



# IMPLEMENTATION OF COMMON DATA ELEMENTS IN AN INTERACTIVE MULTIMEDIA REPORTING SYSTEM

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# PURPOSE:

- The RSNA defines common data elements (CDEs) as “standardized sets of questions and allowable answers used to express observations in diagnoses”.
- CDEs are a vital component of structured reporting as they provide details about a disease using standardized terminology that can be indexed, searched and transmitted across electronic health record systems.
- However, widespread adoption and implementation of CDEs remains limited.
- A framework for using CDEs in an interactive multimedia reporting environment is presented in this exhibit.

MR Rectal Tumor Imaging	
<b>Description</b>	Data elements in support of the Cancer Care Ontario rectal tumor staging template
<b>Contact Name</b>	Charles E. Kahn, Jr., MD, MS
<b>Set References</b>	
<b>Elements</b>	Element Details for Tumor location from anal verge
RDE67 - Image quality	
RDE68 - Tumor location from anal verge	<b>Name</b> Tumor location from anal verge
RDE69 - Distance of lowest extent of tumor from anal verge	
RDE70 - Distance of lowest extent of tumor from top of anal sphincter	<b>Question</b>
RDE72 - Circumferential extent and location	<b>Values</b> Enumerated (exactly 1 value): Low (0 - 5.0 cm) Mid (5.1 cm - 10.0 cm) High (10.1 cm - 15.0 cm)
RDE73 - Craniocaudad extent	<b>Value References</b>
RDE74 - Mucinous tumor	
RDE93 - Structures with possible invasion	<b>Element References</b>
RDE92 - T-category	
RDE94 - Lower extent relative to puborectals	<b>Additional Information</b> <a href="#">More details about Tumor location from anal verge</a>
RDE95 - Most penetrating component	

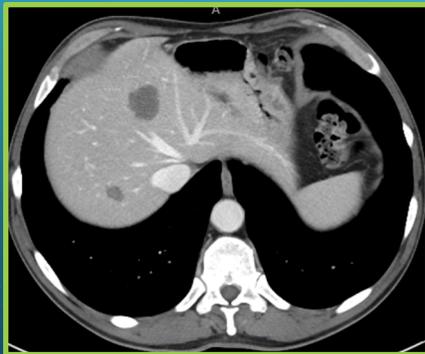
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Example of CDE from <https://radelement.org>

# METHODS:

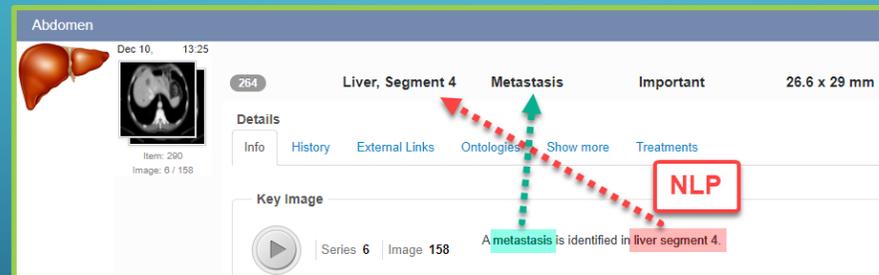
- An interactive multimedia reporting system was developed that works as follows:
  1. Record key images and voice descriptions of image findings
  2. Tag the images with metadata using natural language processing (NLP) that describes anatomy, pathology, and common data elements (CDEs)
  3. Assemble multimedia report with related information arranged in graphical timelines

