ANNOTATION GUIDELINES FOR CAMIR (CORPUS OF ANNOTATED MEDICAL IMAGING REPORTS)

BioNLP Group
University of Washington
Email: npark95@uw.edu

The goal of this annotation project is to label the following four events in radiology reports:

- **Indication**: Medical problems and diagnoses listed as the reason for the radiology exam.
- **Medical problem finding**: Abnormalities (excluding lesion findings) uncovered by the radiology exam.
- **Lesion finding**: Lesion uncovered by the radiology exam. Lesion finding requires detailed annotation, and it is described with 7 attributes in the schema.

Figure 1 presents a brief summary of the schema for indication, medical problem finding, lesion finding, and follow-up recommendation. Each event is represented with an event trigger (marked red) and a number of attributes to capture detailed information about these events. Some of the attributes are span-only (e.g., size) and some are span-with-value (underlined) (e.g., assertion, anatomy).

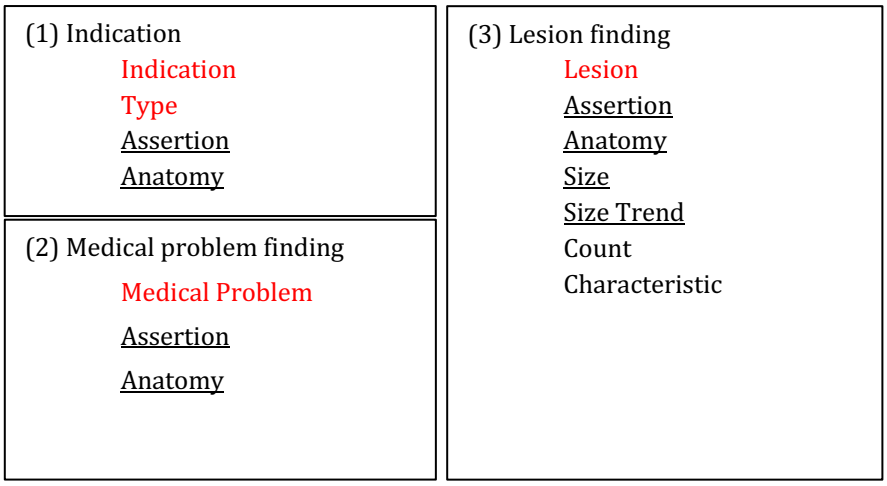


Figure 1. Annotation schema – Triggers (red) are required. Underlined attributes have categorical values. Anatomy values are normalized using a detailed anatomy hierarchy. Normalized labels can be found in Appendix.

Summary

Below is a summary of the event types:

- **Indication** - reason for the imaging, not findings from imaging
- **Medical Problem** - abnormalities uncovered by the imaging that are not associated with lesions
- **Lesion** - lesion-related abnormalities uncovered by the imaging.

Trigger

Table 1 presents Medical Problem and Lesion trigger examples.

Medical Problem		Lesion	
air trapping	fractures	**abscesses**	**lesions**
aneurysmal	hernias	adenocarcinoma	lipomas
ascites	honeycombing	consolidations	**lymphadenopathy**⋆
atelectasis	hypertension	cysts	masses
atrophic	injury	fluid collections	**metastases**
calcifications	intussusceptions	focus	neoplasm
cirrhosis	mosaic attenuation	granulomas	nodes (enlarged/abnormal)
dilation	necrosis	hamartomas	nodularity
distention	pneumothorax	hemangioma	nodules
ectatic	reticulation		sarcomas
effusions	scarring		foci
emboli	stones		
embolisms	stricture		
embolus	thickening		
fat stranding	tortuous		

Table 1. Medical Problem and Lesion examples

⋆Was Medical Problem in the previous version of guidelines.

Assertion

Assertion indicates whether an event is present, absent, or possible. Assertion annotations for absent and possible will always have a strong cue, like "denies" for absent and “likely” for possible; however, present annotations often do not include a cue, and the present label is often implied. Table 2 presents example spans that indicate absent and possible assertion values. Assertion present spans should be the applicable trigger span.

