Repurposing Radiological Data for Different Needs Using Interactive Multimedia Reporting

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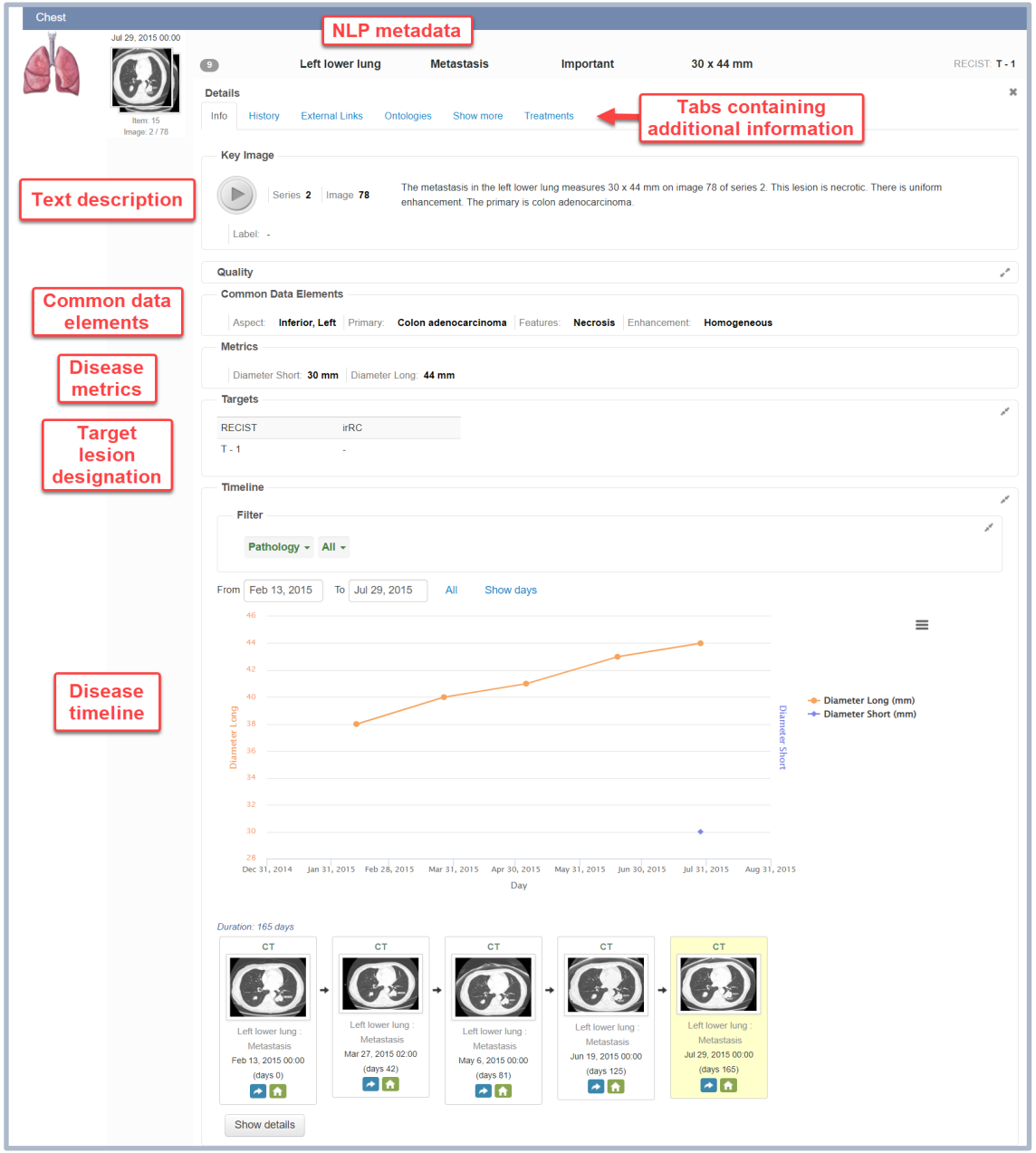
Introduction

- **Conventional radiology reports** often consist of unstructured descriptions of image findings presented in **static documents with limited utility**.
- **Interactive multimedia reporting (IMR)** represents an advance over standard practice as it integrates images, video, graphs, and tables in an interactive environment to **better communicate complex information.**
- In this presentation, an additional benefit of IMR is demonstrated whereby structured radiological data can be **displayed in different formats** to meet the specific needs of clinicians and other users.