## Step 1: Record images/voice



*A metastasis is identified in liver segment 4.*

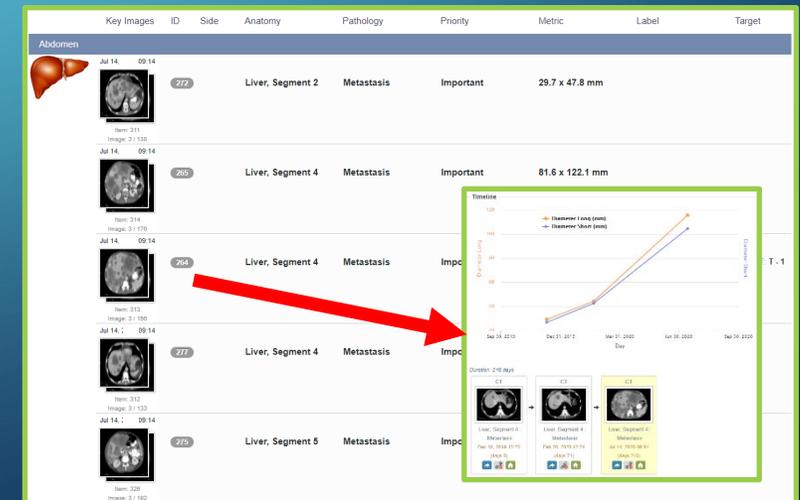
## Step 2: Tag with metadata



The screenshot shows a PACS interface for an abdominal CT scan. The main finding is "Liver, Segment 4 Metastasis" with a size of "26.6 x 29 mm". Below this, there are tabs for "Details", "Info", "History", "External Links", "Ontologies", "Show more", and "Treatments". A "Key Image" section shows a video player for "Series 6 Image 158". A red dashed arrow points from the "NLP" tag to the "Ontologies" tab, and a green dashed arrow points from the "NLP" tag to the "Key Image" section. A red box highlights the text "A metastasis is identified in liver segment 4." which is the NLP output.

Disease metrics and series/image numbers are transmitted automatically using PACS API.

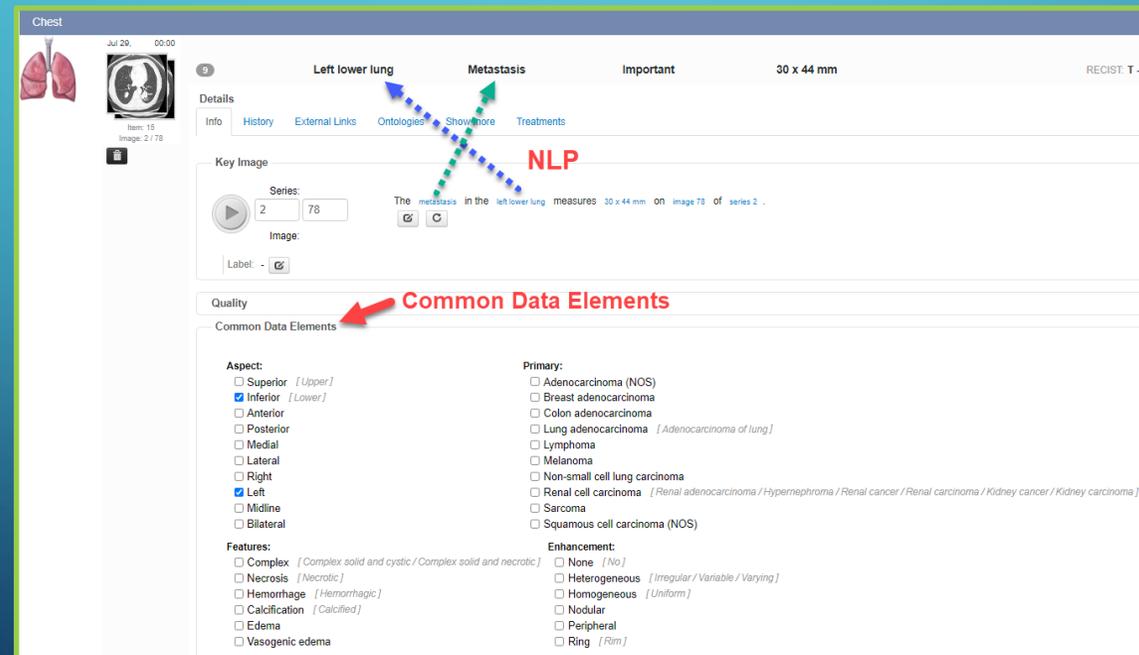
## Step 3: Assemble multimedia report



The screenshot shows a multimedia report for an abdominal CT scan. The report is organized into a table with columns for "Key Images", "ID", "Side", "Anatomy", "Pathology", "Priority", "Metric", "Label", and "Target". The table lists several liver metastases in different segments (2, 4, 5) with their respective sizes and priorities. A red arrow points from the "Metric" column to a "Timeline" graph. The graph shows the "Disease Burden" over time, with a red line representing "Liver, Segment 4" and a blue line representing "Liver, Segment 2". The graph is titled "Timeline" and has a y-axis labeled "Disease Burden" and an x-axis labeled "Date". Below the graph, there are three thumbnail images of liver metastases.

