
Development and clinical experience with a SNOMED CT based self-service analytics solution

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SNOMED CT Expo 2016

*Fri 28 Oct, 14:30-15:00
Soundings Theatre, 2nd Floor*

Contents

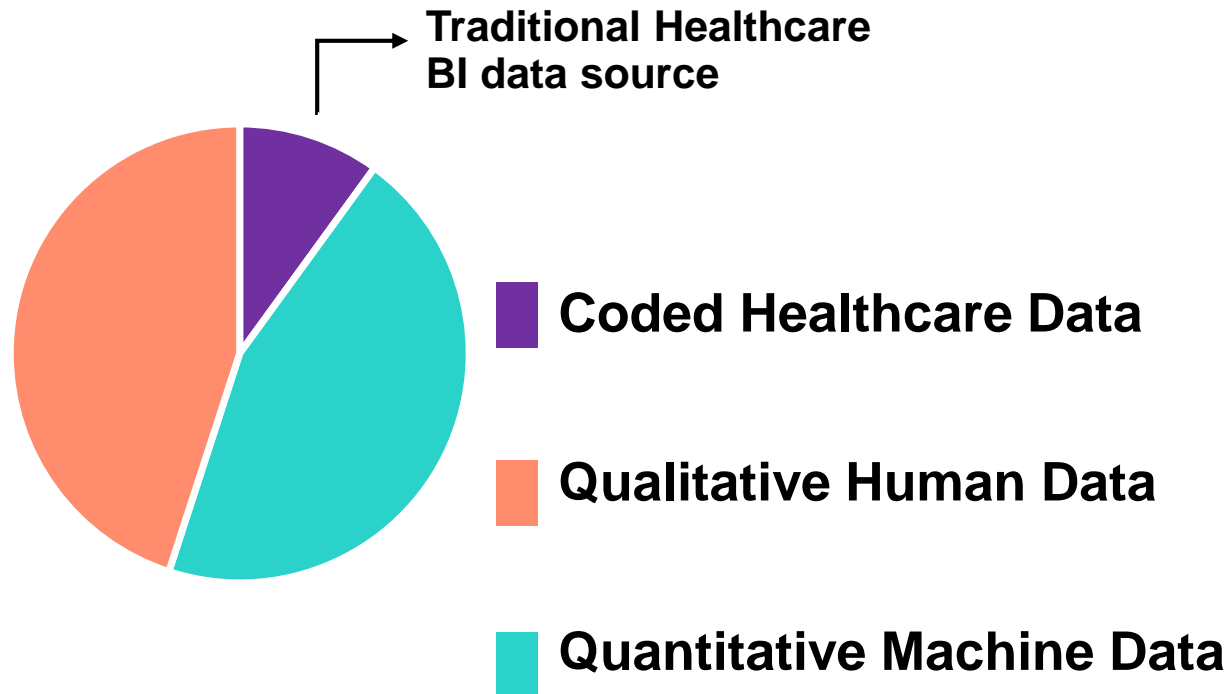
- **Philosophy/Analytics Goals**
 - Data access
 - Users
- **HCAS implementation**
 - Architecture
 - Ontologies, SNOMED CT
 - Functionality Examples
- **Vendor-Client engagement**
 - Engagement model
 - Decision analysis during design
- **Experiences**
 - SCH MPSS
 - SCH USNWR
 - SCH VTE Surveillance
 - CDHB Radiology Pilot
- **Learnings**
- **Future direction**
- **Selected References**
- **Acknowledgements**