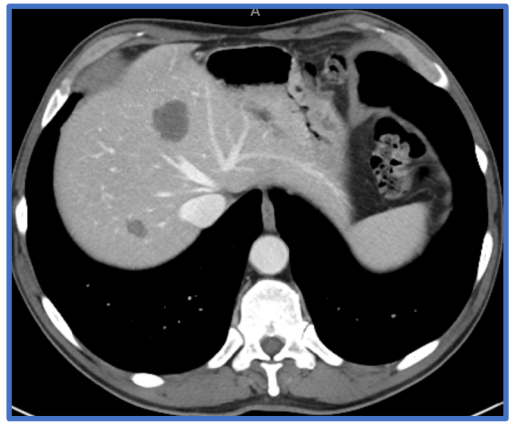


IMR report with interactive elements.

Methods

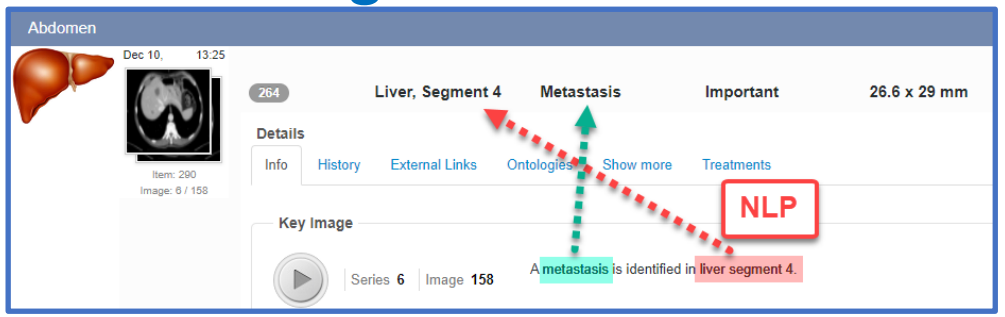
- We developed an IMR solution that works as follows:
  1. Record key images and voice descriptions of radiological findings in a SQL database.
  2. Tag the information with metadata (i.e., anatomy, diagnosis, common data elements) using NLP.
  3. Assemble a multimedia report with related “items” linked in timelines to represent “findings.”
- Each finding is tagged with additional metadata including a number indicating when it first appeared in the report, disease metrics, RECIST target lesion assignments, and user-defined labels. These metadata can be used to arrange report elements in an interactive display and to populate specific report templates.

1 - Record item



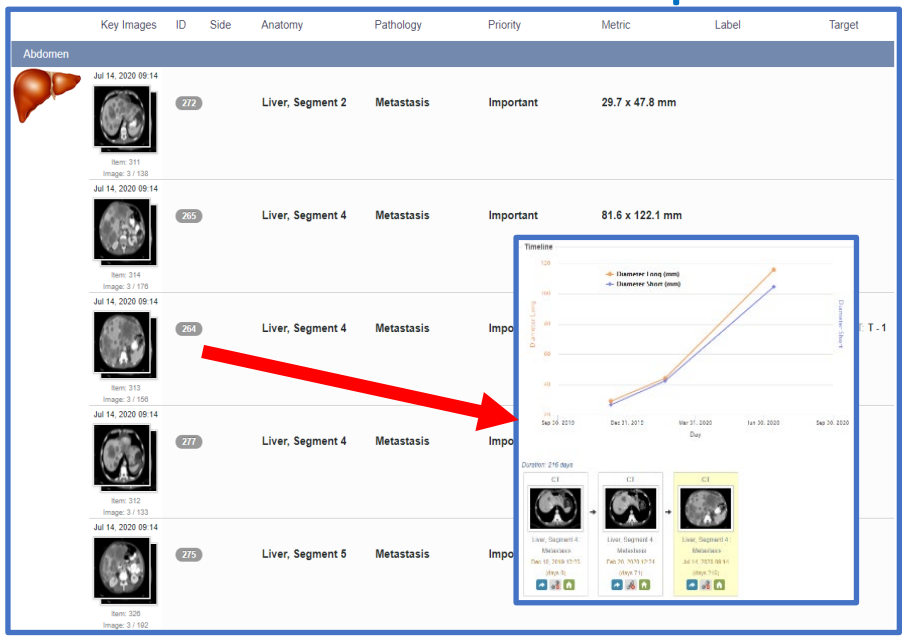
A metastasis is identified in liver segment 4.

