS/PHONE:
/^EMERGENCY
SERVICES^MEDICINE^^^^^^|O||P||||||||||||||||||MH||ACT|||201110
31205800
```

Value	Description
ADT^A01	ADT/ACK - Admit / visit notification
ADT^A02	ADT/ACK - Transfer a patient
ADT^A03	ADT/ACK - Discharge/end visit
ADT^A04	ADT/ACK - Register a patient
ADT^A08	ADT/ACK - Update patient information
ADT^A18	ADT/ACK - Merge patient information
ADT^A34	ADT/ACK - Merge patient information - patient ID only
ADT^A35	ADT/ACK - Merge patient information – account number only
ADT^A47	ADT/ACK - Change internal ID
ORM^O01	ORM - Order message
ORU^R01	ORU/ACK - Unsolicited transmission of an observation message

CT/MRI/Ultrasound
Check In
PLEASE WAIT
HERE TO
CHECK IN

SAFETY FEATURES ON THIS DOCUMENT INCLUDE: ON FACE - COLORED VOID BACKGROUND - MICROPRINT LINES - ERASURE PROTECTION
REVERSE Rx DROPOUT - THERMOCHROMIC INK - ON BACK - ARTIFICIAL WATERMARK - COIN REACTIVE INK

Memorial Hospital
100 W. Main, Hometown, USA PH: 922-222-2222

Name Rex Elephant Date 11/1/13

Address _____ DOB/Age 3/10/65

℞ GIVE FULL DIRECTIONS FOR USE

RUQ US

Indication: RUQ pain

Dr Bob

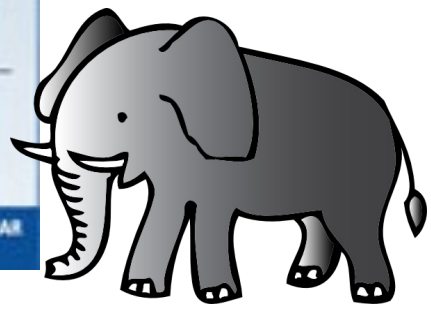
Refills 0-1-2-3-4-5- _____ Signature of prescriber

DEA # _____ Name (Printed)

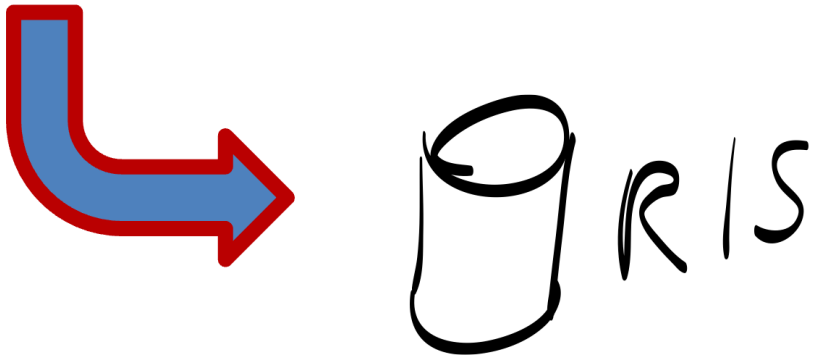
Label unless checked here ☐
Generic substitution unless checked here ☐

U.S. Department of Health & Human Services - Public Health Service - Indian Health Service

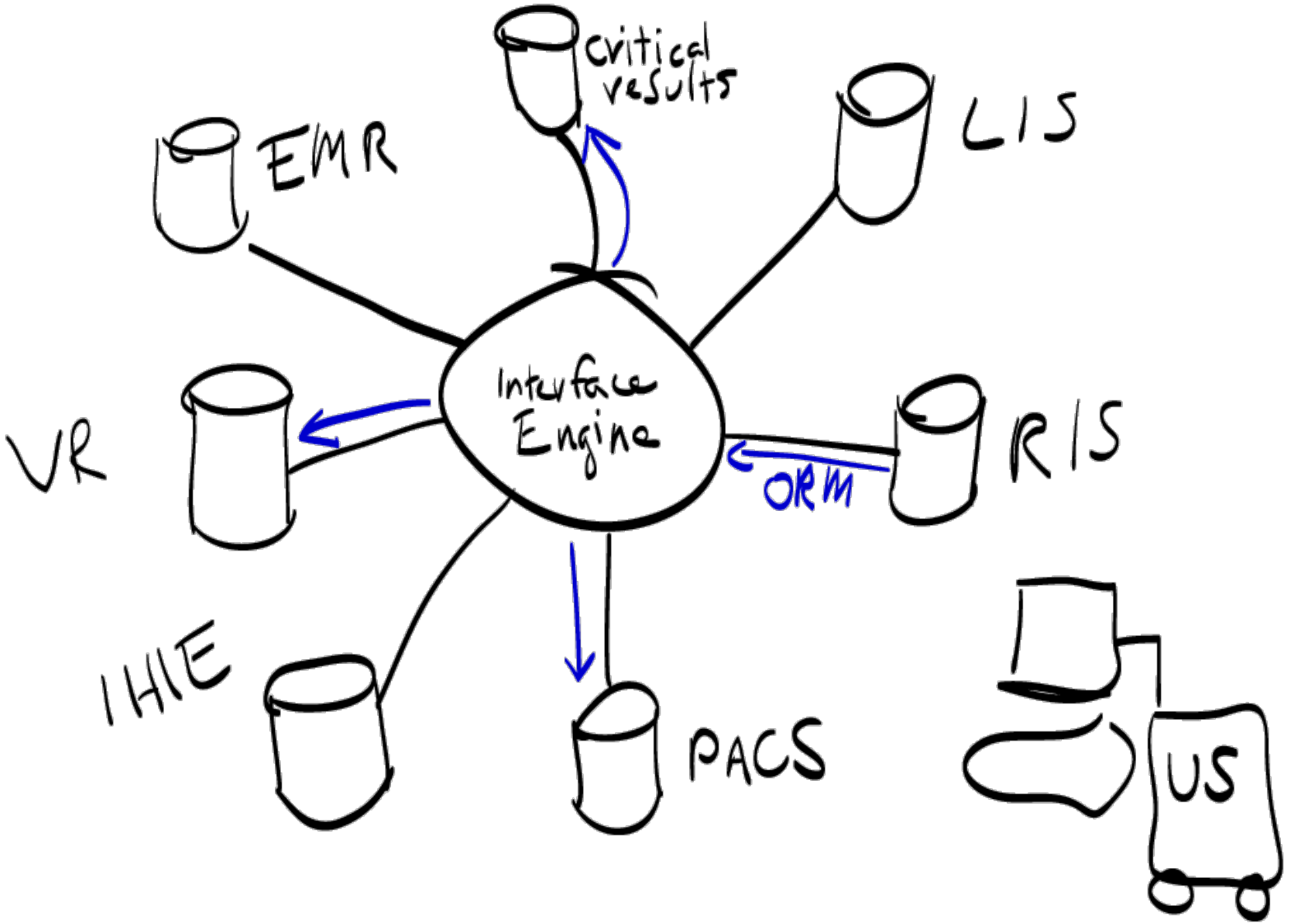
VERIFICATION BOX: HOLD BETWEEN THUMB AND FOREFINGER OR BREATHE ON IT. COLOR WILL DISAPPEAR, THEN REAPPEAR DURING THE ABSENCE OF COLOR THE WORD SECURE WILL SHOW IN THE WINDOW.



Demographics
Medical record number
Accession Number
Procedure Code
Procedure Description



HL7 ORM message


critical results
EMR
LIS
Interface Engine
VR
RIS
ORM
IHIE
PACS
US

ORM Messages

```
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ORC|SC|H94562861-1-1^GPHI|3011038||CM||1^^^200906040053^^N^^Now||200906040117|RTIF||
OBR||^|3011038|US11759^US RUQ|||201106050117|||RAD|||right upper quadrant
pain|DEH^^|^^^^R|093435^DOCTOR^BEST^^^^||||||201106050117||RAD|60^End Procedure||1^^^201106050053^^N^^Now||||right upper
quadrant pain|||||||||||||  ~  ~  |
```

