Structured Cancer Reports: The Case for SNOMED CT

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Cancer Diagnostic Reports

- Surgical pathology (aka: Anatomic pathology, histopathology) reports form the definitive source for cancer diagnoses.
- Formats range from narrative to fully structured (synoptic form)
- Reporting of pathologic assessment of cancer in synoptic form is desirable
    - Canada (Cancer Care Ontario); US (College of American Pathologists); UK, Australia (Royal Colleges)
- Synoptic report format
    - Data elements presented in Question/Answer style
    - Structured format
    - Solicits completeness and uniformity of reports
    - Rendered in human readable form

College of American Pathologists Example

Histologic Type (select all that apply) (Note B)

___ Adenocarcinoma
___ Mucinous adenocarcinoma
___ Signet-ring cell carcinoma
___ Medullary carcinoma
___ High-grade neuroendocrine carcinoma
    ___ Large cell neuroendocrine carcinoma
    ___ Small cell neuroendocrine carcinoma
___ Squamous cell carcinoma
___ Adenosquamous carcinoma
___ Undifferentiated carcinoma
___ Other (specify): _____
___ Carcinoma, type cannot be determined

Histologic Grade (Note C)

___ Not applicable
___ Cannot be assessed
___ Low grade (well-differentiated to moderately differentiated)
___ High grade (poorly differentiated to undifferentiated)
___ Other (specify): _____

Sample from CAP Colorectal Cancer Checklist (version 3.4.0.0)
College of American Pathologists, Northfield, IL USA

Sample Synoptic Report

Specimen: rectosigmoid
Procedure: Rectal/rectosigmoid colon (low anterior resection)
Tumor Site: Rectosigmoid
Tumor Size: Greatest dimension: 2.2 cm
Macroscopic Tumor Perforation: Not identified
Macroscopic Intactness of Mesorectum: Not applicable
Histologic Type: Adenocarcinoma
Histologic Grade: Low-grade (well to moderately differentiated)

Microscopic Tumor Extension: Tumor invades through the muscularis propria into the subserosal adipose tissue or the nonperitonealized pericolic or perirectal soft tissues but does not extend to the serosal surface

If all margins uninvolved by invasive carcinoma: Distance of invasive carcinoma from closest margin: 2.2 cm
distal
Margins: Proximal: Uninvolved by invasive carcinoma
Margins: Distal: Uninvolved by invasive carcinoma
Margins: Radial or Mesenteric: Uninvolved by invasive carcinoma
Treatment Effect: No prior treatment

Lymph-Vascular Invasion: Not identified
Perineural Invasion: Perineural invasion absent
Tumor Deposits (discontinuous extramural extension): Not identified

Primary Tumor (pT) Category: pT3: Tumor invades through the muscularis propria into pericolorectal tissues

Regional Lymph Nodes (pN): pN0: No regional lymph node metastasis

Number of lymph nodes examined: 13
Number of lymph nodes involved: 0

Distant Metastasis (pM): pMX: Cannot be assessed

We need to encode this data

One detail…Terminology

- Machine readable terminology is lacking for surgical pathology

- SNOMED CT
  - 340+ Tumor Observables
  - Meant for CAP checklists
  - No definitional attribute/value pairs
  - All primitive => limited inferential ability

- LOINC
  - Limited number of concepts for CAP worksheets (~120)
  - Definitional structure orthogonal, flat concept model
  - Limited inferential ability

- SNOMED CT/LOINC Observable and Investigation Project
  - Bind LOINC and SNOMED CT for laboratory
  - Use of newly defined attributes for the Observable Entity hierarchy

Objective and Methods

Objective:

Create the definitional content for observables (questions) represented in the CAP cancer worksheets.