# METHODS:

- The metadata that tags each finding consists of Anatomy and Pathology (aka, Diagnosis) terminology referenced to an ontology (i.e., controlled vocabulary).
- Anatomy and Pathology labeling triggers the display of relevant CDE menus to guide and inform radiologists about what to say about a particular diagnosis.



Display of CDEs triggered by Anatomy-Pathology terms (Left lower lung – Metastasis)

# METHODS:

- As the radiologist dictates additional information about a finding, the NLP searches the transcribed text for CDE elements to populate the appropriate fields in the multimedia report.
- Signed reports only display selected CDEs.

The screenshot shows a medical report interface for a chest CT scan. The key image is a CT scan of the left lower lung showing a metastasis. The text of the key image is: "The metastasis in the left lower lung measures 30 x 44 mm on image 78 of series 2. This lesion is necrotic. There is uniform enhancement. The primary is colon adenocarcinoma." The CDEs are populated as follows:

Aspect	Primary	Features	Enhancement
<input type="checkbox"/> Superior [Upper]	<input type="checkbox"/> Adenocarcinoma (NOS)	<input type="checkbox"/> None [No]	<input type="checkbox"/> None [No]
<input checked="" type="checkbox"/> Inferior [Lower]	<input checked="" type="checkbox"/> Breast adenocarcinoma	<input checked="" type="checkbox"/> Necrosis [Necrotic]	<input type="checkbox"/> Heterogeneous [Irregular / Variable / Varying]
<input type="checkbox"/> Anterior	<input checked="" type="checkbox"/> Colon adenocarcinoma	<input type="checkbox"/> Hemorrhage [Hemorrhagic]	<input checked="" type="checkbox"/> Homogeneous [Uniform]
<input type="checkbox"/> Posterior	<input type="checkbox"/> Lung adenocarcinoma [Adenocarcinoma of lung]	<input type="checkbox"/> Calcification [Calcified]	<input type="checkbox"/> Nodular
<input type="checkbox"/> Medial	<input type="checkbox"/> Lymphoma	<input type="checkbox"/> Edema	<input type="checkbox"/> Peripheral
<input type="checkbox"/> Lateral	<input type="checkbox"/> Melanoma	<input type="checkbox"/> Vasogenic edema	<input type="checkbox"/> Ring [Rim]
<input type="checkbox"/> Right	<input type="checkbox"/> Non-small cell lung carcinoma		
<input checked="" type="checkbox"/> Left	<input type="checkbox"/> Renal cell carcinoma [Renal adenocarcinoma / Hypernephroma / Renal cancer / Renal carcinoma / Kidney cancer / Kidney carcinoma]		
<input type="checkbox"/> Midline	<input type="checkbox"/> Sarcoma		
<input type="checkbox"/> Bilateral	<input type="checkbox"/> Squamous cell carcinoma (NOS)		

As the radiologist dictates additional details, the CDEs are automatically populated by NLP.

Note the use of synonyms that point to key concepts.

CDEs are automatically populated as more details are described

The screenshot shows the same medical report interface after signing. The key image and text are the same. The CDEs are now displayed in a summary format:

Aspect: Inferior, Left Primary: Colon adenocarcinoma Features: Necrosis Enhancement: Homogeneous

Metrics: Diameter Short: 30 mm | Diameter Long: 44 mm

After signing a report, only selected CDEs are displayed

# METHODS:

- The ontology used to label each finding consists of hierarchies of Anatomy and Pathology terms
- CDEs applied to a parent term within the hierarchies may be transmitted to a child (i.e., inheritance) or blocked by design.

The screenshot displays two hierarchical ontologies side-by-side. The left panel, titled 'Anatomy', shows a tree structure starting with 'Entire Body' and branching into 'Head', 'Neck', 'Chest', 'Heart', 'Lungs', 'Pleura', 'Mediastinum', 'Breast', 'Artery, chest', 'Vein, chest', 'Lymphatic, chest', 'Nerve, chest', 'Skeleton, chest', 'Muscle, chest', 'Soft tissue, chest', 'Abdomen', 'Pelvis', 'Upper extremity', and 'Lower extremity'. The 'Lungs' term is highlighted. The right panel, titled 'Pathology', shows a tree structure starting with 'Normal' and branching into 'Inflammation', 'Neoplasm', 'Trauma', 'Systemic', 'Function', 'Observation', 'Lesion', 'Lesions', 'Mass', 'Masses', 'Nodule', 'Mass effect', 'Calcification', 'Fluid collection', 'Gas collection', 'Atelectasis', 'Opacity', 'Cavity', 'Cystic lung disease', 'End-stage lung disease', 'Hyperlucent lung', 'Increased activity [NM]', 'Abnormal rotation', 'Radiological sign', 'Siemens MM Oncology', 'Variant', 'Radiation treatment planning', and 'Artifact'. The 'Mass' term is highlighted, and a context menu is open over it, listing options: 'Edit term', 'Assign priority', 'Assign Specificity', 'Remove term', 'Common data elements' (highlighted in yellow), 'Recommendations', 'Conditions', 'Ontologies: Anatomy - Pathology', 'External links', and 'Laboratory'. A red arrow points from the 'Mass' term to the 'Common data elements' option in the menu.