```
MSH|^~\&|RAD|WISH|||200906040117||ORM^O01|RMS|P|2.3.1|


ORC|SC|H94562861-1-
1^GPHI|3011038||CM||1^^^200906040053^^N^^Now||20090604011
7|RTIF||

OBR||^|3011038|US11759^US
RUQ|||201106050117|||RAD|||right upper quadrant
pain|DEH^^|^^^^R|093435^DOCTOR^BEST^^^^|||||201106050117
||RAD|60^End Procedure||1^^^201106050053^^N^^Now||||right
upper quadrant pain||||||||||||||  ~  ~  |
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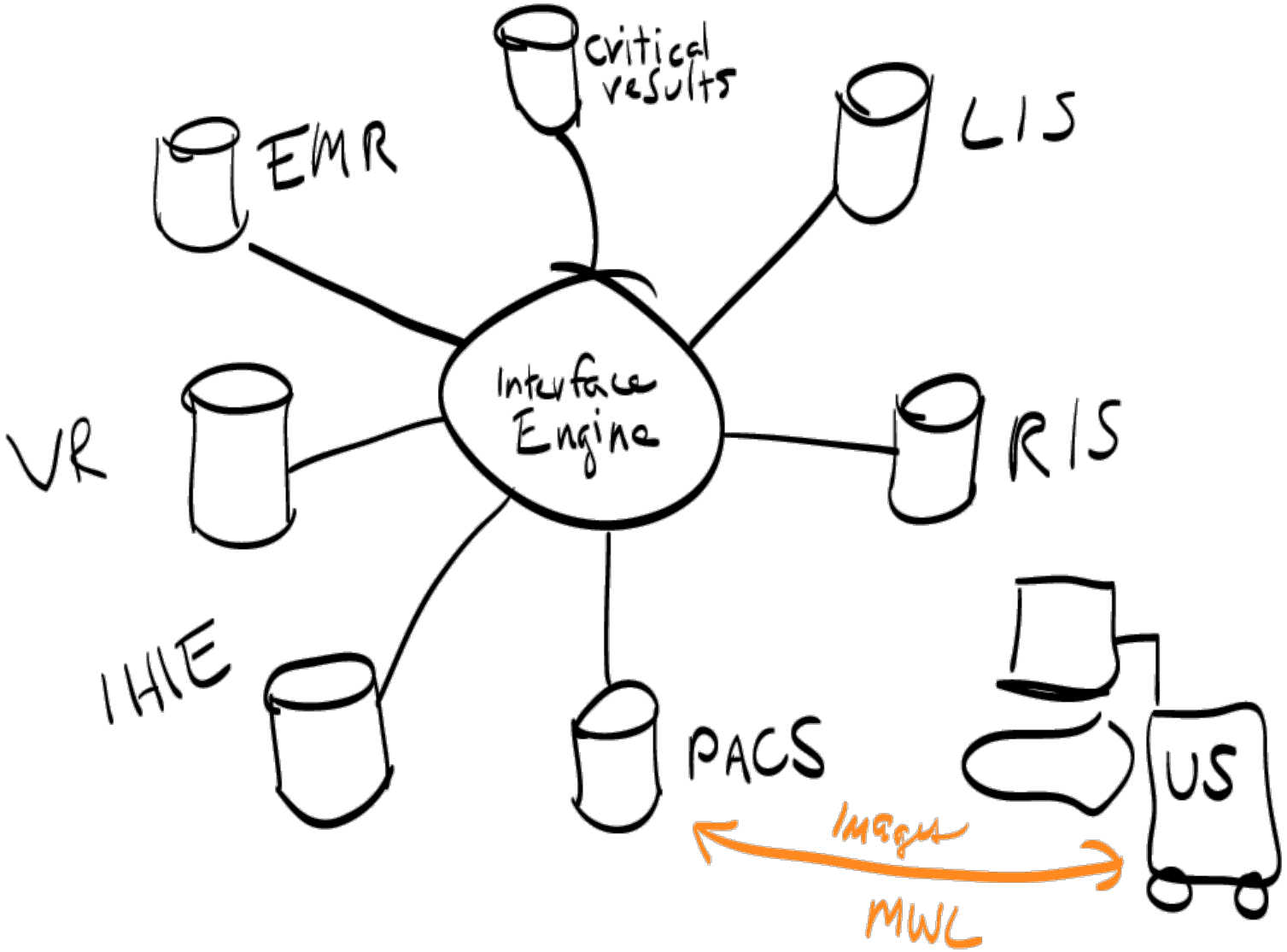
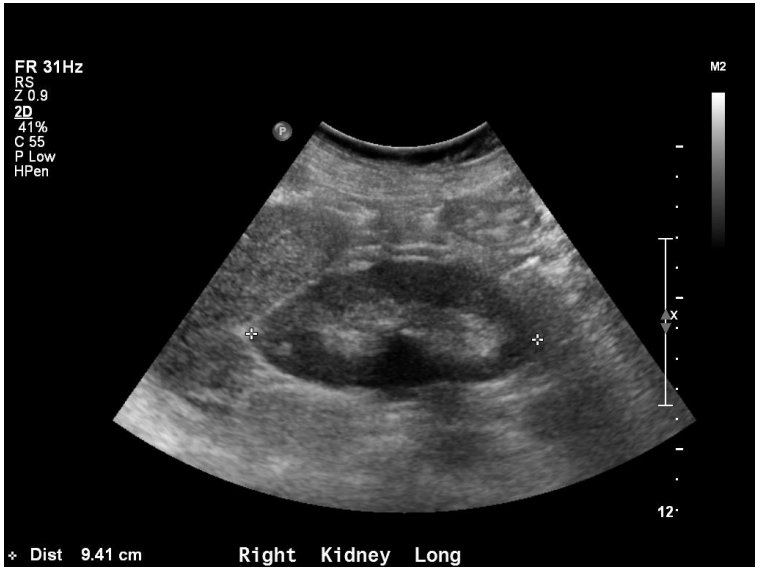

critical results
EMR
LIS
Interface Engine
VR
RIS
IHE
PACS
US
Image
MWL

PHILIPS
Patient Data
End Exam
Pause Exam
Cancel Exam
Clear Patient Data
Edit
Update Worklist
Patient Search...
Temporary ID
Close
General Information
Last Name
First Name
M.I.
Patient ID
Accession #
Sonographer
Study Description
Ref. M.D.
Birth Date
MM/DD/YYYY
Age:
Gender
Comments
Study Type
None
Worklist
Study Info
Paused Exams
Find
by
Name
Updated at: 11/01/2013 08:25AM
Exam Time/Date
Name
ID
Accession #
Study Descrip...
Gender
08:16AM 11/01/2013 US Guided A... F
07:54AM 11/01/2013 US Renal Tra... M
09:00AM 11/01/2013 US Guided R... M
06:11AM 11/01/2013 US Renal F
07:00AM 11/01/2013 US Guided A... M
09:50PM 11/01/2013 US RUQ/Liver... M
03:21PM 11/01/2013 US Guided N... F
01:21PM 11/01/2013 US Guided Th... F
08:30AM 11/01/2013 US RUQ/Liver... M
08:30AM 11/01/2013 US Guided N... M
Elephant, Rex
iSCAN

FR 29Hz
RS
Z 0.9
2D
43%
C 55
P Low
HPen
M2
14
Right Liver Long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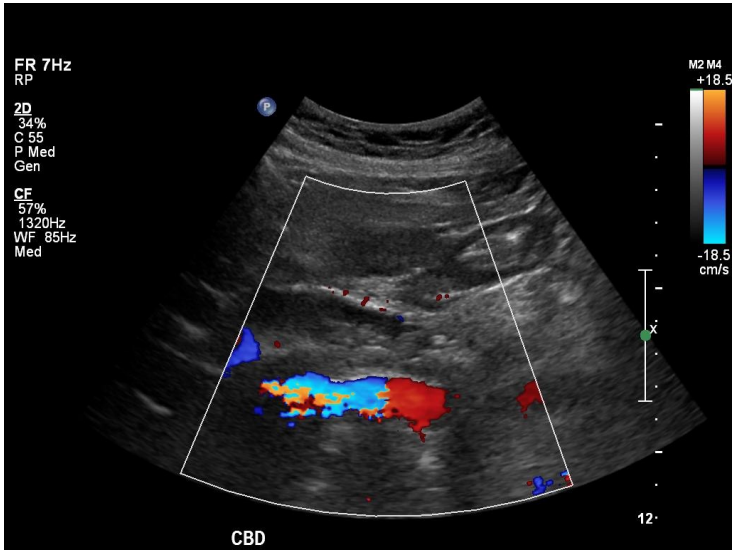
RS
Z 0.9
2D
41%
C 55
P Low
HPen
M2
12
Dist 9.41 cm
Right Kidney Long


FR 7Hz
RP
2D
34%
C 55
P Med
Gen
CF
57%
1320Hz
WF 85Hz
Med
M2 M4
+18.5
-18.5
cm/s
12
CBD

NEMA, Suite 1752
1300 North 17th Street
Rosslyn, VA 22209
Ph: (703) 841-3281
http://dicom.nema.org
dicom@medicalimaging.org

Search the DICOM website

Search

DICOM Calendar

2013 International Conference & Seminar

About DICOM

PURPOSE & ORGANIZATION

- Strategic Document & Principal Contacts
- Members of the DICOM Standards Committee
- Approved Work Items
- DICOM Brochure
- NEMA/Medical

PROCESS

- DICOM Procedures
- Meeting Minutes
- Demonstrations, Presentations & Workshops
- Patent Disclosures

PRODUCTS

- The DICOM Standard
- Recently Approved Change Proposals
- Recently Approved Supplements
- Purchase the Standard
- Legal Issues (Trademark)

Technical Assistance

- DICOM Resources
- DICOM Discussion Group
- To Obtain a Free DICOM Viewer
- To Obtain a Unique Identifier

Administrative Assistance

- Contact the Webmaster
- Contact the Secretariat
- Member's Handbook

DICOM Part 1: Introduction and Overview

DICOM Part 2: Conformance

DICOM Part 3: Information Object Definitions

DICOM Part 4: Service Class Specifications

DICOM Part 5: Data Structures and Encoding

DICOM Part 6: Data Dictionary

DICOM Part 7: Message Exchange

DICOM Part 8: Network Communication Support for Message Exchange

DICOM Part 10: Media Storage and File Format for Media Interchange

DICOM Part 11: Media Storage Application Profiles

DICOM Part 12: Media Formats and Physical Media for Media Interchange

DICOM Part 14: Grayscale Standard Display Function

DICOM Part 15: Security and System Management Profiles

DICOM Part 16: Content Mapping Resource

DICOM Part 17: Explanatory Information

DICOM Part 18: Web Services

DICOM Part 19: Application Hosting

DICOM Part 20: Imaging Reports using HL7 Clinical Document Architecture

DICOM Part 21: Transformations between DICOM and other Representations

DICOM Part 22: Real-Time Communication

DICOM Conformance Statements - Artificial Intelligence

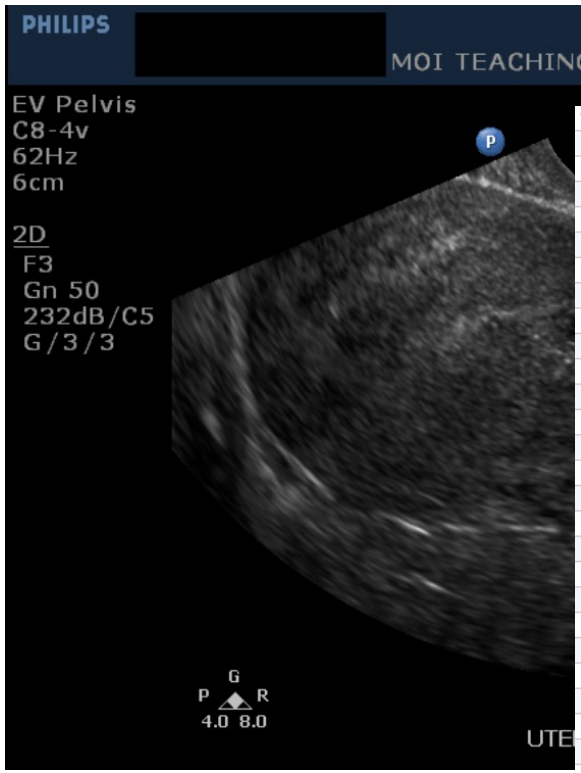
› Go back to DICOM overview

Artificial Intelligence

System / Version	Date of creation	PDF
AI-Rad Companion Chest CT		
VA40A (Pulmonary) / VA22A (Cardiovascular+Musculoskeletal)	January 2024	↗ Download
VA30 (Pulmonary) / VA21 (Cardiovascular+Musculoskeletal)	October 2023	↗ Download

https://www.siemens-healthineers.com/services/it-standards/dicom-conformance-statements-digital-and-automation/artificial-intelligence