2 - Tag with metadata



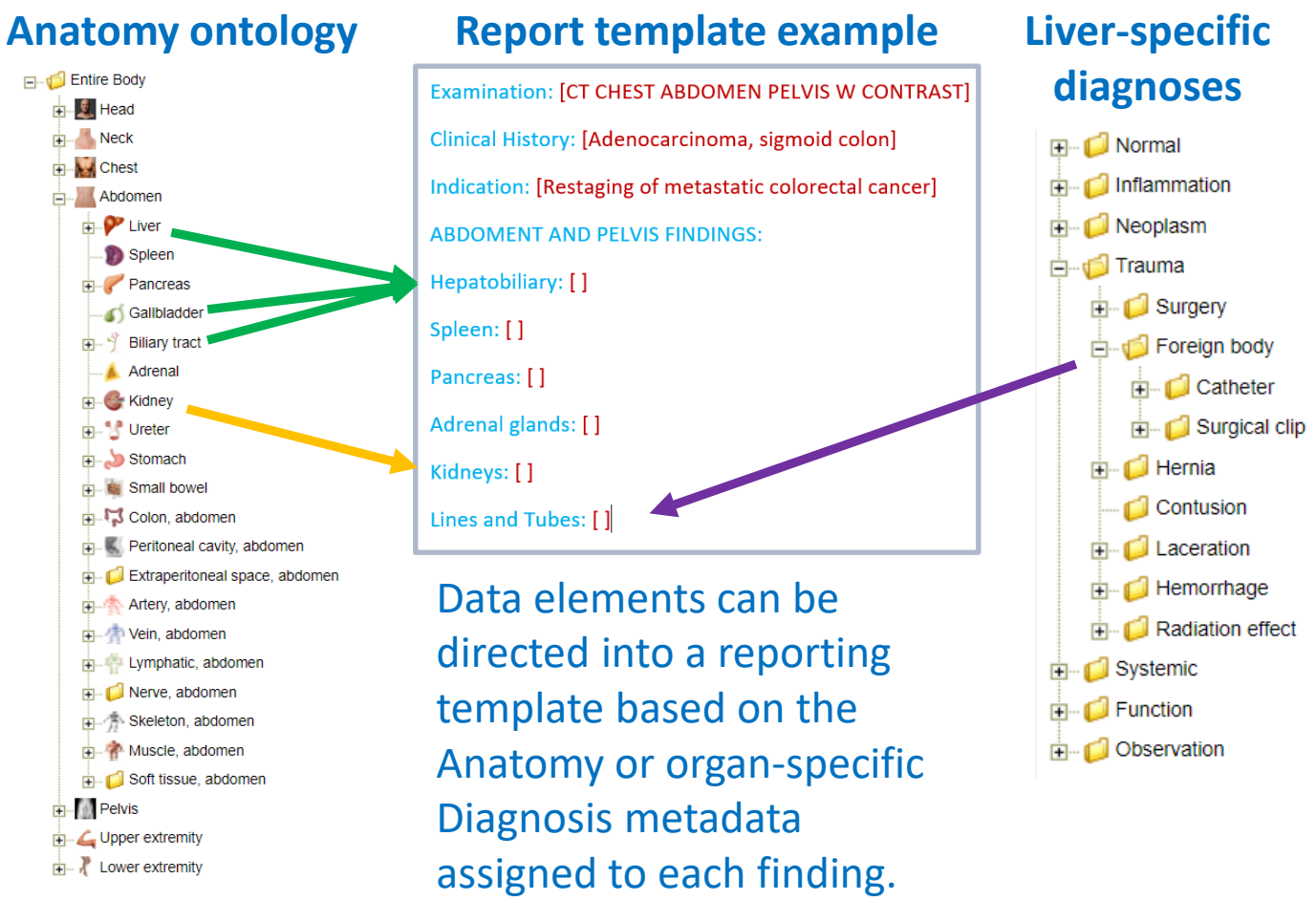
Natural language processing labels items with multiple types of metadata that are managed in an ontology.