Methods:

- Use the SNOMED CT/LOINC Observables project model design recommendations
- Use colorectal resection and invasive breast cancer worksheets a pilot project
- Model observable entity concepts in NE Lexicon (Namespace ID: 1000004)
- Deploy within UNMC Pathology Information System and Biobank

Process

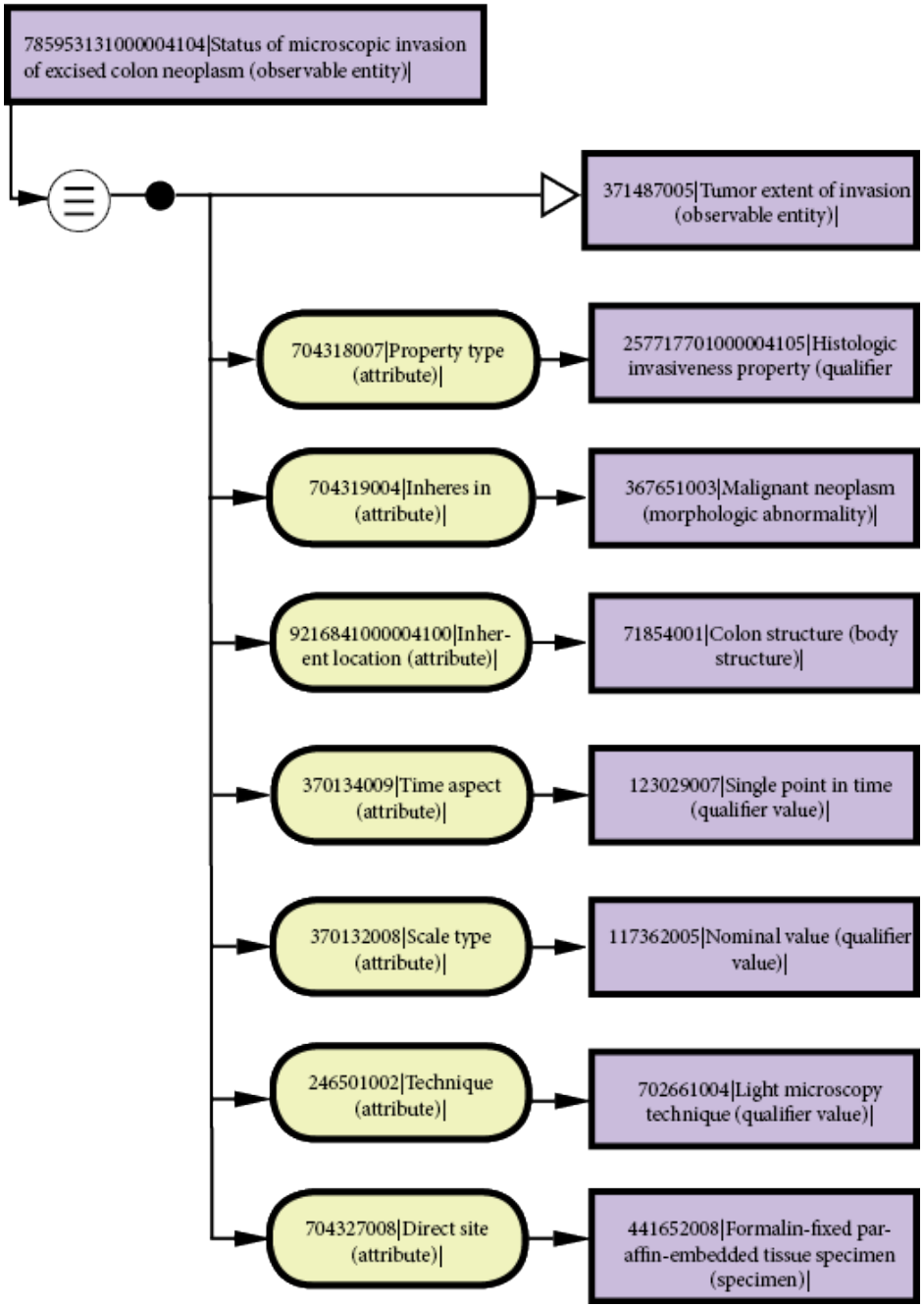
- Convened meeting of IPaLM SIG in London, September 2015
    - Representatives: US NLM, CAP, UK HSCIC(now Digital Health), IHTSDO terminology heads, pathologists from US and UK
    - Developed trial concept model for anatomic pathology (AP) concepts
    - Could not reach consensus on model for molecular pathology