Camera	Nikon D7000
Exposure	0.025 sec (1/40)
Aperture	f/2.8
Focal Length	40 mm
ISO Speed	2000
Exposure Bias	-1/3 EV
Flash	Off, Did not fire
Image Description	Amazing detail recreating the posterior neck lymphatic system.
X-Resolution	240 dpi
Y-Resolution	240 dpi
Software	Adobe Photoshop Lightroom 3.6 (Macintosh)
Date and Time (Modified)	2012:08:05 17:27:21
Exposure Program	Aperture-priority AE
Sensitivity Type	Recommended Exposure Index
Date and Time (Original)	2012:07:31 06:47:04
Date and Time (Digitized)	2012:07:31 06:47:04
Max Aperture Value	2.8
Subject Distance	0.79 m
Metering Mode	Multi-segment
Light Source	Unknown



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TransferSyntaxUID	0002,0010	1.2.840.10008.1.2.1
ImplementationClassUID	0002,0012	1.2.276.0.7230010.3.0.3.5.4
ImplementationVersionName	0002,0013	OFFIS_DCMTK_354
▶ImageType	0008,0008	ORIGINAL\PRIMARY\GYNECOLOGY\0001
SOPClassUID	0008,0016	1.2.840.10008.5.1.4.1.1.6.1
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AcquisitionDate	0008,0022	20110719
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StudyTime	0008,0030	165205.000000
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Manufacturer	0008,0070	Philips Medical Systems
InstitutionName	0008,0080	MOI TEACHING&REFERRAL HOSPITAL
ReferringPhysiciansName	0008,0090	
StationName	0008,1010	OEM-PCXG7NXJPVQ
PatientsName	0010,0010	Adenomyosis
PatientID	0010,0020	002
PatientsBirthDate	0010,0030	
PatientsSex	0010,0040	
PatientIdentityRemoved	0012,0062	YES
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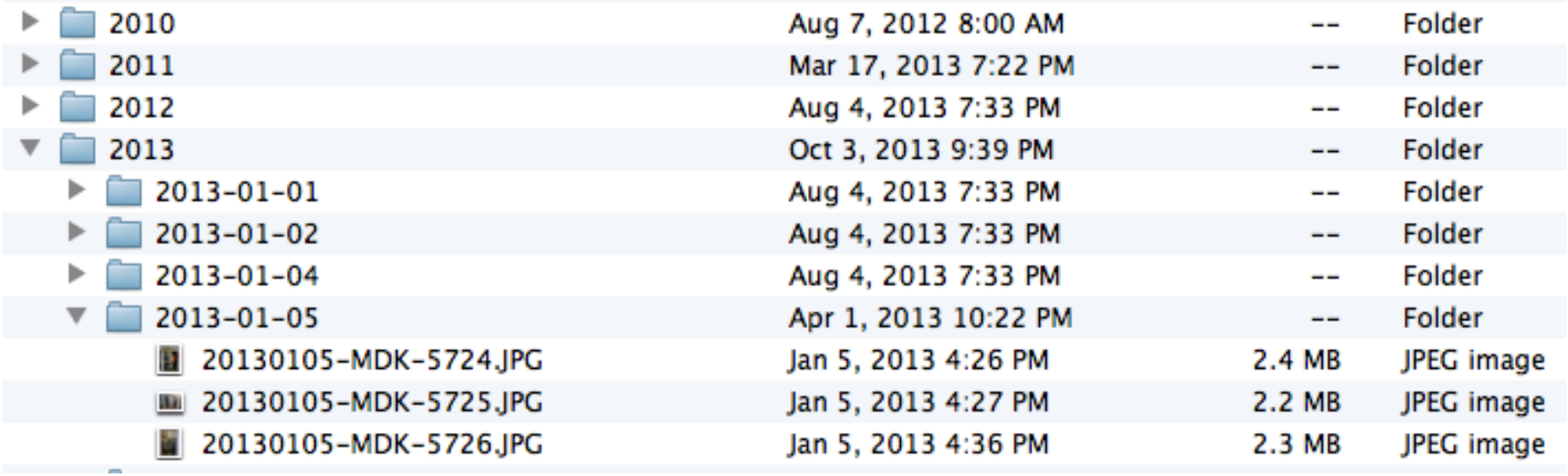
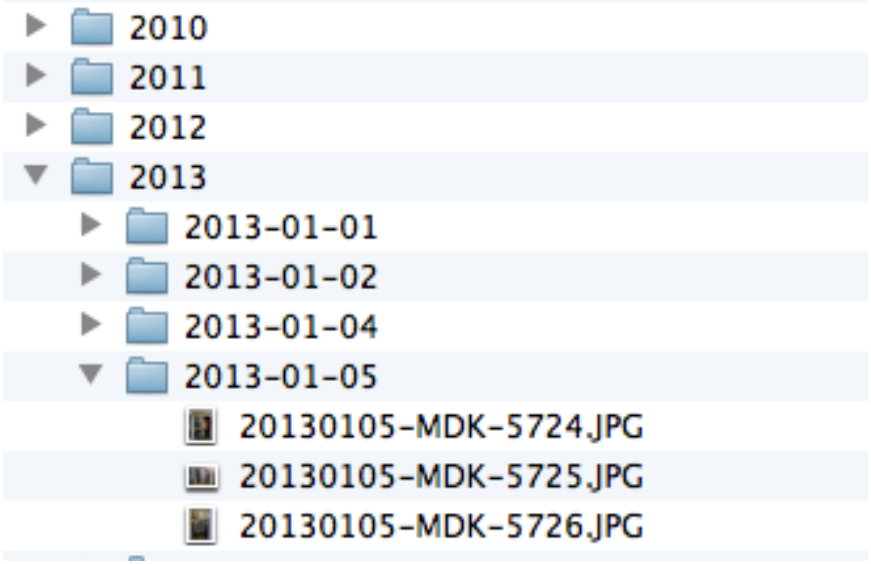
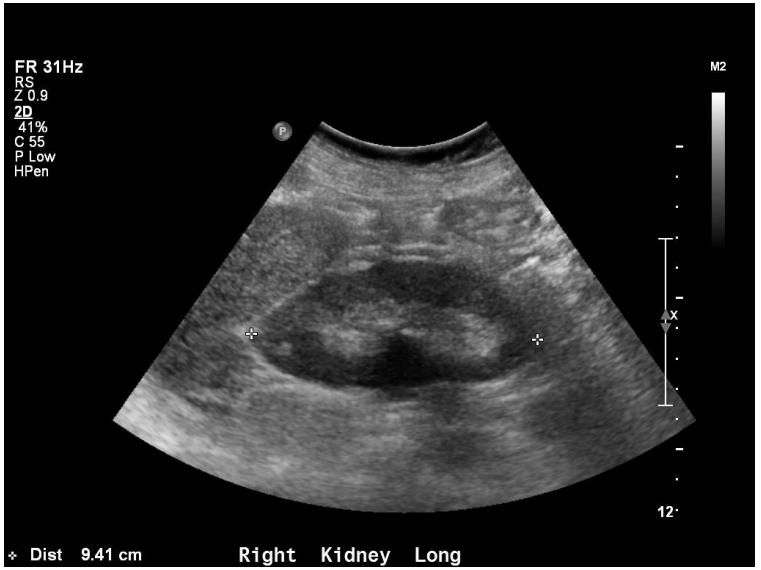
▶DeidentificationMethodCodeSequence	0012,0064	113100\DCM\Basic Application Confidentiality Profi
▶TransducerData	0018,5010	C8-4v\UNUSED\UNUSED
ProcessingFunction	0018,5020	OBEVPelvis
▶SequenceofUltrasoundRegions	0018,6011	1\1\3\120\60\800\524\340\81\3\3\0\0\0.01692
TransducerType	0018,6031	CURVED LINEAR
▶ContributingEquipmentSequence	0018,a001	PixelMed\ISMACK_11112\DicomCleaner\Sun Jul 17
StudyInstanceUID	0020,000d	1.3.6.1.4.1.5962.99.1.2235507725.1075062900.1
SeriesInstanceUID	0020,000e	1.3.6.1.4.1.5962.99.1.2235507725.1075062900.1
StudyID	0020,0010	
SeriesNumber	0020,0011	1
InstanceNumber	0020,0013	3

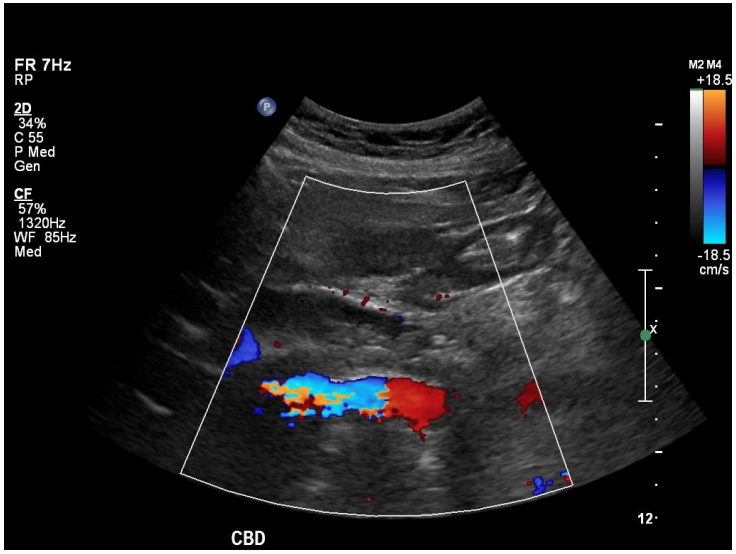

2010 Aug 7, 2012 8:00 AM -- Folder
2011 Mar 17, 2013 7:22 PM -- Folder
2012 Aug 4, 2013 7:33 PM -- Folder
2013 Oct 3, 2013 9:39 PM -- Folder
2013-01-01 Aug 4, 2013 7:33 PM -- Folder
2013-01-02 Aug 4, 2013 7:33 PM -- Folder
2013-01-04 Aug 4, 2013 7:33 PM -- Folder
2013-01-05 Apr 1, 2013 10:22 PM -- Folder
20130105-MDK-5724.JPG Jan 5, 2013 4:26 PM 2.4 MB JPEG image
20130105-MDK-5725.JPG Jan 5, 2013 4:27 PM 2.2 MB JPEG image
20130105-MDK-5726.JPG Jan 5, 2013 4:36 PM 2.3 MB JPEG image