Each anatomy term is associated with a pathology tree.  
Right-mouse button click accesses CDE authoring tool.

# METHODS:

- The authoring application that supports CDEs allows for menus of questions and answers to be constructed with the following options:
  - Pick list with single answer
  - Pick list will multiple-choice answers
  - Fill-in-the blank field with free text
  - Fill-in-the blank field with disease metrics

COMMON DATA ELEMENTS FOR LUNGS-MASS

Aspect: (inherited from Chest) (anatomy specific menu) [Edit](#)

**Reusable** **Master** **Pick many** **Order: 1**

Name	Ontologies	Translations	Synonyms
Superior	R L 9 0	S ... ar de fr es tr zh	s
Inferior	R L 9 0	S ... ar de fr es tr zh	s
Anterior	R L 9 0	S ... ar de fr es tr zh	
Posterior		ar de fr es tr zh	
Medial		ar de fr es tr zh	
Lateral		ar de fr es tr zh	
Right		ar de fr es tr zh	
Left		ar de fr es tr zh	

Appearance: [Edit](#)

**Pick one** **Order: 2**

Name	Ontologies	Translations	Synonyms
Incomplete			zh
Benign			zh
Probably benign			zh
Suspicious			zh

Activity: [Edit](#)

**Pick one** **Order: 3**

Name	Ontologies	Translations	Synonyms
Baseline			
New		ar de fr es tr zh	
Stable		ar de fr es tr zh	
Increased		ar de fr es tr zh	s
Decreased		ar de fr es tr zh	s

CDEs for Lung-Mass derived from ACR's Lung-RADS

# METHODS:

- CDEs may be applied to the following to allow for versatility in their application:
  - Anatomy terms
  - Pathology terms
  - Anatomy-Pathology term combinations
- CDEs are cross-referenced to multiple ontologies, including SNOMED, RadLex, ICD-10, and others.
- CDEs applied to a particular anatomical term, for example “muscle,” may be transmitted to all occurrences of muscle terminology across the ontology (i.e., transference).

## COMMON DATA ELEMENTS FOR STOMACH

Location: (anatomy specific menu)

Pick many Order: 1

Name	Ontologies	Translations	Synonyms
Cardia	R L 9 0	S ... ar de fr es tr zh	
Fundus	R L 9 0	S ... ar de fr es tr zh	s
Antrum	R L 9 0	S ... ar de fr es tr zh	
Pylorus	R L 9 0	S ... ar de fr es tr zh	

CDEs specific for the anatomical parts of the Stomach

Abdomen

Oct 1, 2008 08:00

Item: 19  
Image: 2 / 159

12 Sigmoid colon Polyp Indeterminate 10 mm

Details

Info History External Links Ontologies Show more Treatments

Key Image

Series: 2 159 A 10 mm pedunculated polyp is identified in the mid sigmoid colon on image 159 of series 2. This is a C-RADS 3

Image: Label: -

Quality

Common Data Elements

Location:  Proximal  Middle  Distal

Shape:  Sessile  Pedunculated  Flat lesion  Mass

Metrics

Diameter Short: mm Diameter Long: 10 mm Diameter 2: mm

Recommendation

C-RADS 2 - Intermediate polyp or indeterminate finding; Surveillance colonoscopy recommended

C-RADS 3 - Polyp, possibly advanced adenoma; Colonoscopy recommended

CDEs for Colon-Polyp term combination, including C-RADS recommendations

# RESULTS:

- The ontology used in the reporting process currently consists of 1794 Anatomy terms and 21,821 Pathology (i.e., Diagnosis) terms.
- A total of 1387 CDEs have been implemented in the system to date.
- CDE sources include the RSNA's RadElement repository, American College of Radiology's RADS reporting systems, and the College of American Pathologists' Cancer Protocol Templates.
- The principles of inheritance and transference of CDE properties provide for an efficient way to manage and maintain the ever-growing CDE library.