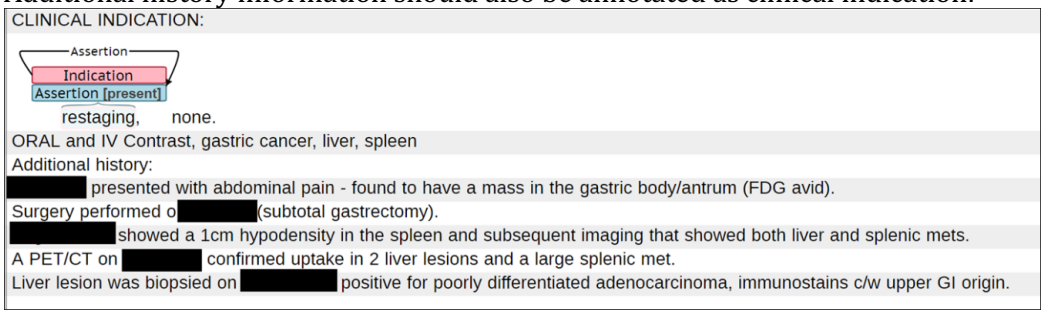
Assertion – absent		Assertion – possible	
absent	no	cannot be excluded	likely indicates
denies	no evidence	concern	may be
		consistent	possible
		could be	presumed
		could represent	question
		likely	suggestive
			suggests

Table 2. Assertion absent and possible examples

(1) Indication

Indication is a simple, concise statement of the reason for the study and applicable clinical information and diagnosis. They are usually listed at the beginning of the document under the section title "Indication," "clinical indication," or "history". Indication is represented with trigger, type, assertion and anatomy.

Additional history information should also be annotated as clinical indication:



1.1 Indication - Trigger (required)

Text span that describes the reason for the test. These spans usually describe trauma, diagnosis and sign/symptoms.

Indication-Description examples	**Annotation Notes**
INDICATION: **High speed motor vehicle collision**.	Events that cause the need for radiologic exam such as accidents, collusions, falls are labeled as indication.
INDICATION: **MVC**	
Clinical Indication: question of pulmonary **sarcoid**	
INDICATION: **Found down**	
INDICATION: abdominal **pain**.	Pain is usually associated with anatomy, such as abdominal pain. For such cases, "pain" is labeled as trigger and "abdominal" and "back" are labeled as anatomy.
INDICATION: **Abnormal – CT** will be repeated at [LOCATION]	There are cases when the indication is about a finding from a previous exam. For this example "Abnormal – CT" is the indication trigger.

Table 3. Indication trigger examples

1.2 Type

Indication type is a value assigned to an indication trigger to capture the nature of the reason for the test. It has the following values: Trauma, Symptom, Neoplastic diagnosis, Non-neoplastic diagnosis. The Indication Trigger and Type should generally have the same span.

Type value	Example sentence
Trauma	INDICATION: **High speed motor vehicle accident**. INDICATION: **MVC**
Symptom	INDICATION: **found down**
Neoplastic Diagnosis	Clinical History: x year old man with **seminoma**.
Non-Neoplastic Diagnosis	Clinical History: x year old male with clinical concern for **amiodarone toxicity** Clinical Indication: question of pulmonary **sarcoid**

Table 4. Indication type examples

Some indication statements include different types of indication. The following example includes both symptoms and non-neoplastic diagnosis indications.

1.3 Assertion (required)

Assertion attribute is **a span with value attribute**. Value set includes: possible, present, absent indicating the likelihood of the medical problem. Assertion present spans are the associated indication trigger span, assertion absent spans are the phrases indicating the absence of the indication, and assertion possible spans are the phrases indicating uncertainty or rule out of the indication. All indication events require an assertion attribute.

Assertion value	Example sentence	Annotation notes
present	abd **pain**, **bloody diarrhea** Follow-up of primary CNS **lymphoma**.	Present cases usually describe diagnosis, signs and symptoms.
absent	-	Negation is not something we usually observe in indication. We did not remove it for the sake of simplicity.
possible	r/o **abscess** question of pulmonary **sarcoid**. clinical concern for **amiodarone toxicity** concern for **PE**	Possible cases usually capture the real reason for the test.

Table 5. Assertion examples. In example sentences, **triggers are in bold** and assertion spans are underlined.

1.4 Anatomy

Anatomy is a **span** which captures the body part associated with the indication. If there are multiple body parts, each body part should be annotated separately.