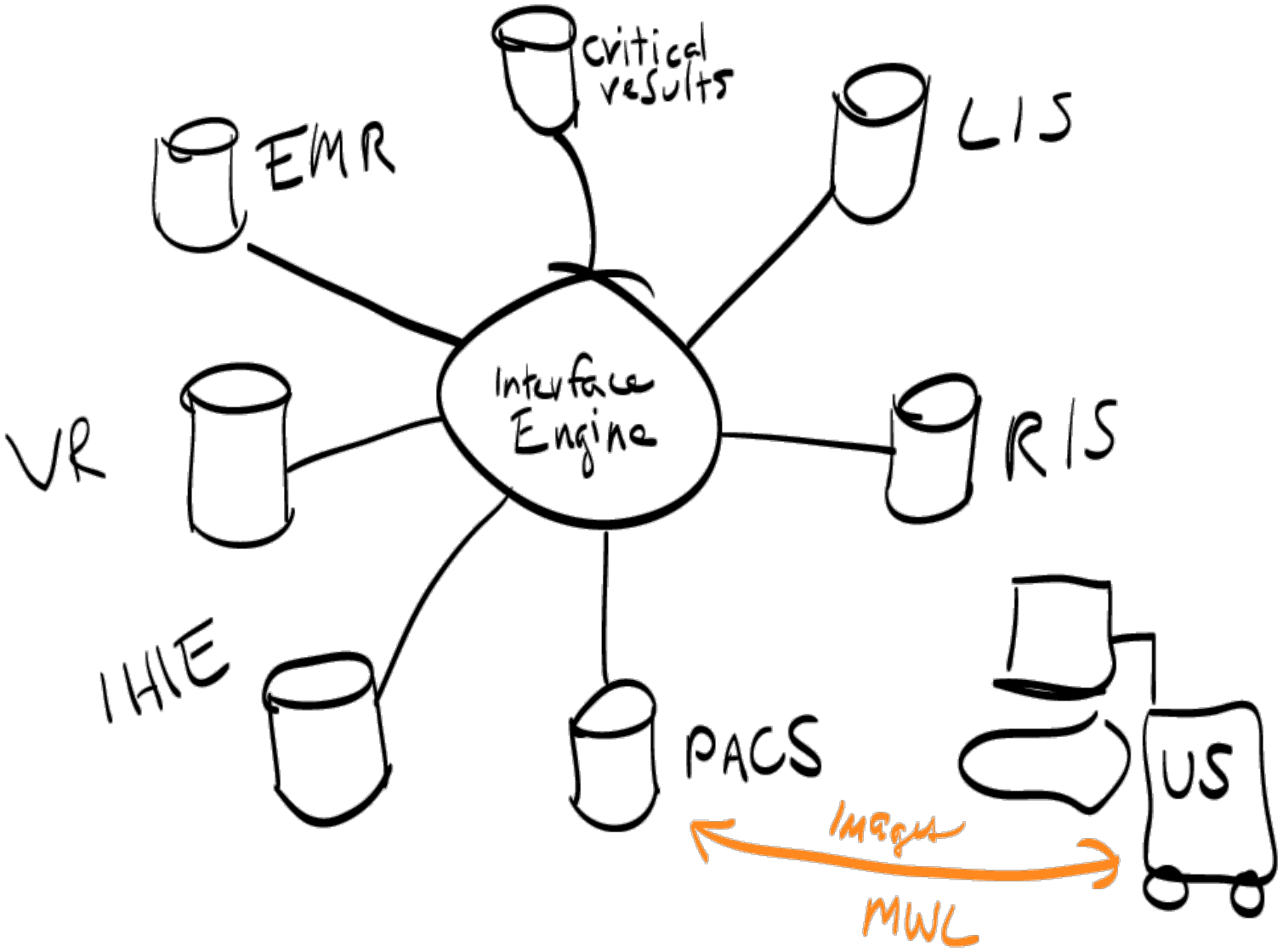



```
patient
|-- study
     |-- series1
          |-- instance1
          |-- instance2
          |-- instance3
     |-- series2
          |-- instance4
          |-- instance5
          |-- instance6
```

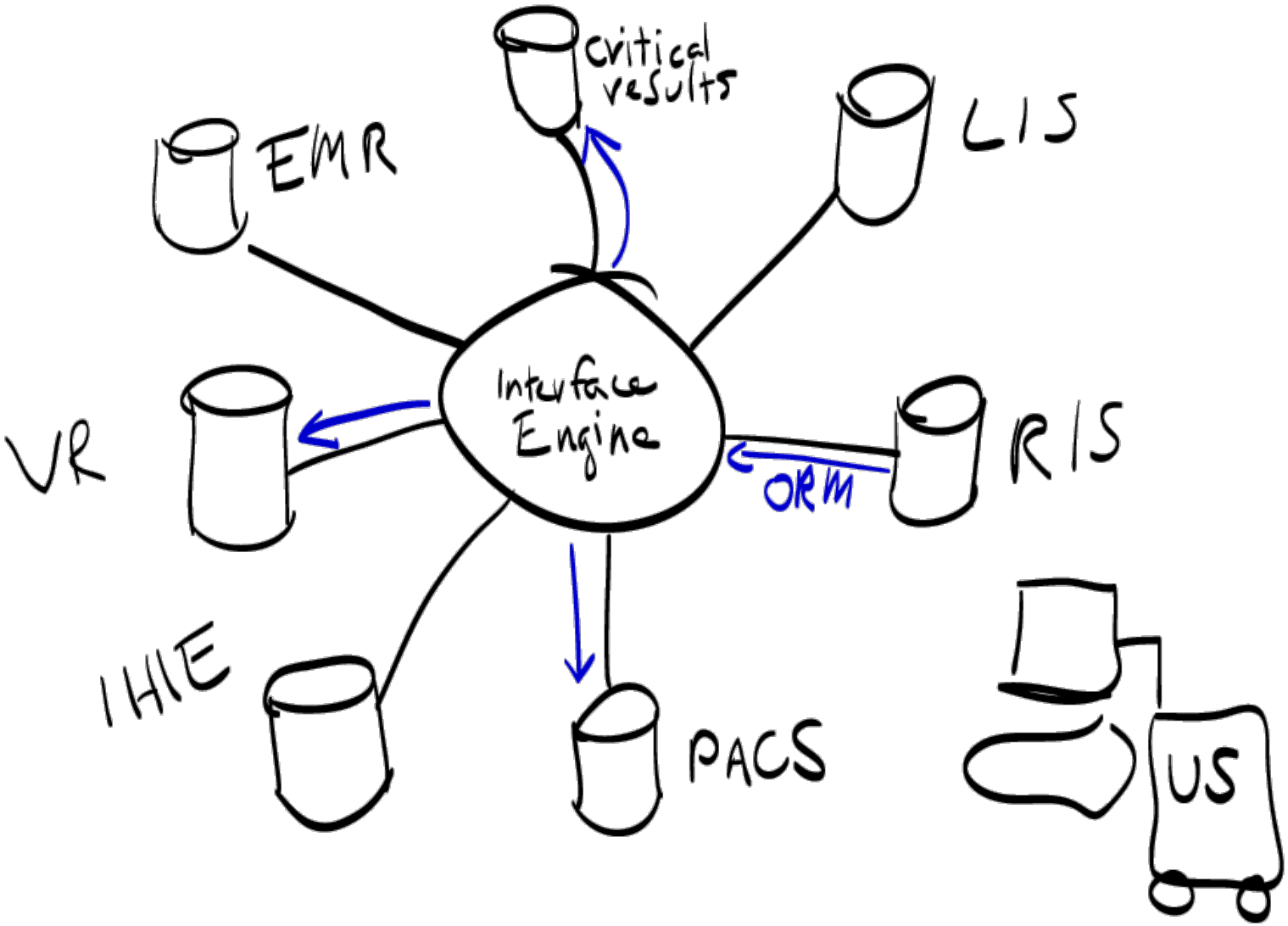
FR 29Hz
RS
Z 0.9
2D
43%
C 55
P Low
HPen
M2
14
Right Liver Long