•AP model reviewed in Montevideo, Uruguay at Fall 2015 IHTSDO business meeting

- Model approved to proceed by Observables Project Group

•MP model proposed and approved in April 2016 at IHTSDO spring business meeting by Observables Project Group

•Concepts authored for colorectal cancer, invasive breast cancer and associated biomarker worksheets



Example: Microscopic Invasion of colon tumor

Example Value set

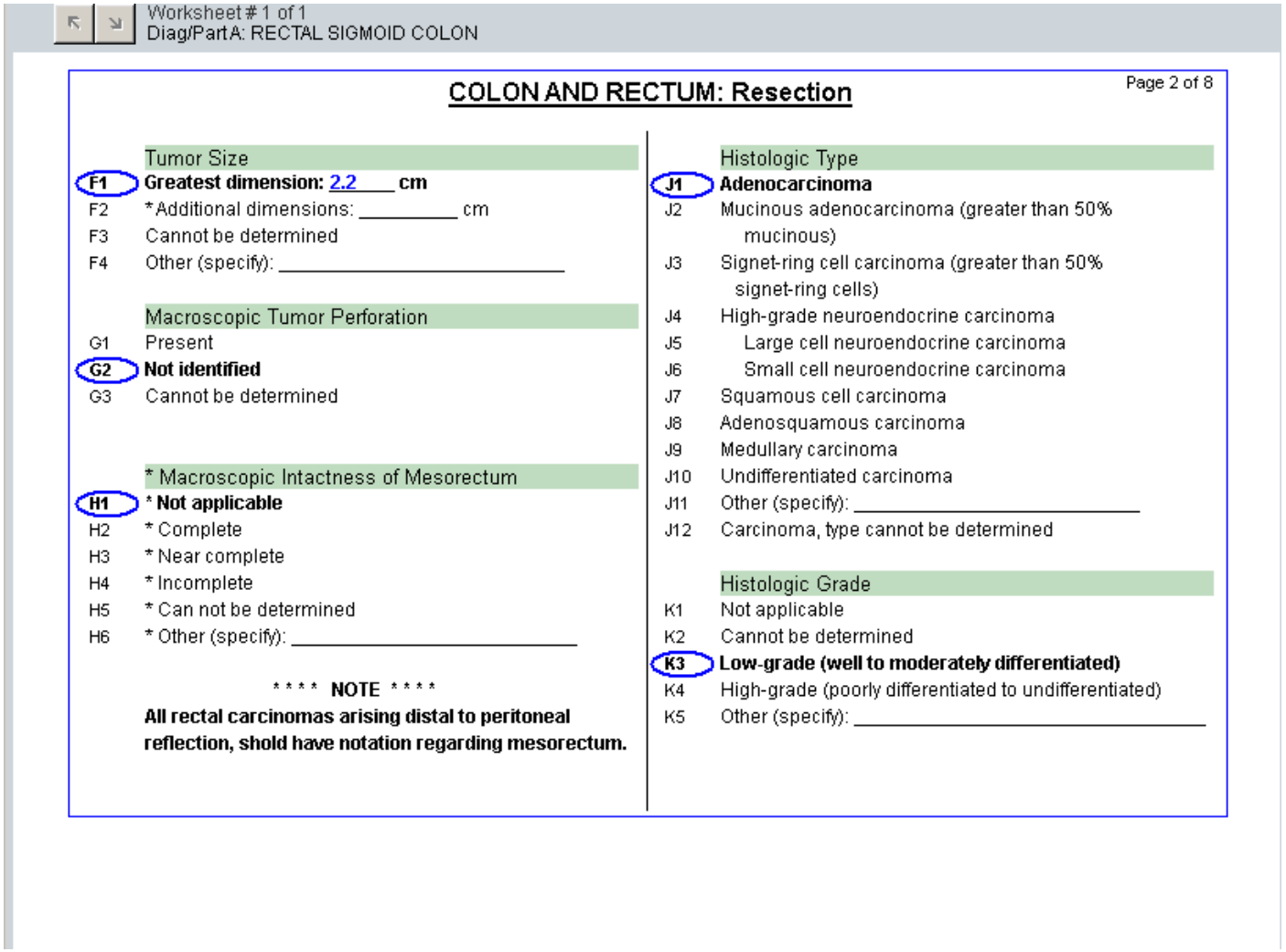
Direct extension of colon tumor	785953131000004104|Status of microscopic invasion of excised colon neoplasm (observable entity)		
		Tumor invasion cannot be assessed	87100004 | Topography unknown (body structure) |
		No evidence of primary tumor	21229009 | Topography not assigned (body structure) |
		Carcinoma in situ, intraepithelial	42978003 | Colonic epithelium (body structure) |
		Carcinoma in situ, invasion of lamina propria	113284008 | Colonic lamina propria (body structure) |
Value set of answers		Tumor invades submucosa	61647009 | Colonic submucosa (body structure) |
		Tumor invades muscularis propria	41948009 | Colonic muscularis propria structure (body structure) |
		Tumor invades through the muscularis propria into the subserosa or into non-peritonealized pericolic or perirectal tissue	52010009 | Colonic subserosa (body structure) |
		Tumor penetrates serosa	90132000 | Colonic serosa (body structure) |