Example sentences	Annotation Notes
Indication: Suspected <u>pulmonary</u> **embolus**	
INDICATION: <u>R-sided chest</u> **pain**	
Invasive lobular **carcinoma** of the <u>right breast</u>	

Table 6. Anatomy examples. In example sentences, **triggers are in bold** and <u>anatomy spans are underlined.</u>

1.5 BRAT examples

Figure 2 and Figure 3 are BRAT Indication examples.

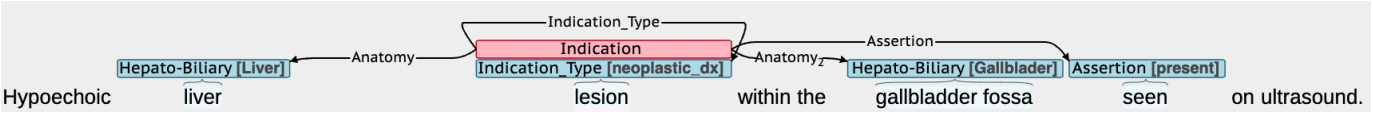


Figure 2. Indication event example with a single indication

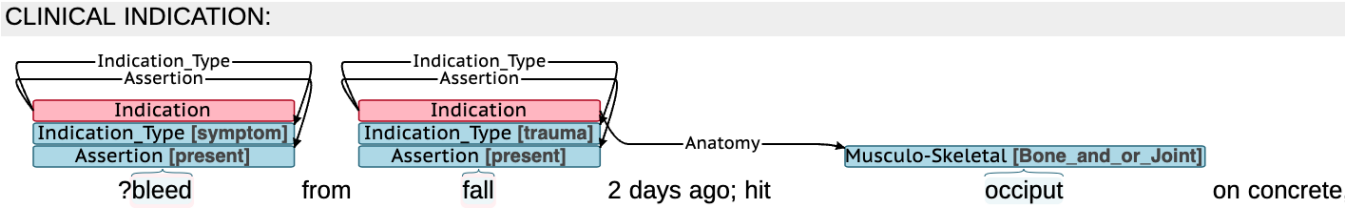


Figure 3. Indication event examples with multiple indications

Color coding

Indication
Span-with-value
Span-only

(2) Medical problem finding

Medical problem findings are abnormalities uncovered by the radiology imaging test. These abnormalities cover everything except lesion findings. The medical problem finding event is described with 3 attributes: medical problem (trigger), anatomy, and assertion. Figure 3 presents a sentence with two medical problem finding events.

2.1 Medical problem - Trigger (required)

The description of a medical problem serves as the event trigger. The text span can be a single or multi-word phrase that identifies the actual medical problem, such as "**fracture**" and "**osteophyte formation**". "Abnormal radiotracer uptake" should also be annotated as medical problem:

Table 6 includes a list of common medical problems triggers.

Medical problem examples
There is a **nondisplaced linear fracture** of the lateral epicondyle…
Heart: no **pericardial fluid**.
The liver is nodular and **atrophic.**
Increased amount of **ascites** compared to prior study.
No evidence of renal **stones** or **scarring**.
The remaining thoracic aorta is **tortuous** and **ectatic**.
Aneurysmal and **tortuous** thoracic aorta measuring up to 4.5 cm in the …
Left posterior thigh/buttock sarcoma with a central hypodense focus, likely **necrosis**.
Aortic valve **calcification**.
Main pulmonary artery diameter is increased in diameter suggestive of pulmonary arterial **hypertension**.
These cysts are possibly related to ductal plate **anomalies**.

Table 6. Medical Problem trigger examples

Medical problem descriptors should not be annotated as triggers. Example descriptors (NOT triggers) include cavitation, postinflammatory, air-fluid level, and loculation.

2.2 Assertion (required)

Assertion attribute is **a span with value attribute**, indicating the likelihood of the medical problem. Value set includes: possible, present, and absent. Assertion present spans are the associated medical problem trigger span, assertion absent spans are the phrases indicating the absence of the medical problem, and assertion possible spans are the phrases indicating uncertainty regarding the medical problem. All medical problem events require an assertion attribute.