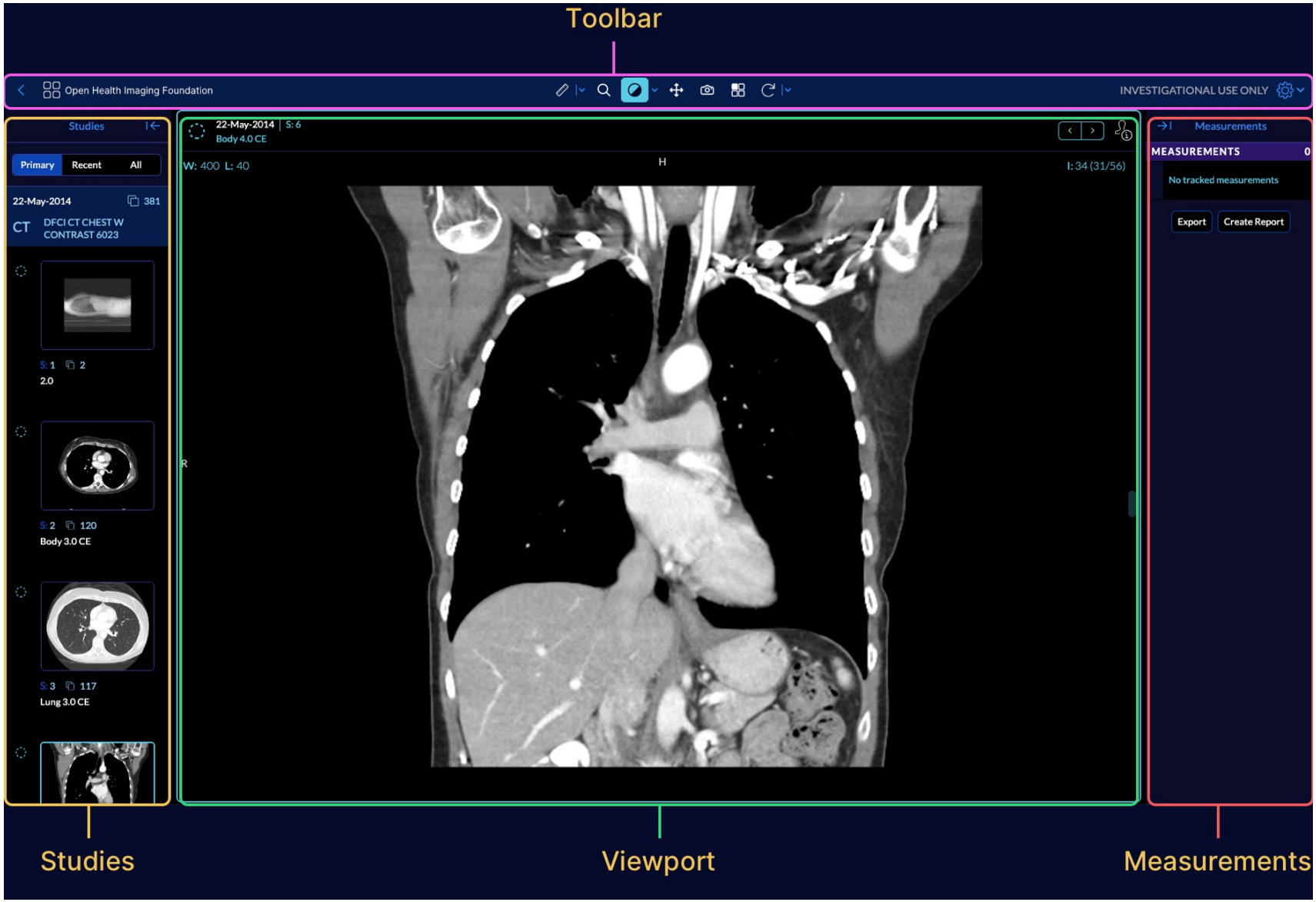

FR 31Hz
RS
Z 0.9
2D
41%
C 55
P Low
HPen
M2
12
Dist 9.41 cm
Right Kidney Long


FR 7Hz
RP
2D
34%
C 55
P Med
Gen
CF
57%
1320Hz
WF 85Hz
Med
M2 M4
+18.5
-18.5
cm/s
12
CBD


critical results
EMR
LIS
Interface Engine
VR
RIS
IHIE
PACS
US
Image
MWL

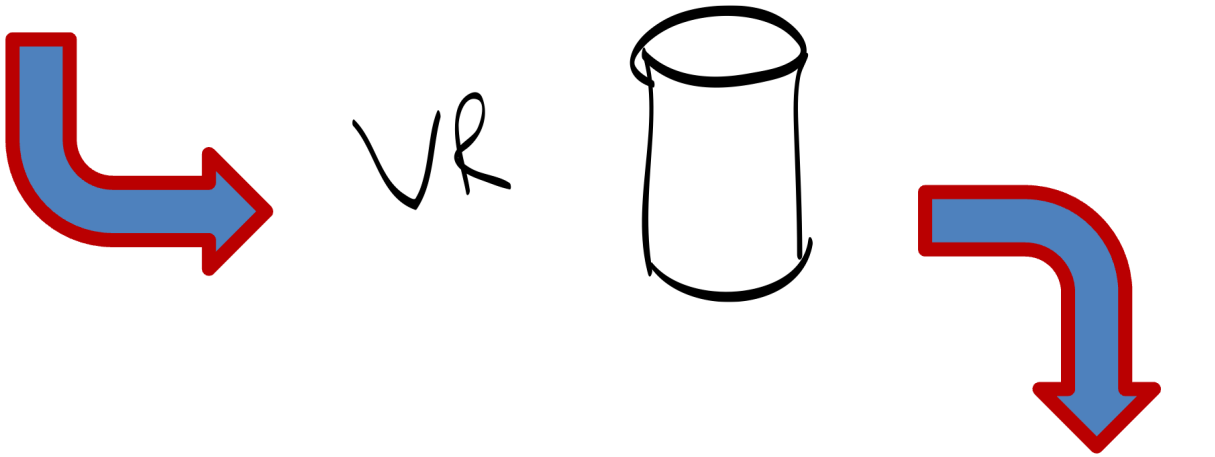
Completion Time
Contrast
Performing Technologist
Tech Comments


critical results
EMR
LIS
Interface Engine
VR
RIS
ORM
IHIE
PACS
US

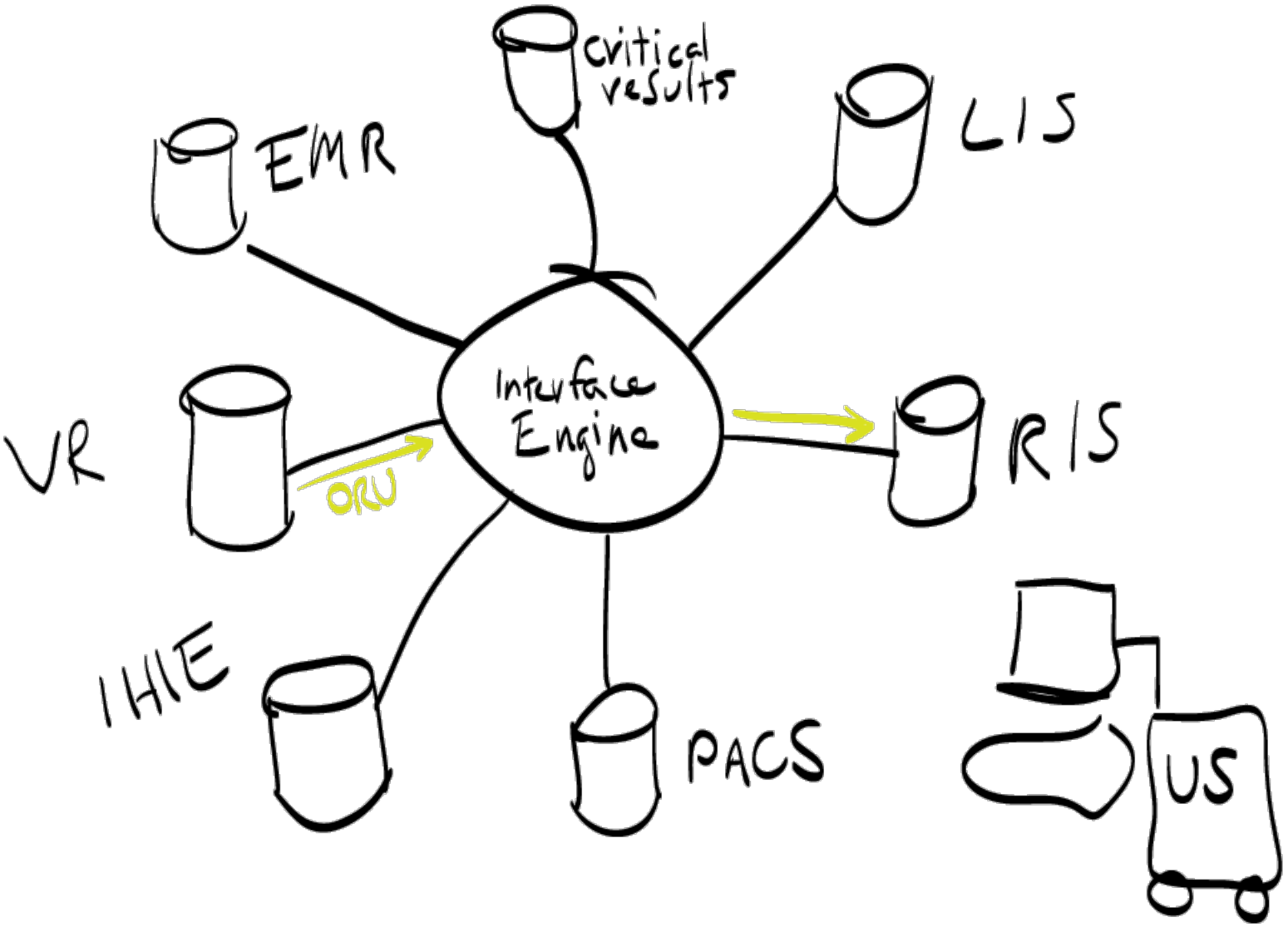

Toolbar
Open Health Imaging Foundation
INVESTIGATIONAL USE ONLY
Studies
Primary
Recent
All
22-May-2014
381
CT
DFCI CT CHEST W CONTRAST 6023
S: 1
2
2.0
S: 2
120
Body 3.0 CE
S: 3
117
Lung 3.0 CE
22-May-2014 | S: 6
Body 4.0 CE
W: 400 L: 40
H
I: 34 (31/56)
R
Measurements
MEASUREMENTS
0
No tracked measurements
Export
Create Report
Studies
Viewport
Measurements