Total number of new concepts

-Colorectal Ca, Invasive Breast Ca

SNOMED CT Hierarchy	# of new AP concepts	# of new MP concepts	Total new concepts
Observable entity	133	41	174
Qualifier values	16	9	25
Clinical findings	20	7	27
Body structure	15	19	34
Attribute	1	3	4
Specimen	1	0	1
Substance	0	8	8
Total	186	87	273

Terms Bound to Pathologist GUI



Worksheet # 1 of 1
Diag/Part A: RECTAL SIGMOID COLON

COLON AND RECTUM: Resection

Tumor Size

- F1 **Greatest dimension: 2.2 cm**
- F2 *Additional dimensions: _____ cm
- F3 Cannot be determined
- F4 Other (specify): _____

Macroscopic Tumor Perforation

- G1 Present
- G2 **Not identified**
- G3 Cannot be determined

* Macroscopic Intactness of Mesorectum

- H1 *** Not applicable**
- H2 * Complete
- H3 * Near complete
- H4 * Incomplete
- H5 * Can not be determined
- H6 * Other (specify): _____

****** NOTE ******

All rectal carcinomas arising distal to peritoneal reflection, shold have notation regarding mesorectum.

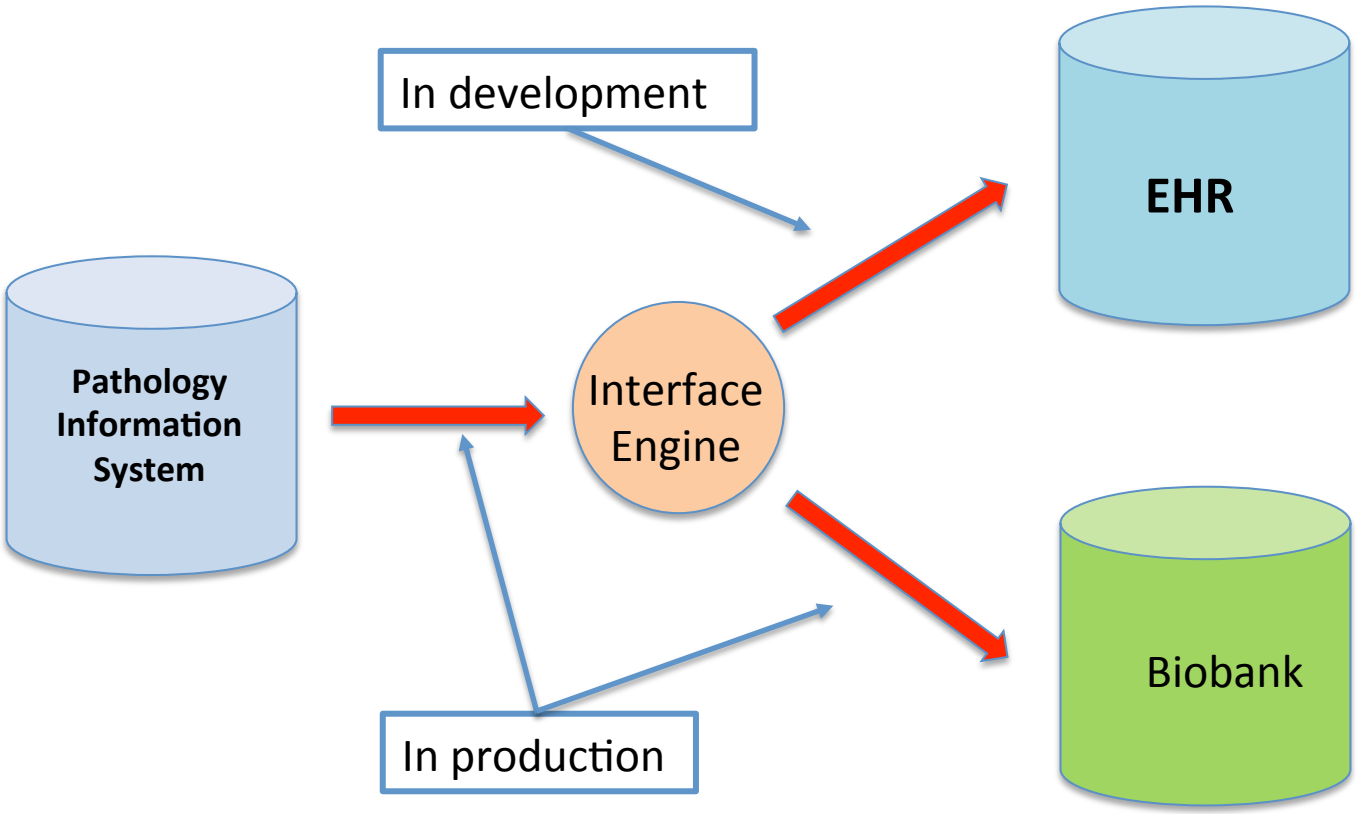
Histologic Type

- J1 **Adenocarcinoma**
- J2 Mucinous adenocarcinoma (greater than 50% mucinous)
- J3 Signet-ring cell carcinoma (greater than 50% signet-ring cells)
- J4 High-grade neuroendocrine carcinoma
- J5 Large cell neuroendocrine carcinoma
- J6 Small cell neuroendocrine carcinoma
- J7 Squamous cell carcinoma
- J8 Adenosquamous carcinoma
- J9 Medullary carcinoma
- J10 Undifferentiated carcinoma
- J11 Other (specify): _____
- J12 Carcinoma, type cannot be determined

Histologic Grade

- K1 Not applicable
- K2 Cannot be determined
- K3 **Low-grade (well to moderately differentiated)**
- K4 High-grade (poorly differentiated to undifferentiated)
- K5 Other (specify): _____

Information Flow



Information Exchange

- Information exchanged via HL7 message
  (v2.3.1 based on current pathology information system limitation)

- Sample Message:

Question **Answer**

OBX|5|CWE|245642601000004106^Colon-Intramural vascular (Large vessel) invasion^SCT||127494000^Absent^SCT|||||F

OBX|6|CWE|534796361000004106^Colon-Extramural vascular (Large vessel) invasion^SCT||127494000^Absent^SCT|||||F