3 - Assemble IMR report



Methods

- The ontology used to label findings includes attributes indicating to which physiological category a particular anatomy belongs and common data elements that provide details about each diagnosis.
- The combination of metadata tags enables findings to be dynamically sorted and displayed to meet the needs of end-users, including arranging findings by an anatomical hierarchy, sorting findings by physiologic categories, grouping findings by TNM (tumor, nodes, metastasis), or sorting findings by disease metrics or the sequence of appearance in a report.
- Most importantly, the metadata tags can direct the population of reporting templates with the data elements as described in the following slides.



Methods

- The system employs a scripting process to construct report templates that are populated with data elements from the IMR database.
- Scripting starts with the creation of a template containing report headings (shown in **blue**).
- Each template is named and linked to associated radiological examinations for which it is applicable.

Template name: CT Abdomen and Pelvis

Radiological procedures:

CT, abdomen/pelvis, without contrast (UID 17000004);
CT, abdomen/pelvis, with contrast (UID 17000005);
CT, abdomen/pelvis, without and with contrast (UID 17000006)

ABDOMEN AND PELVIS FINDINGS:

Hepatobiliary:

Spleen:

Tubes and Lines:

Methods

- Next, “normal” phrases (highlighted in **green**) are added that will populate sections of a report when no findings are created for those sections.

Template name: CT Abdomen and Pelvis

ABDOMEN AND PELVIS FINDINGS:

Hepatobiliary:

<Normal> <The liver parenchyma is homogeneous. There are no gallstones. No biliary duct dilatation is seen.>

Spleen:

<Normal> <Normal.>

Tubes and Lines:

<Normal> <None.>

Methods

- Finally, ontological data elements including unique identifiers (shown in **magenta**) are added that will direct data elements from the IMR database to those sections of the report template.
- The anatomical elements are defined in the ontology with diagnoses (i.e., Foreign body in this example) specific to each anatomical site.
- The ontology employs inheritance so that the Couinaud liver subsegments are found under the parent term “Liver.” Similarly, terms like Catheter, Surgical clips, and Medical devices are located under the diagnosis term “Foreign body.” The children of parent terms will be directed to the sections of the report defined by the parent.

Template name: CT Abdomen and Pelvis

ABDOMEN AND PELVIS FINDINGS:

Hepatobiliary:

<Normal> <The liver parenchyma is homogeneous. There are no gallstones. No biliary duct dilatation is seen.>
<Liver (UID 0000411), Gallbladder (UID 0000415), Biliary tract (UID 0000421)>

Spleen:

<Normal> <Normal.>
<Spleen (UID 0000412)>

Tubes and Lines:

<Normal> <None.>
<Foreign body (UID 1000010)>

Methods

- In this example, a TNM report template is constructed using the above principles. Note that the template name is appended with “TNM.”
- “Malignant neoplasm” is a Diagnosis term in the ontology, and more specific diagnoses exist under this parent term for each anatomical location.
- Lymph node anatomy terms exist in each body section that must be included in the structure (truncated list shown here).
- The OTHER section will contain findings not defined by TNM and will be arranged according to an anatomical hierarchy.
- The IMR data can be used to populate a multitude of templates using this repurposing process.

Template name: CT Abdomen and Pelvis (TNM)

TUMOR:

<Normal> <Primary tumor not reported.>
<Malignant neoplasm (UID 1000006)>

NODES:

<Normal> <No lymph nodes reported.>
<Lymph nodes, head (UID 0000939);
Lymph nodes, neck (UID 0001271);
Lymph nodes, chest (UID 0001272); … >

METASTASIS:

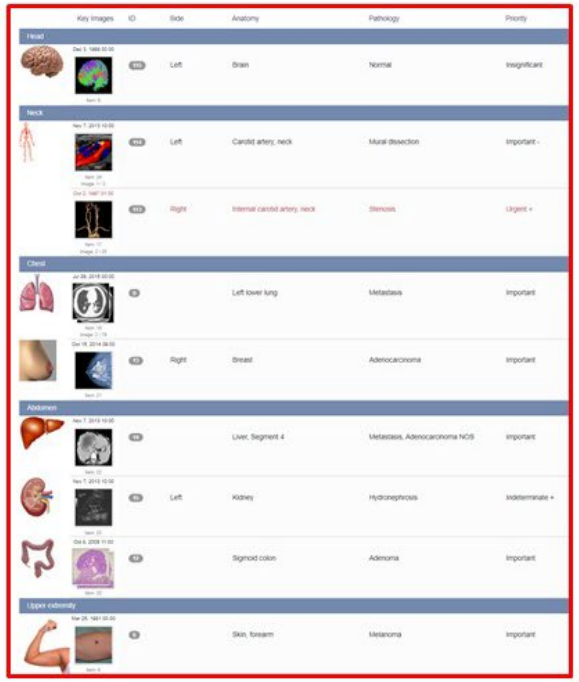
<Normal> <No metastasis reported.>
<Metastasis (UID 1000007)>

OTHER:

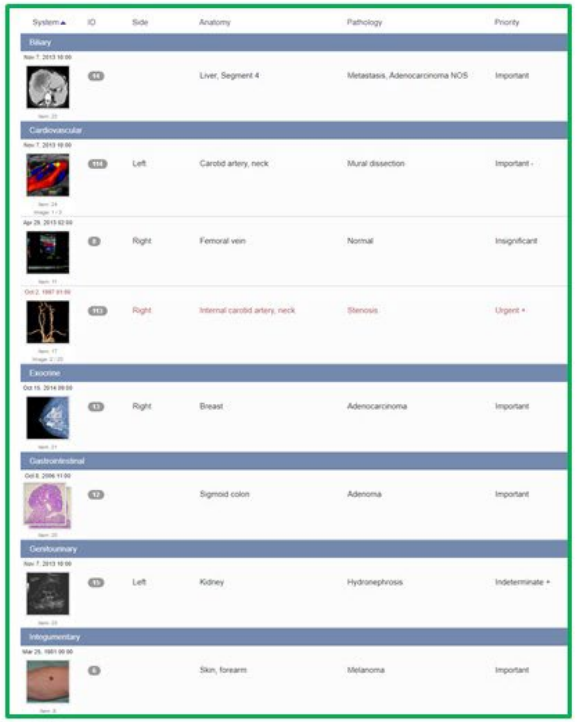
Results

- The IMR system is in use at our institution where it supports 40 clinical trials with the purpose of performing RECIST disease response assessments.
- To date the system has generated 2,956 reports on 639 patients with a total of 50,563 items of information linked in timelines representing 17,157 findings.
- Radiologists typically use the anatomical presentation of findings when interpreting exams and linking new items to prior findings, whereas clinicians prefer the TNM display for disease staging.