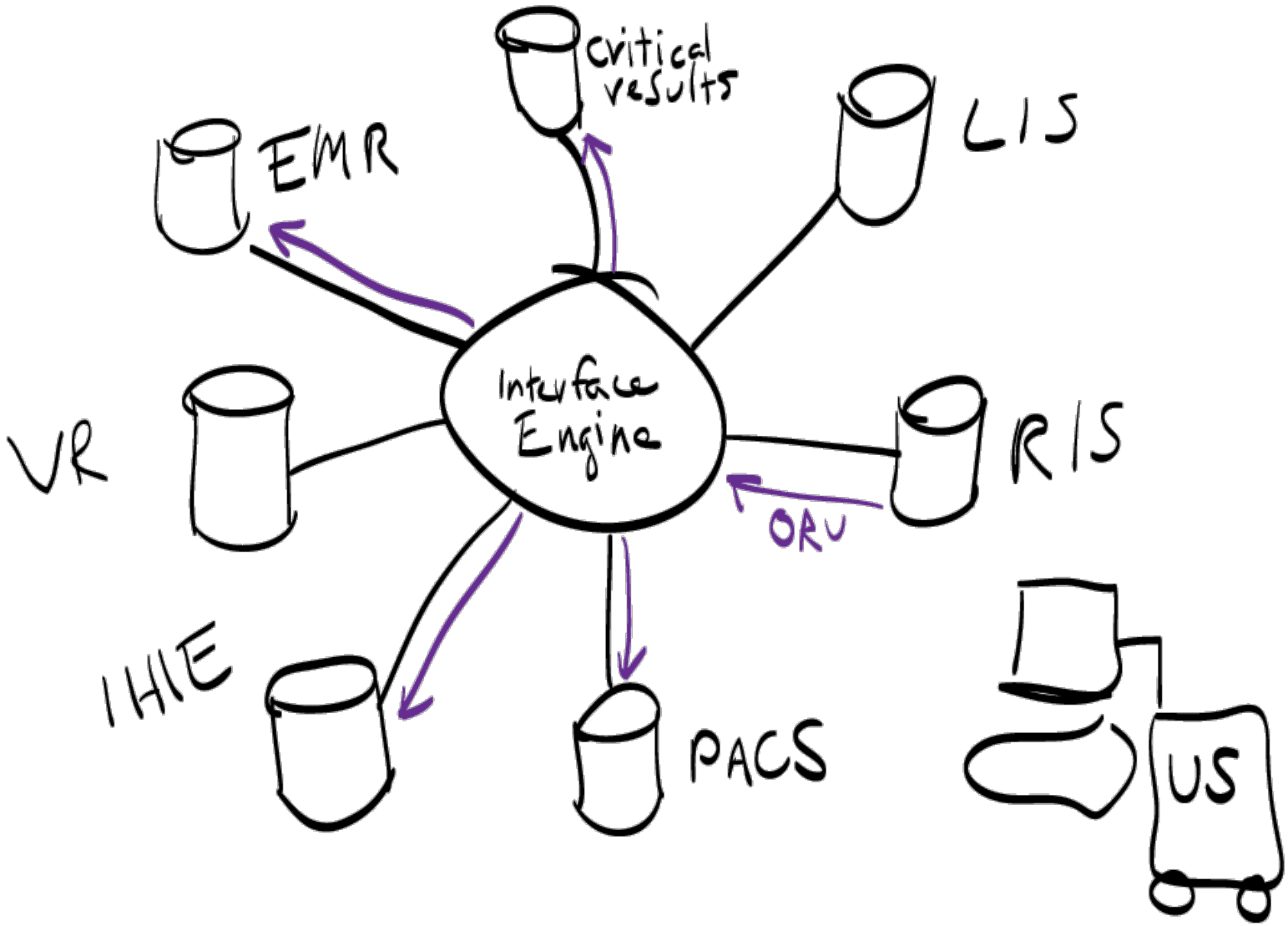
PHILIPS
Left Liver Lung

Report Text
Exam Status
Dictating Radiologist
Accession Number



HL7 ORU message


critical results
EMR
LIS
Interface Engine
VR
ORU
RIS
IHIE
PACS
US


critical results
EMR
LIS
Interface Engine
VR
RIS
ORU
IHIE
PACS
US

ORU Messages

```
MSH|^~\&|RAD|WISH|||200810052215||ORU|RMS|P|2.3||
PID|||000009871^^^ZOO^US||REX^ELEPHANT^^^||196007290000|F||6|1234 MAIN^^ANY^IN^^||12386|||
PV1|1|O|||||||||||||||E|||||||||||||||||||
OBR||^|3011038|US11759^US
RUQ^|||201106050117|||RAD|||||^^^^L|||||||200810052215|||F||1^^^^^N^^Now|072801^SPACEMAN^DR||||
059980^KOHLI^M^^^|
OBX|1|XCN|11780&SDR^US RUQ^WMHRAD||059980^KOHLI^M^|
OBX|2|TX|11780&GDT^US RUQ^WMHRAD||Right Upper Quadrant Ultrasound: 06-05-2011  Indication:
Right upper quadrant pain, nausea.  Findings: The liver is normal in size, contour, and
echotexture.  No intra or extra hepatic biliary duct enlargement.  The gallbladder demonstrates
gallstones without pericholecystic fluid or wall thickening.  The right kidney is normal
without hydronephrosis or hyperechoic renal stones.  ||||||F|
OBX|3|TX|11780&GDT^US RUQ||~Transcribed by - PSC~Transcription Date - 200810052215||||||F|
OBX|4|TX|11780&IMP^US RUQ^WMHRAD|| Gallstones without acute cholecystitis||||||F|
```

OBR||^|3011038|US11759^US
RUQ^|||201106050117|||RAD|||||^^^^L|||||||200810052215|||F||1^^
^^^N^^Now|072801^SPACEMAN^DR||||059980^KOHLI^M^^^|

OBX|1|XCN|11780&SDR^US RUQ^WMHRAD||059980^KOHLI^M^|

OBX|2|TX|11780&GDT^US RUQ^WMHRAD||Right Upper Quadrant
Ultrasound: 06-05-2011 Indication: Right upper quadrant pain,
nausea. Findings: The liver is normal in size, contour, and
echotexture. No intra or extra hepatic biliary duct
enlargement. The gallbladder demonstrates gallstones without
pericholecystic fluid or wall thickening. The right kidney is
normal without hydronephrosis or hyperechoic renal stones.
||||||F|

OBX|3|TX|11780&GDT^US RUQ||~Transcribed by - PSC~Transcription
Date - 200810052215||||||F|

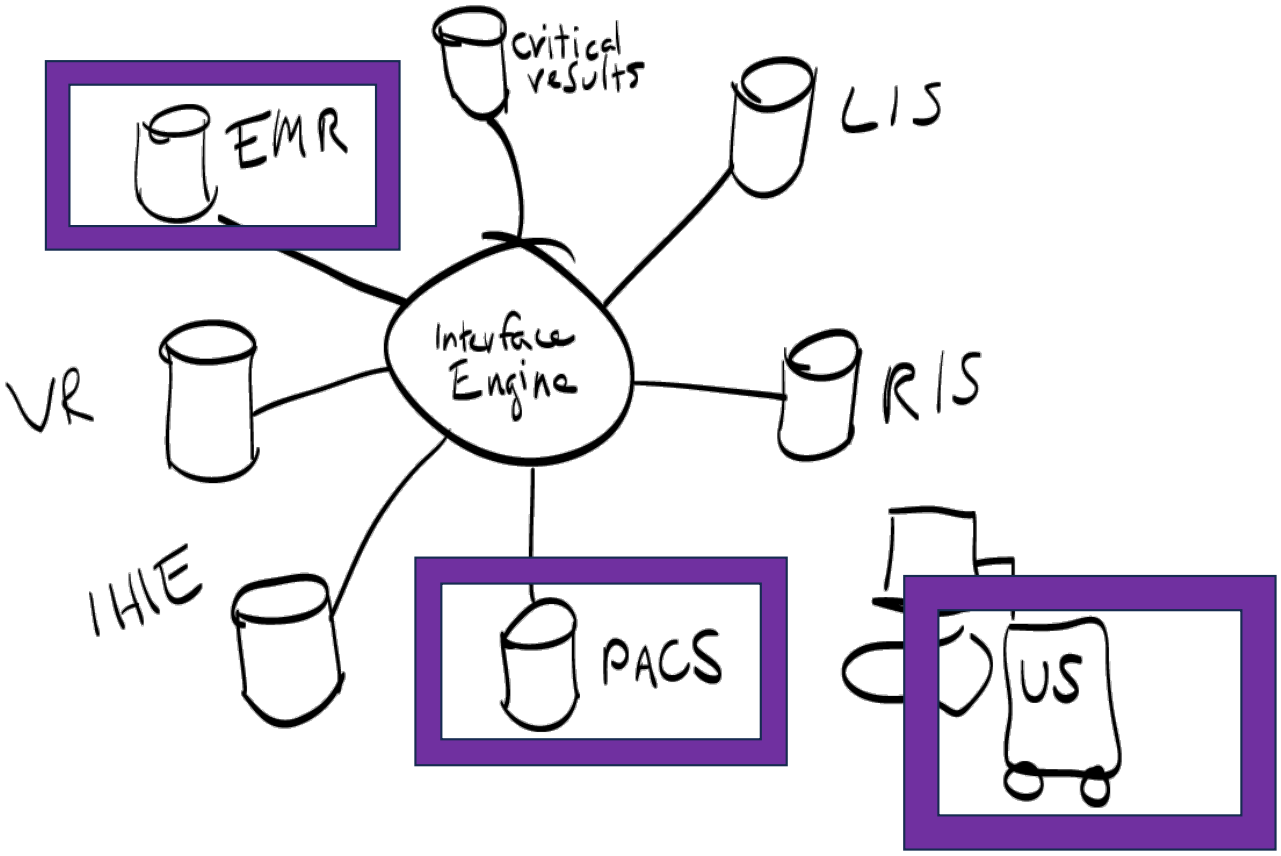
OBX|4|TX|11780&IMP^US RUQ^WMHRAD|| Gallstones without acute
cholecystitis||||||F|