OBX|7|CWE|372327521000004100^Colon-Polyp Type in which invasive carcinoma arose^SCT||2667000^None identified^SCT|||||F

OBX|8|CWE|661259881000004105^Colon-Treatment Effect^SCT||997170731000004106^No prior treatment^SCT|||||F

OBX|9|CWE|769094541000004105^Colon-Status of surgical margins involved by tumor^SCT||55182004^Negative - No surgical margins involved by tumor^SCT|||||F

OBX|10|CWE|508176221000004106^Colon-Surgical margin closest to tumor^SCT||161739961000004108^Mesenteric margin^SCT|||||F

Benefits of approach

- Synoptic data capture methods unchanged for pathologists
- Synoptic data represented using accepted standard
  - Provides rich semantic, computable structure of data
    - Data mining, Data reuse
- Synoptic data easily representable within context of EPIC flow sheets
  - Ease of use for physicians/caregivers
  - Leverage episode of care
    - Disease progression, Reduction of test duplication
- Data populates Tissue Biobank database and used for case characterization and identification

Research Use Case Example

How many colorectal cancer cases with histologic type of adenocarcinoma by pT stage are in the tissue biobank?

Part	QuestionCode	Question	AnswerCode	Answer	pT	STAGE
1	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	35917007	Adenocarcinoma, no subtype (morphologic abnormality)	pT category (observable entity)	pT0 category (finding)
2	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	35917007	Adenocarcinoma, no subtype (morphologic abnormality)	pT category (observable entity)	pT0 category (finding)
3	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	35917007	Adenocarcinoma, no subtype (morphologic abnormality)	pT category (observable entity)	pT1: Tumor invades submucosa (colon/rectum) (finding)
4	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	35917007	Adenocarcinoma, no subtype (morphologic abnormality)	pT category (observable entity)	pT1: Tumor invades submucosa (colon/rectum) (finding)
5	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	35917007	Adenocarcinoma, no subtype (morphologic abnormality)	pT category (observable entity)	pT2: Tumor invades muscularis propria (colon/rectum) (finding)
6	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	715143191000004006	Adenocarcinoma, with mucinous features (morphologic abnormality)	pT category (observable entity)	pT2: Tumor invades muscularis propria (colon/rectum) (finding)
7	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	35917007	Adenocarcinoma, no subtype (morphologic abnormality)	pT category (observable entity)	pT3: Tumor invades through the muscularis propria into the subserosa or into non-peritonealized pericolic or perirectal tissues (colon/rectum) (finding)
8	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	715143191000004006	Adenocarcinoma, with mucinous features (morphologic abnormality)	pT category (observable entity)	pT3: Tumor invades through the muscularis propria into the subserosa or into non-peritonealized pericolic or perirectal tissues (colon/rectum) (finding)
9	411549531000004007	Histologic subtype of excised colon neoplasm (observable entity)	981501271000004007	Adenocarcinoma, with signet ring cell features (morphologic abnormality)	pT category (observable entity)	pT3: Tumor invades through the muscularis propria into the subserosa or into non-peritonealized pericolic or perirectal tissues (colon/rectum) (finding)

Molecular Use Case?

Find all malignant neoplasms form any body system assessed for any BRAF mutation AND reported lymphatic metastases.

- Subsumes of BRAF variants
  - v600e, v600k, v600r, v600d
  - BRAF vus (variant of unknown significance)
- Subsumes differing techniques
  - Immunohistochemistry
  - Sequencing technique
- Independent of value set
  - Includes present/absent answers
  - Includes variant call formatted data

Next Steps

- Goal – complete all 82 CAP checklists in 15 - 18 months (about 5 per month)
- Working with IHTSDO to get project on production schedule for international deployment
- Current content developed at UNMC to be shared via US NLM website for review and comment
- Working with Regenstreif for new concepts to be represented using LOINC codes using SNOMED CT definitional structure/Observables Project

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