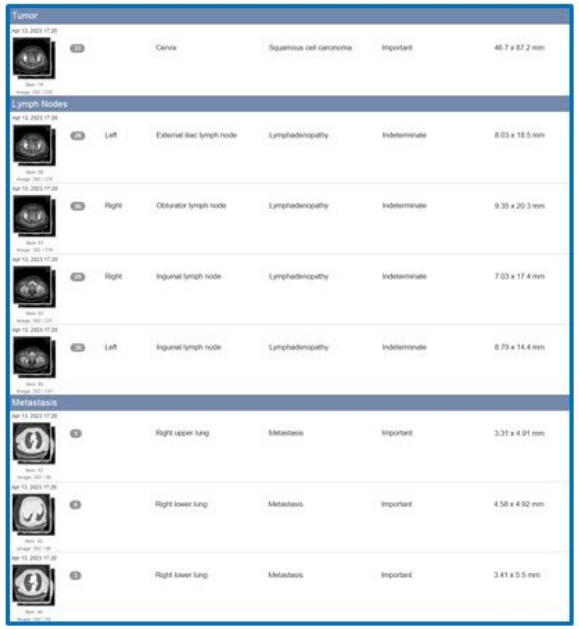
Arranged by Anatomical Hierarchy



Arranged by Physiological Categories

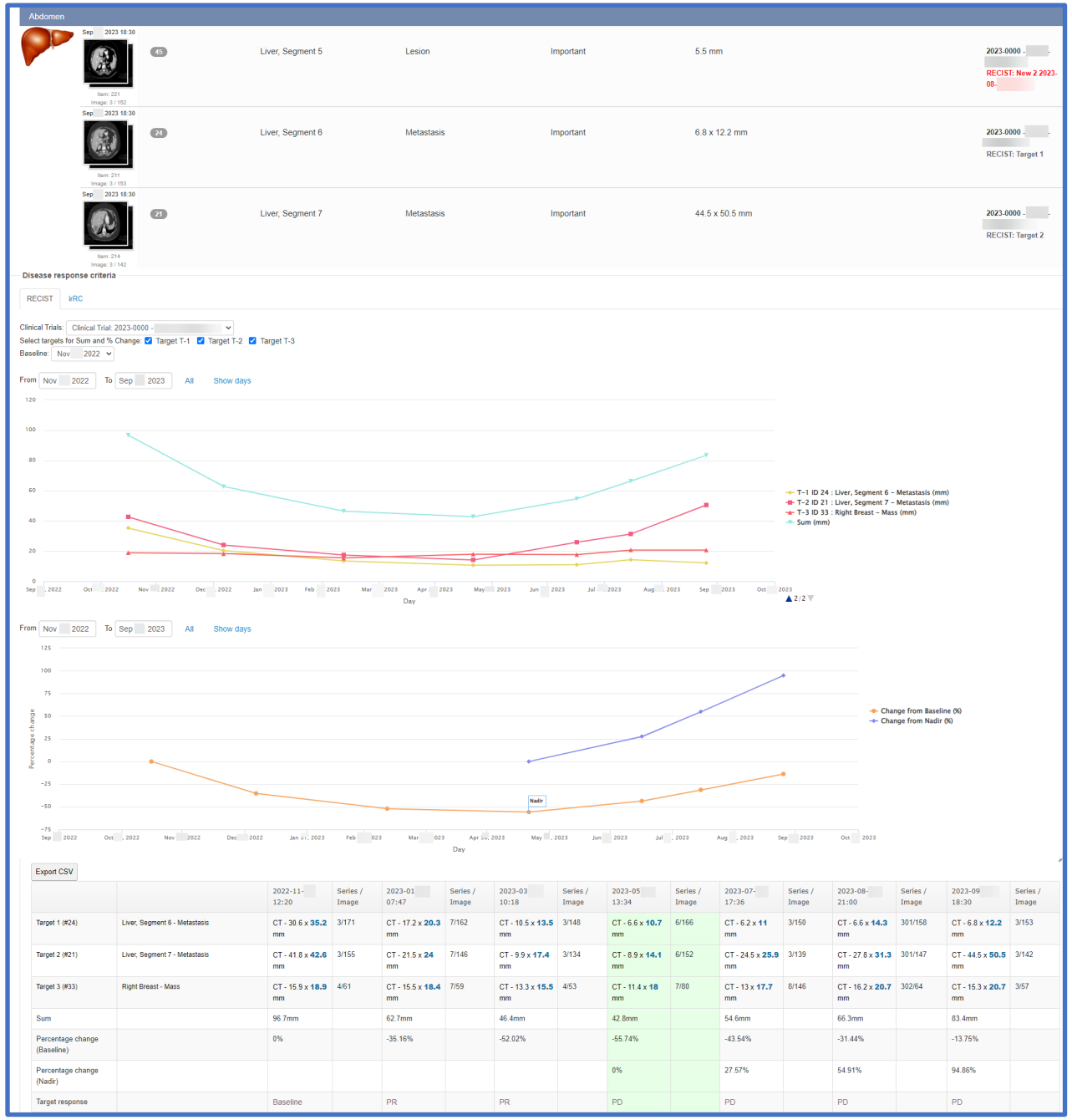


Arranged for TNM Staging



Discussion

- IMR represents a significant advance over conventional radiology reporting, especially as it can repurpose radiological data to meet the needs of different stakeholders.
- By tagging radiological findings with an array of metadata, findings can be **randomly generated and then presented in several ways**, including by anatomical hierarchies, physiological groups, TNM staging, and in graphs and tables.
- IMR transforms a radiology report from a static document to a **dynamic set of elements with increased utility**.



IMR report with RECIST data arranged in graphs and tables.