Another life saved by
Scheduled Workflow

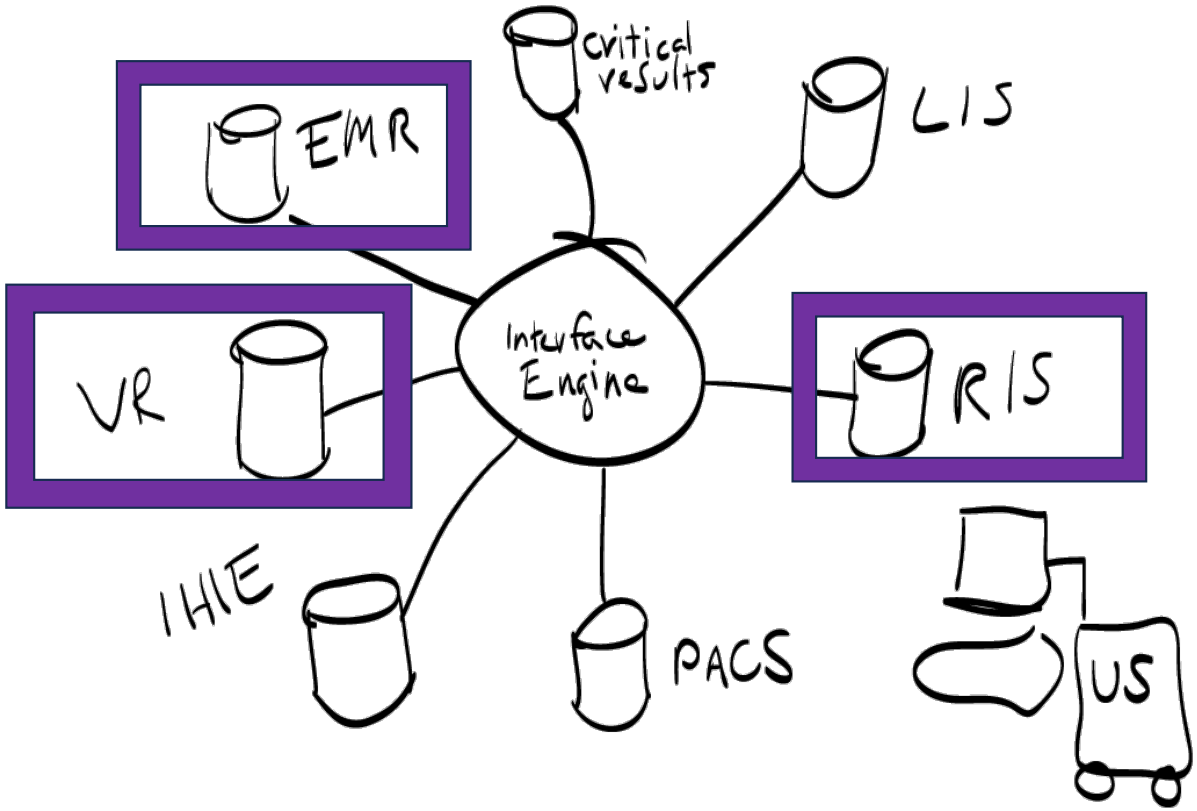
Objectives

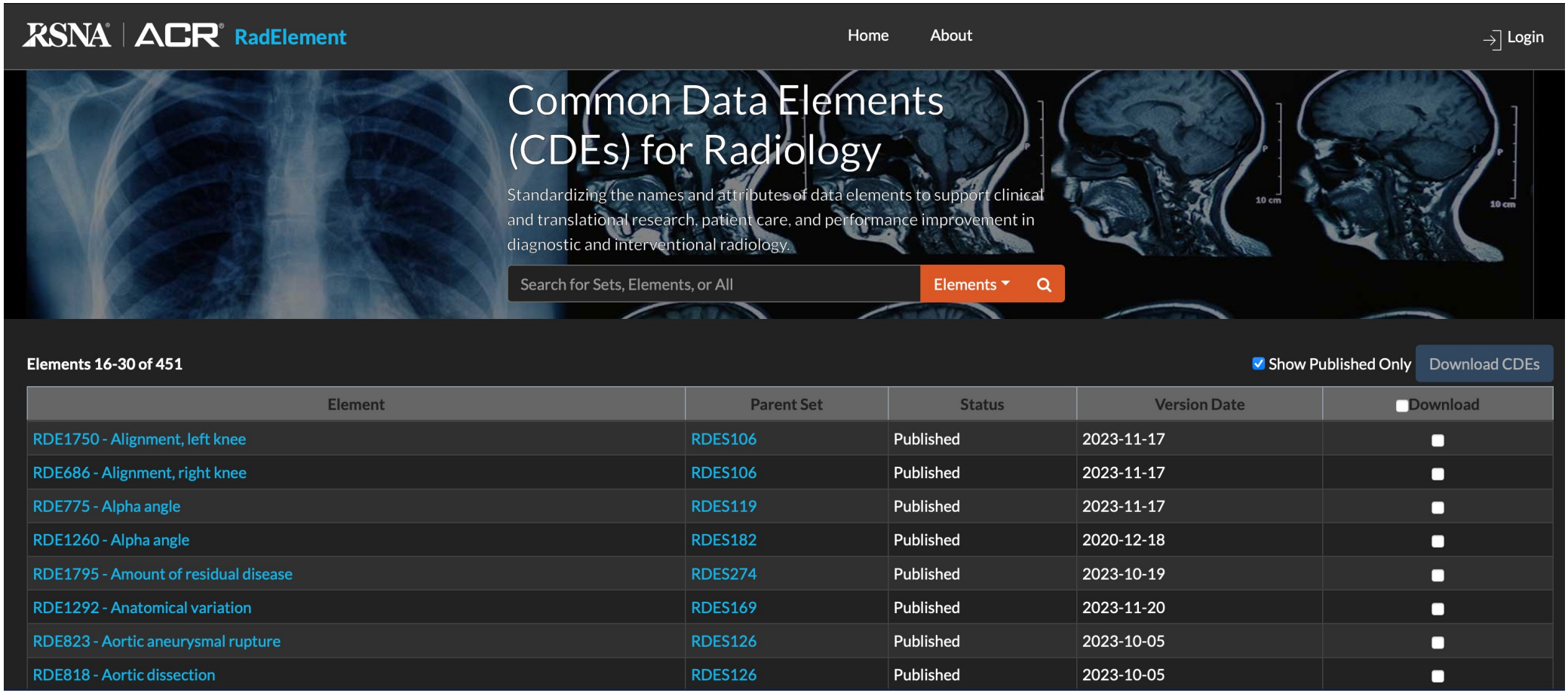
- Discuss standards relevant to imaging workflows
- Discuss imaging workflow
- **Summarize imaging informatics workflow in the context of AI development and deployment**