Oct 1 10:00

Rectum Adenocarcinoma Important 35.9 x 50.5 mm

Details

Info History External Links Ontologies Show more Treatments

Key Image

The primary adenocarcinoma is seen along the right rectal wall. This measures 10 cm from the anal verge. This lesion is 8 cm from the anorectal junction. The craniocaudal length is 6 cm. This is a semicircumferential lesion. The mesorectal fascia is high-risk. This lesion extends above the anterior peritoneal reflection. There is no mucin. There is extramural venous invasion. The MR tumor stage is T4a.

Series: 25 46

Image: [G] [C]

Label: [G]

Quality

Common Data Elements

Aspect:

Superior [Upper]

Inferior [Lower]

Anterior

Posterior

Medial

Lateral

Right

Left

Midline

Bilateral

Distance to anal verge: 10 cm

Distance to anorectal junction: 8 cm

Craniocaudal length: 6 cm

**CDEs derived from radiology sources**

Morphology:

Polypoid

Circumferential

Semicircumferential

Mesorectal fascia:

Clear - tumor margin > 2 mm

Threatened - tumor margin < 2 mm

High risk - tumor margin < 1 mm or involved

Anterior peritoneal reflection:

Above

Straddles

Below

Mucin:

Present [There is]

Not present [There is no]

Extramural Venous Invasion (EMVI): [EMVI/Extramural venous invasion]

Present [There is]

Not present [There is no]

mrTumor stage: [T stage / Tumor stage]

mrTX - Cannot be evaluated [Cannot be evaluated / mrTX / TX]

mrT0 - No evidence of tumor [No evidence of tumor / mrT0 / T0]

mrTis - Carcinoma in situ [Carcinoma in situ / mrTis / Tis]

mrT1 - Invades submucosa [Invades submucosa / mrT1 / T1]

mrT2 - Invades muscularis propria [Invades muscularis propria / mrT2 / T2]

mrT3 - Invades pericolorectal tissues [Invades pericolorectal tissues / mrT3 / T3]

mrT4 - Invades visceral peritoneum or other organs [mrT4 / T4]

mrT4a - Invades visceral peritoneum [Invades visceral peritoneum / mrT4a / T4a]

mrT4b - Invades other organs [Invades other organs / Invades bladder / Invades vagina / Invades uterus / Invades prostate / Invades seminal vesicles / mrT4b / T4b]

Response assessment:

mrTRG 1 - Complete response [No evidence of tumor / No evidence of treated tumor / mrTRG 1 / Complete response / Complete radiologic response / mrtrg1]

mrTRG 2 - Good response [mrTRG 2 / Good response]

mrTRG 3 - Moderate response [mrTRG 3 / Moderate response]

mrTRG 4 - Slight response [mrTRG 4 / Slight response]

mrTRG 5 - No response [mrTRG 5 / No response]

Histologic grade:

G1, well differentiated

G2, moderately differentiated

G3, poorly differentiated

G4, undifferentiated

GX, cannot be assessed

pTumor stage: [Tumor stage / T stage]

pT0 - No evidence of tumor [pT0 / T0 / No evidence of tumor]

pTis - Carcinoma in situ [pTis / Tis / Carcinoma in situ]

pT1 - Invades the submucosa [pT1 / T1 / Invades the submucosa]

pT2 - Invades the muscularis propria [pT2 / T2 / Invades the muscularis propria]

pT3 - Invades pericolorectal tissues [pT3 / T3 / Invades pericolorectal tissues]

pT4a - Invades visceral peritoneum [pT4a / T4a / Invades visceral peritoneum]

pT4b - Invades other organs [pT4b / T4b / Invades other organs]

**CDEs specific for pathology**

Tumor bud score: [Tumor bud score]

Low (0-4) [Low]

Intermediate (5-9) [Intermediate]

High (10 or more) [High]

Cannot be determined

CDEs may originate from multiple sources as in this case for rectal cancer staging

# CONCLUSIONS:

- Common data elements are an essential component of radiology reporting and data science initiatives.
- A practical and efficient method for implementing CDEs in an interactive multimedia reporting environment has been demonstrated.