Assertion Value	Example Sentences
present	Patient is status post distal esophagectomy for distal esophageal **adenocarcinoma** on [DATE]. C5-6 lucency with well corticated margins is consistent with **osteophyte formation**.
absent	Visualized osseous structures show no acute **osseous abnormality**.
possible	There is a possible nondisplaced L5 spinous process **fracture**. Liver: There is a mildly nodular contour of the liver as before, possibly representing **cirrhosis**. Alternatively, if this opacity never in fact cleared, consider the possibility that this is in fact a **postobstructive pneumonia** or other chronic lung **parenchymal process**, even bronchoalveolar **cell carcinoma**.

Table 7. Assertion examples. In example sentences, **triggers are in bold** and assertion spans are underlined.

2.3 Anatomy

Anatomy is a **span** which captures the body part associated with the medical problem. If there are multiple body parts they need to be annotated separately. The anatomy span should generally be the most specific anatomical location. For example, "left thyroid gland" should be annotated over just "thyroid" or "thyroid gland." Table 8 includes a list of anatomies for Medical Problem events.

Ex.	Example sentences	Annotation Notes
1	Stable subcentimeter **low-attenuation** in the left thyroid gland.	
2	Right kidney: No **injury** Pleura: New bilateral small pleural **effusions**, with loculations.	Mentions of anatomy as subsection headers need to be labeled if they are linked to a medical problem mention. Only annotate subheadings only for the first sentence.
3	There is are two short segment small bowel **intussusceptions** in the left abdomen anterior to the left kidney. Two small bowel **intussusceptions** in the left lower quadrant. **Atelectatic** left lower lung appears to be predominantly immediately adjacent to the aorta.	Multiple anatomy span may be relevant for a single trigger
4	The liver appears **increased in density**.	
5	Possible **tree in bud opacities** within the right middle lobe.	Sometimes the sentence content might not be enough to determine the anatomic label. When that is the case, use the entire note to determine which anatomic label the anatomy mention belongs to.
6	Interval worsening of bilateral pleural **effusions**, now with loculation.	

Table 8. Anatomy examples. In example sentences, **triggers are in bold** and anatomy spans are underlined.

2.4 Medical problem BRAT examples

Figure 3, Figure 4, and Figure 5 are Medical Problem BRAT examples.

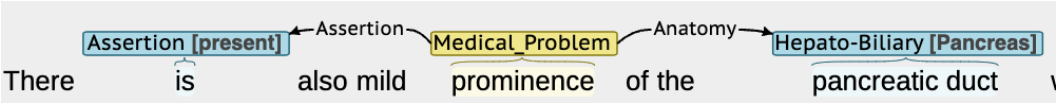


Figure 3. Medical Problem example with Assertion-present

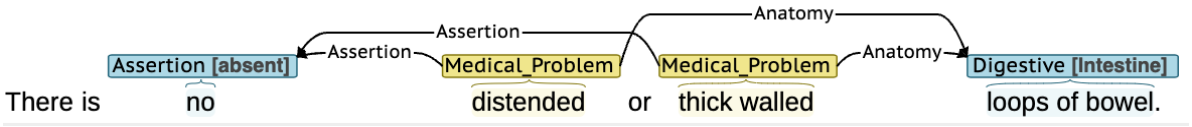


Figure 4. Medical Problem BRAT example with Assertion-absent

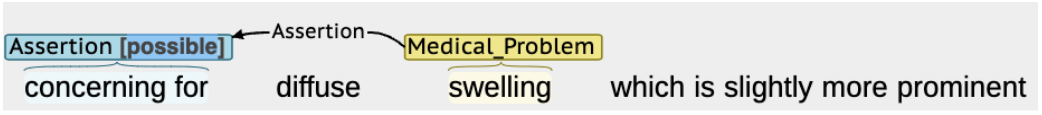


Figure 5. Medical Problem BRAT example with Assertion-possible

Color coding
Medical Problem
Span-with-value
Span-only

(3) Lesion finding

Lesion finding describes the extent of lesion development, which includes lesion (trigger), assertion, anatomy, lesion size, size trend, count, and characteristics.

3.1 Lesion (trigger)

Lesion description is the trigger for Lesion finding event.

Lesion serves as the event trigger and is mandatory. Common text spans are ("mass", "node", "nodule", "opacity", "tumor").