Dataset Curation

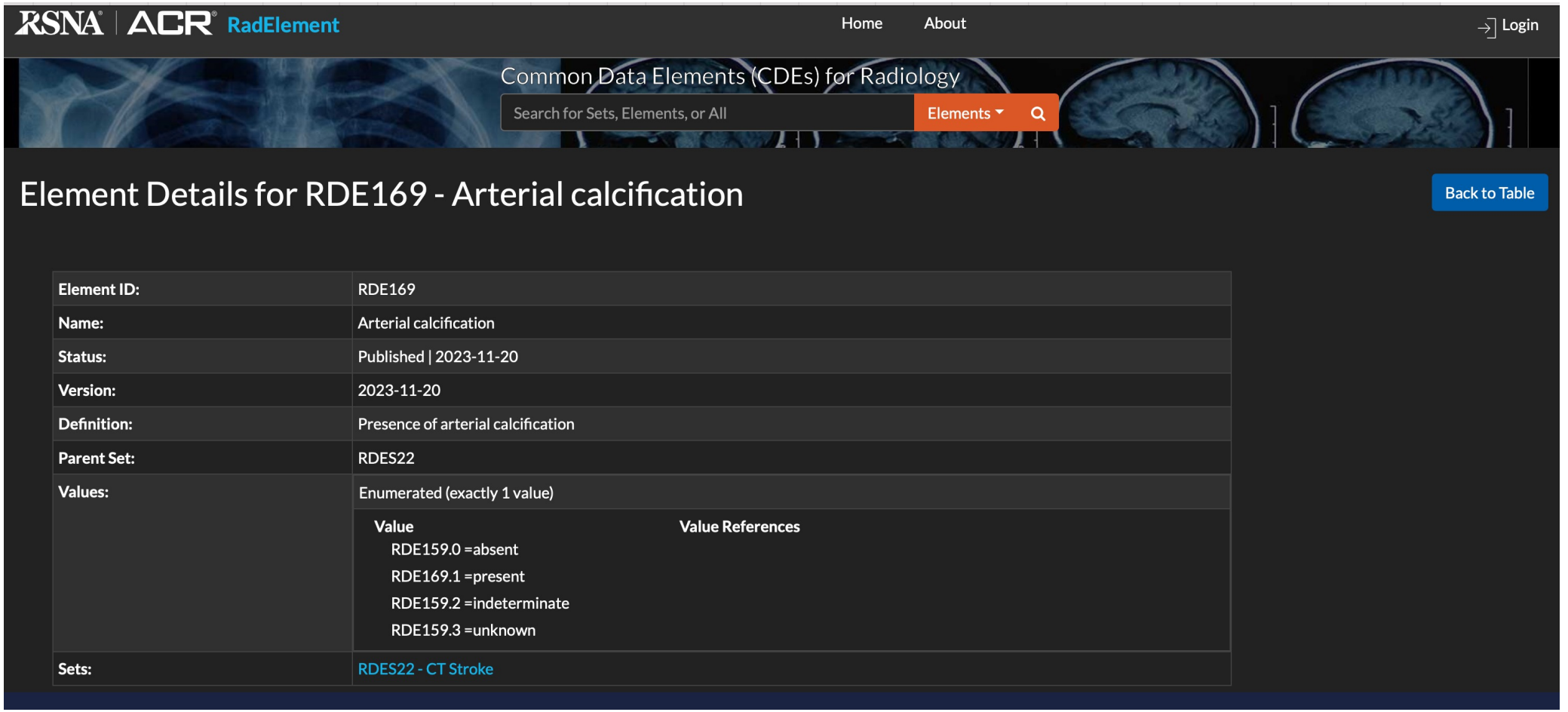


Dataset Labels



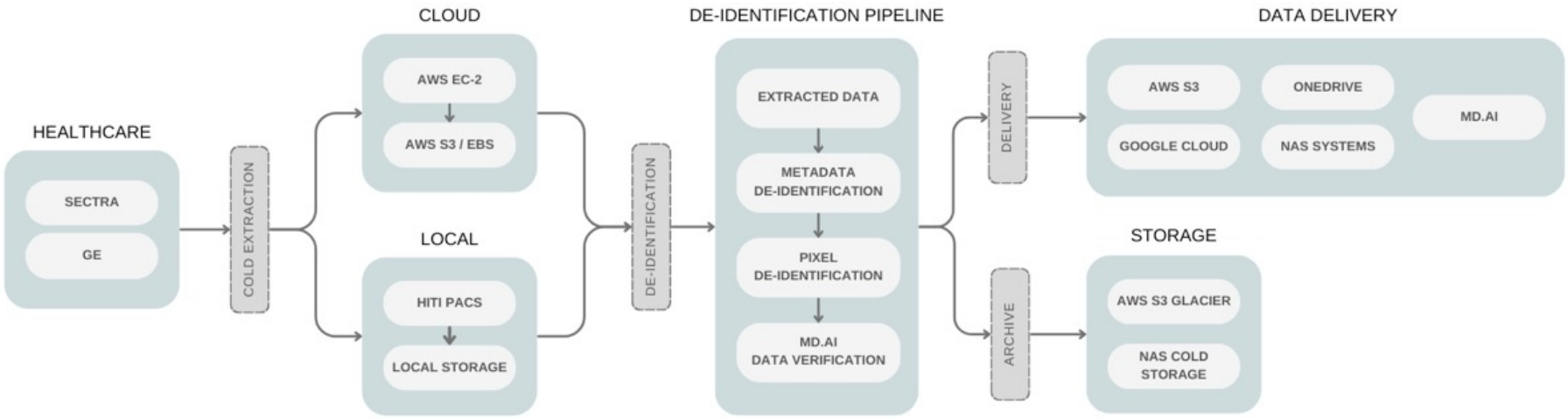


https://www.radelement.org/home/elements

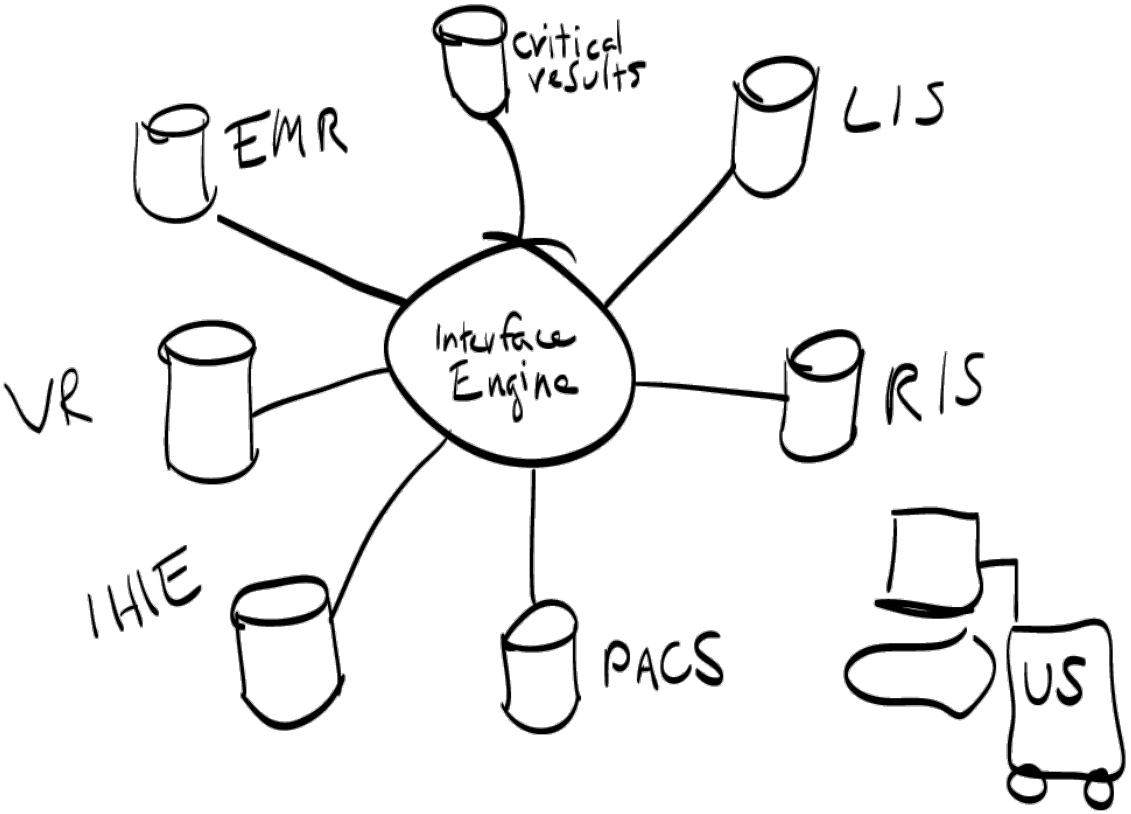


https://www.radelement.org/home/elements/element/RDE169

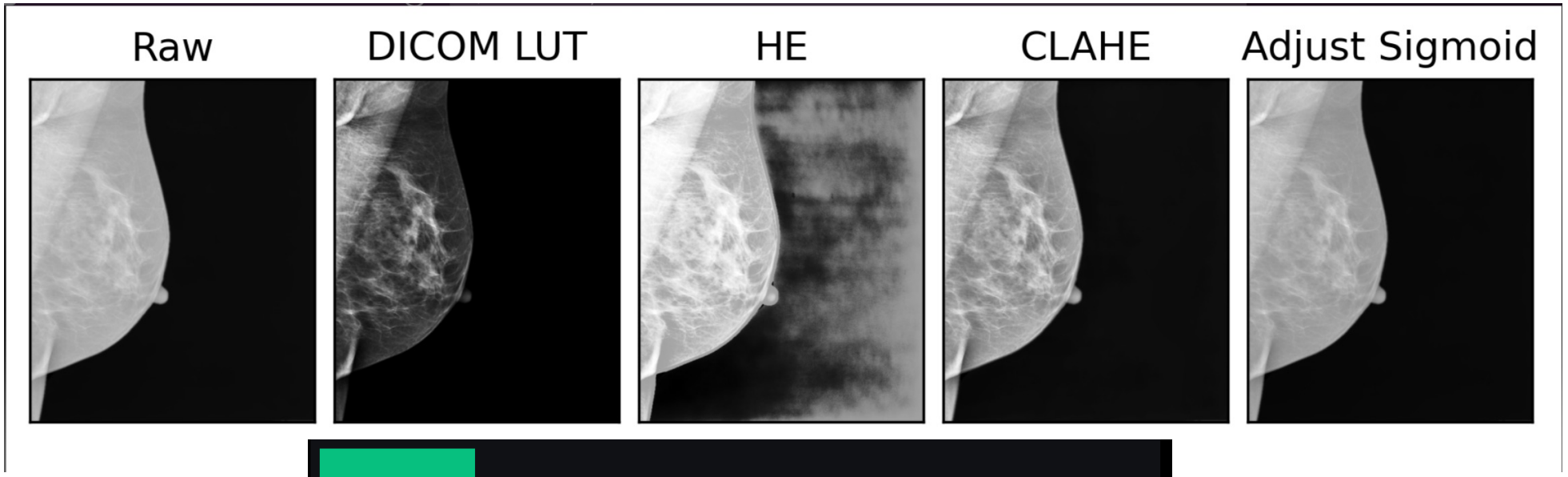
HITI Dataset curation pipeline



AI deployment



DL model development



3:45 PM - 4:30 PM

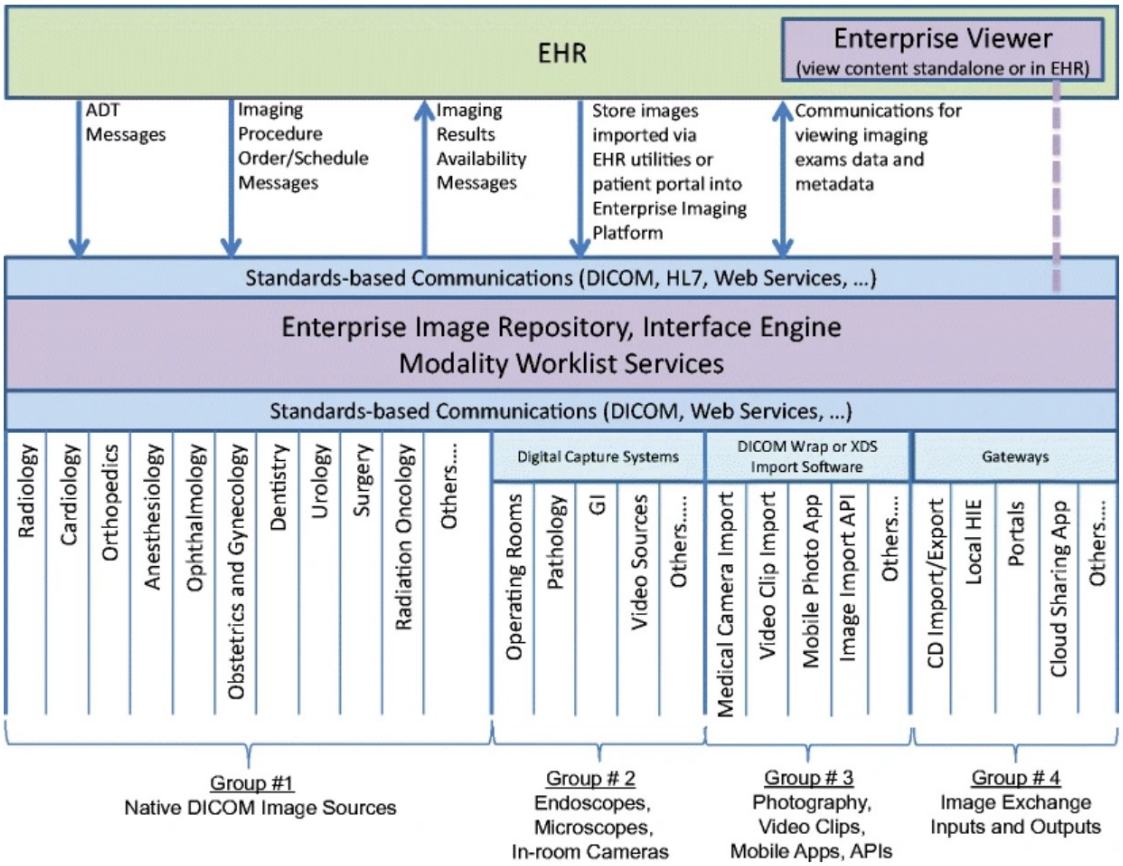
Emory CXR - Data Preprocessing

In this hands-on session, participants will learn how to open a chest X-ray image and perform image preprocessing.

THEO DAPAMEDE
Emory University

THEO DAPAMEDE
Emory University

Enterprise Imaging



https://link.springer.com/article/10.1007/s10278-016-9882-0/figures/1

ing platform provides the standards-based enterprise infrastructure to support departmental imaging w

Objectives

- Discuss standards relevant to imaging workflows
- Discuss imaging workflow
- Summarize imaging informatics workflow in the context of AI development and deployment

Assignment

- Sketch your workflow for data curation or AI product deployment in the radiology imaging / enterprise imaging workflow

- judywawira@emory.edu
- @judywawira

Healthcare Innovation and Translational Informatics (HITI) Lab at Emory