Ex.	Example Sentences	Annotation Notes
1	There are prominent **nodes** within the right lower quadrant of the abdomen.	
2	Lung bases: Partially calcified 2.5 cm peripheral left lower lobe pulmonary **nodule**, which could reflect a small **hamartoma** versus **granuloma** .	There are 3 lesion events in this sentence.
3	Abdominal Lymph Nodes and Retroperitoneum: Multiple prominent but nonenlarged mesenteric lymph **nodes**.	
4	Right hepatic lobe subcentimeter **hypodensity** is too small to characterize, but favored to represent a flash filling **hemangioma.**	There are two lesion events in this sentence.
5	Left Kidney: Atrophic cortex, with the lobular **cyst**.	
6	Lymph nodes: Mild mediastinal **lymphadenopathy** is present with numerous small lymph nodes, predominantly in the precarinal and AP window regions.	
7	Image [DATE], 2.7 mm soft tissue density **mass** posterior to the distal thoracic aorta.	
8	Numerous ill - defined small pulmonary nodular **densities** in the upper lobes bilaterally…	
9	The number and size of many of these nodular **opacities** has significantly increased in the interval.	
10	No abnormal **enhancement** if seen.	

Table 9. Example lesion description examples. In example sentences, **triggers are in bold**.

Additional Annotation Notes:

1. Phrases describing lesions may include trigger and anatomy spans (e.g. *brain lesion* or *pulmonary nodules*). The lesion trigger and anatomy should be annotated as two separate entities, i.e. lesion-anatomy (*brain, pulmonary*) and lesion-description (*lesion, nodules*).
2. Lymph nodes will be only considered lesions (1) if they are enlarged or (2) if they were previously identified as cancer (including ones that got smaller with treatment). Label "node" as the trigger.
3. **Do not annotate normal lymph nodes. Examples include:**
    - Abdominal Lymph Nodes and Retroperitoneum: Multiple prominent but nonenlarged mesenteric lymph nodes.
    - Multiple small lymph nodes are identified in the left axillary region, likely reactive.
    - Lymph nodes: Prominent nodes in the left axilla, likely reactive.

3.2 Assertion (required)

Assertion attribute is a **span with value attribute**, indicating the likelihood of the lesion finding. Values include: possible, present, and absent. Assertion present spans are the associated lesion trigger span, assertion absent spans are the phrases indicating the absence of the lesion, and assertion possible spans are the phrases indicating uncertainty regarding the lesion. All lesion events require an assertion attribute.

Value	Sentence Examples	Annotation Notes
present	Intense FDG uptake is noted within 3 mm **nodule** in left lower lobe, consistent with biopsy-proven invasive **adenocarcinoma**.	
absent	Findings: No suspicious enhancing **nodule** is seen. No obvious intracystic septations or mural **nodularity** are seen. No retroperitoneal or mesenteric **lymphadenopathy** identified. … the primary **lesion** cannot be visualized by FDG PET…	
possible	Hypovascular round **lesions** up to 9 mm in segment 7 on the portal venous and delayed phase correlate to hypovascular portions on the arterial phase, thus most likely representing devascularized satellite **nodules** of HCC. This mostly likely represents an ovarian cystic **neoplasm** such as cystadenocacinoma.	In this example, there are two lesion events with triggers lesions and nodules. The first one is "present". No annotation needed. Second one is "possible" assigned to the text span "most likely"
possible	However, if there is a real lung **nodule**, then the possibility of metastases would have to be considered.	

Table 10. Assertion examples. In example sentences, **triggers are in bold** and assertion spans are underlined.

3.3 Anatomy

Anatomy is a **span** which captures body part associated with the lesion. If there are multiple body parts they need to be annotated separately.

Ex.	Example sentences	Annotation Notes
1	There are prominent **nodes** within the right lower quadrant of the abdomen.	
2	Lung bases: Partially calcified 1.1 cm peripheral left lower lobe pulmonary **nodule**, which could reflect a small hamartoma versus granuloma.	
3	Right hepatic lobe subcentimeter **hypodensity** is too small to characterize, …	
4	Abdomen: Innumerable hepatic **cysts** of varying sizes, as before.	
5	No gross mediastinal, hilar, or axillary lymph node enlargement is seen. Mediastinum and Heart: No **masses**. Left posterior thigh / buttock **sarcoma** with a central hypodense focus, likely necrosis .	Anatomy separated by conjunctions or punctuation should generally be separated
6	Image 81/2, 21 x 23 mm soft tissue density **mass** posterior to the distal thoracic aorta.	
7	No soft tissue neck **mass** or cervical **fluid collections**.	

Table 11. Lesion - Anatomy examples. In example sentences, **triggers are in bold** and anatomy spans are underlined.

3.4 Size

Size is a span with value attribute and captures the size of the lesion (whether the size is current or past)

Value	Sentence Examples	Annotation Notes
Present	The **lesion** measures 39.8 x 23.4 cm in the axial plane and approximately 30.9 cm in the cranicaudad dimensions.	Annotate the entire phrase that describes the measurement details.
Past	Multiple new small **cysts** noted in the right ovary on [DATE]	Modifiers like tiny, large, small are annotated as size.
Present	**upper lobes** bilaterally measuring up to 5 mm on image 37 series 3 in the left upper lobe anteriorly	Make sure to include modifiers for dimensions
Present	enlarged pretracheal lymph **node** on image 4:27 measures 9 mm.	Make sure to include units (“mm”)

Table 12. Size examples. In example sentences, **triggers are in bold** and size spans are underlined.

Do not annotate size if the lesion's assertion value is absent.

3.5 Size trend

Size trend is a span with value attribute. Some lesion descriptions contain size trend which is a categorical value (new, disappear, increasing, deceasing, no-change). Example: "**Interval increase in size**".
Do not annotate size trend if the lesion's assertion value is absent.

Value	Examples
new	On the current exam, there is a newly identified hypodense well-delineated **mass**
disappear	The previously identified 3-cm **mass** in the right lower lobe is not seen Complete resolution of left lower lobe groundglass **opacity**.
increasing	0.6 cm pulmonary **nodule** the left lower lobe (3/32) previously measured 0.5 cm. Interval increase in size of moderate bilateral pleural effusions with bibasal atelectasis. More peripherally, there is 10 x 9 mm **nodule** adjacent to the suture line (4/63) which is gradually increasing in size since [DATE], too small to characterize on PET . … **nodules** and **consolidations** throughout both lungs which have increased in size in relation to previous study …
decreasing	Decreasing size of the hypodense **lesion** within the inferior aspect of the right hepatic lobe now measuring 0.6 cm compared to 1.5 cm on [DATE] The **mass** in the proximal ureter has decreased significantly in size, currently measuring 3 mm (4/104), decreased from 7 x 8 mm.
no-change	There is a hypoattenuating left adrenal **nodule** that has been increasing in size since x though it is unchanged since [DATE]. Enlarged inferior mediastinal and right hilar lymph **nodes** are unchanged since [DATE].

Table 13. Size trend examples. In example sentences, **triggers are in bold** and size trend spans are underlined.

3.6 Count

Some lesion descriptions include the number of nodules or lesions. Common spans include modifiers like multiple, several, numerous, few, and innumerable, as well as numbers 2, 3, two, three.

Ex.	Sentence Examples	Annotation Notes
1	There are 3 hepatic **lesions** with peripheral puddling contrast…	
2	Lungs: There is stable appearance of two peripheral 3 mm **nodules** within the posterior segments of the right upper lobe.	Mentions of numerical values including: Two, three, 3-5
3	Multiple small **cysts**. Numerous ill-defined small pulmonary nodular **densities** in the upper lobes bilaterally … Abdomen: Innumerable hepatic **cysts** of varying sizes, as before.	Modifiers like single, multiple, several are annotated as count.

Table 14. Count examples. In example sentences, **triggers are in bold** and count span is underlined.

3.7 Characteristic

Characteristic attribute indicates the lesion characteristics. Examples are presented in Table 12.

Text span	Example sentence	Annotation Notes
peripheral	Lungs: There is stable appearance of two peripheral 3 mm **nodules** within the posterior segments of the right upper lobe.	
destructive	No destructive osseous **lesion**.	
indeterminate	Greater than [DATE] stability of indeterminate 3 mm **nodules** in the right upper lobe.	
enlarged	No enlarged cervical lymph **nodes** are seen.	

Table 15. Characteristic examples. In example sentences, **triggers are in bold** and characteristic spans are underlined.

Characteristic spans will generally not include the phrases like “abnormal,” “suspicious,” etc.
Do not annotate characteristics if the assertion value of the trigger is absent.

3.8 Lesion BRAT examples

Figure 6 and Figure 7 are Lesion BRAT examples.

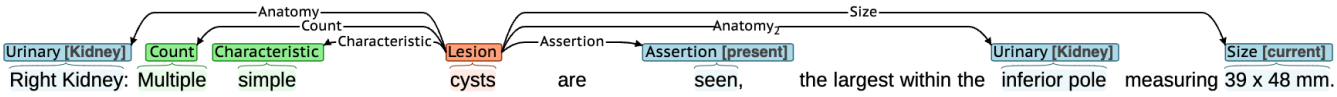


Figure 6. Lesion BRAT examples with Assertion-present

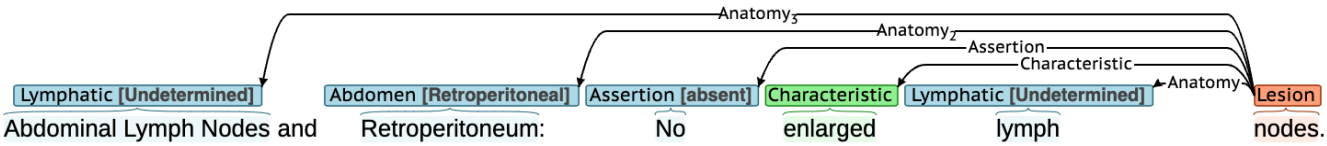


Figure 7. Lesion BRAT examples with Assertion-absent

Color coding
Lesion
Span-with-value
Span-only

Appendix – Anatomy Hierarchy

Anatomy Parent	Anatomy Children
Abdomen (113345001)	Abdominal Wall (83908009), Adrenal Gland (23451007), Mesentery (89679009), Peritoneal Sac (118762006), Retroperitoneal (699600004), Spleen (78961009), Undetermined
Cardiovascular System (59820001)	Arterial (51114001), Coronary Artery (41801008), Heart (80891009), Pericardial Sac (76848001), Pulmonary Artery (81040000), Venous (119553000), Undetermined
Digestive System (49596003)	Esophagus (32849002), Intestine (113276009), Large Intestine (14742008), Small Intestine (30315005), Stomach (69695003), Undetermined
Female Reproductive System (27436002) & Obstetric (308762002)	Adnexal (23043003), Breast (76752008), Extra-embryonic (314908006), Female Genital Structure (53065001), Fetus (55460000), Ovary (15497006), Placenta (78067005), Umbilical Cord (29870000), Uterus (35039007), Undetermined
Head & Neck (774007)	Ear (117590005), Eye (371398005), Laryngeal (4596009), Mouth (385294005), Nasal Sinus (2095001), Neck (45048000), Pharynx (54066008), Thyroid (69748006), Undetermined
Hepato-Biliary System (34707002, 122489005)	Bile Duct (28273000), Gallbladder (28231008), Liver (10200004), Pancreas (15776009), Undetermined
Lymphatic (91688001)	Undetermined
Male Reproductive System (90264002)	Epididymis (87644002), Prostate (119231001), Testis (40689003), Undetermined
Miscellaneous	Adipose Tissue (55603005), Biomedical Device (63653004), Connective Tissue (21793004), Undetermined
Musculoskeletal (312717002)	Bone/Joint, Skeletal and or Muscle (71616004), Undetermined
Neurological System (25087005)	Brain (12738006), Cerebrospinal Fluid Pathway (280371009), Cerebrovascular System (28661005), Extraaxial (1231004), Nerve (3057000), Pituitary (56329008), Spine Cervical (122494005), Spine Cord (2748008), Spine Lumbar (122496007), Spine Sacral (699698002), Spine Thoracic (122495006), Spine Unspecified (421060004), Undetermined

Table A 1. Anatomy Parent-Child SNOMED Hierarchy. SNOMED concept names are shortened due to lack of space. There are 16 Parent and 71 Child labels. Undetermined Child labels are catch-all categories.