HCAS Analytics Goals

Seamless integration of structured and unstructured data

Comprehensive use of available clinical data



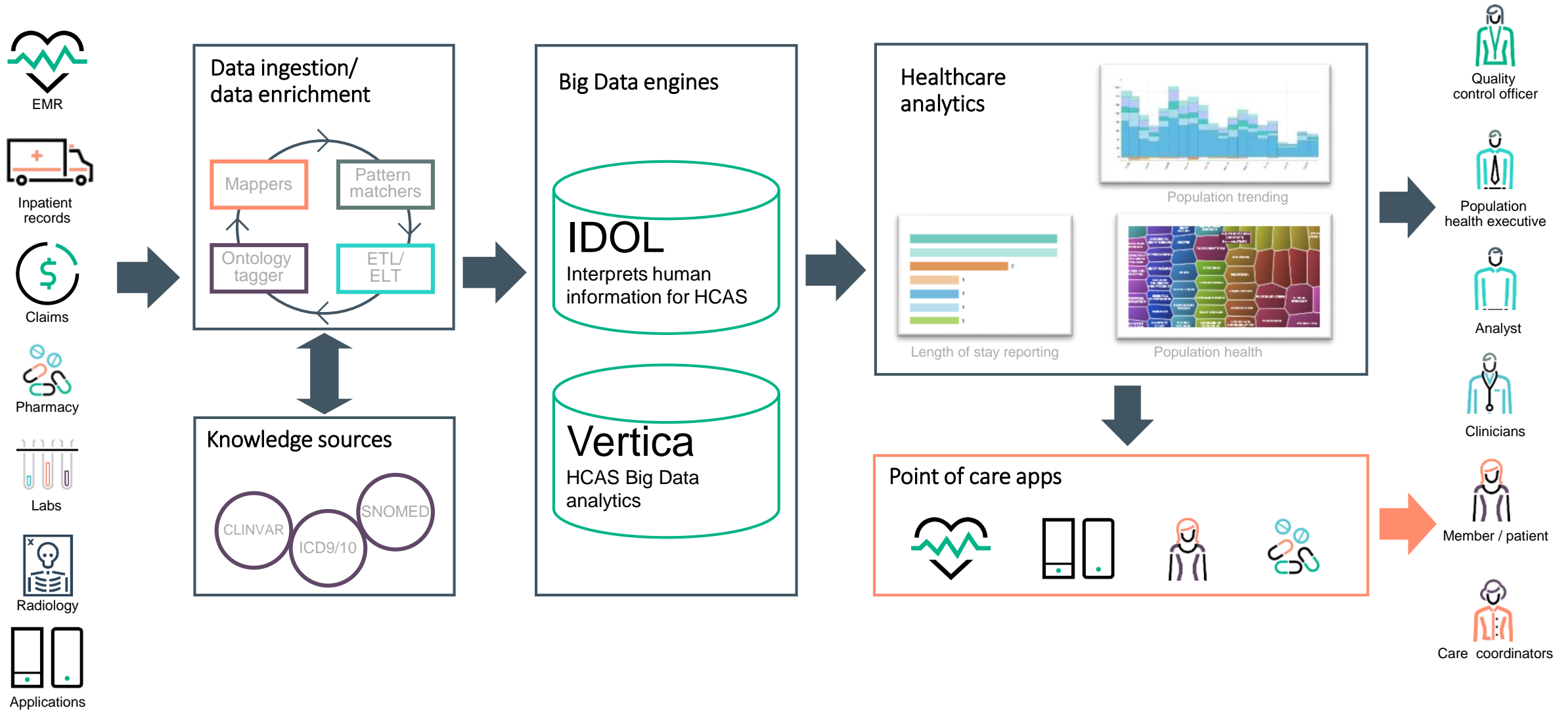
Self service analytics

Benefits a broad range of users and use-cases

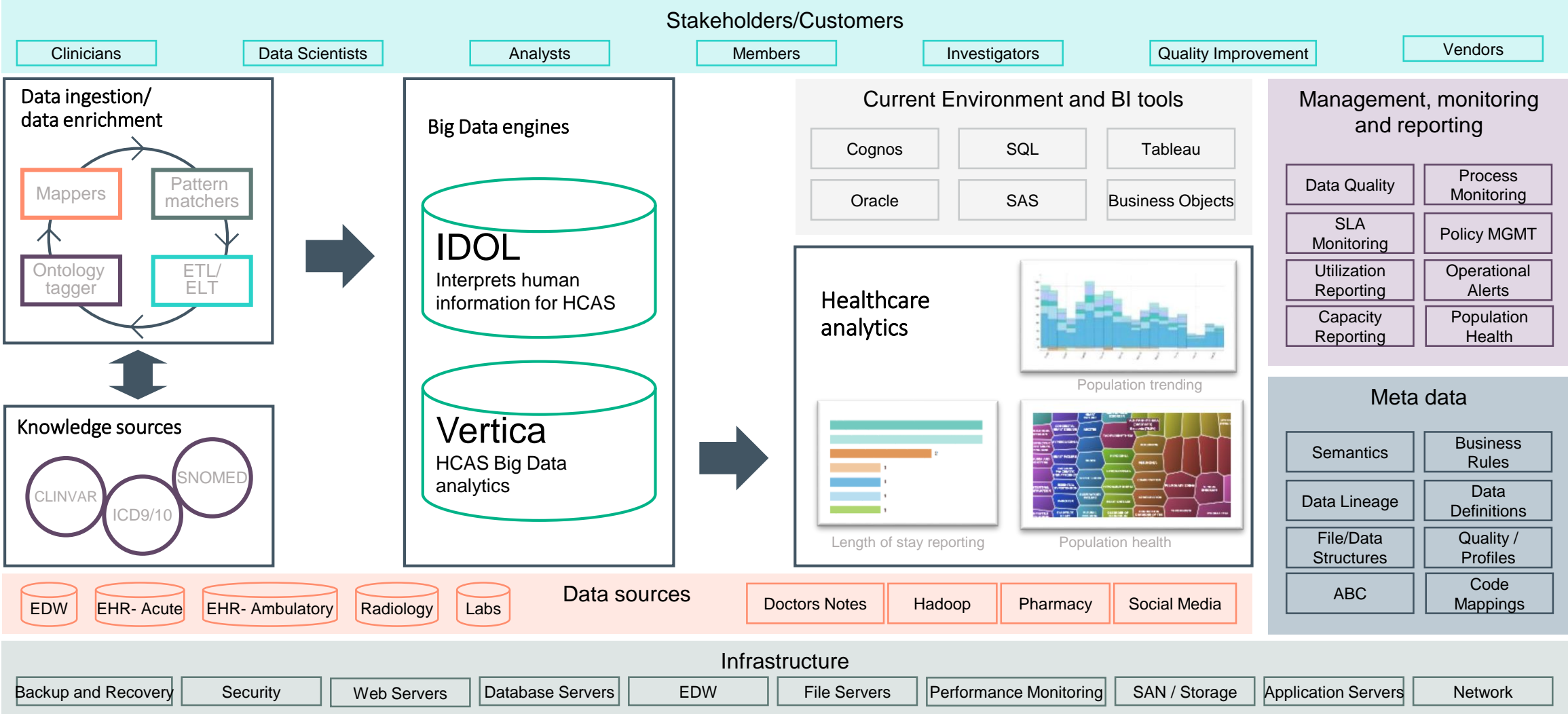


Intuitive Data Access

HCAS Architecture



HCAS in the Healthcare IT Ecosystem

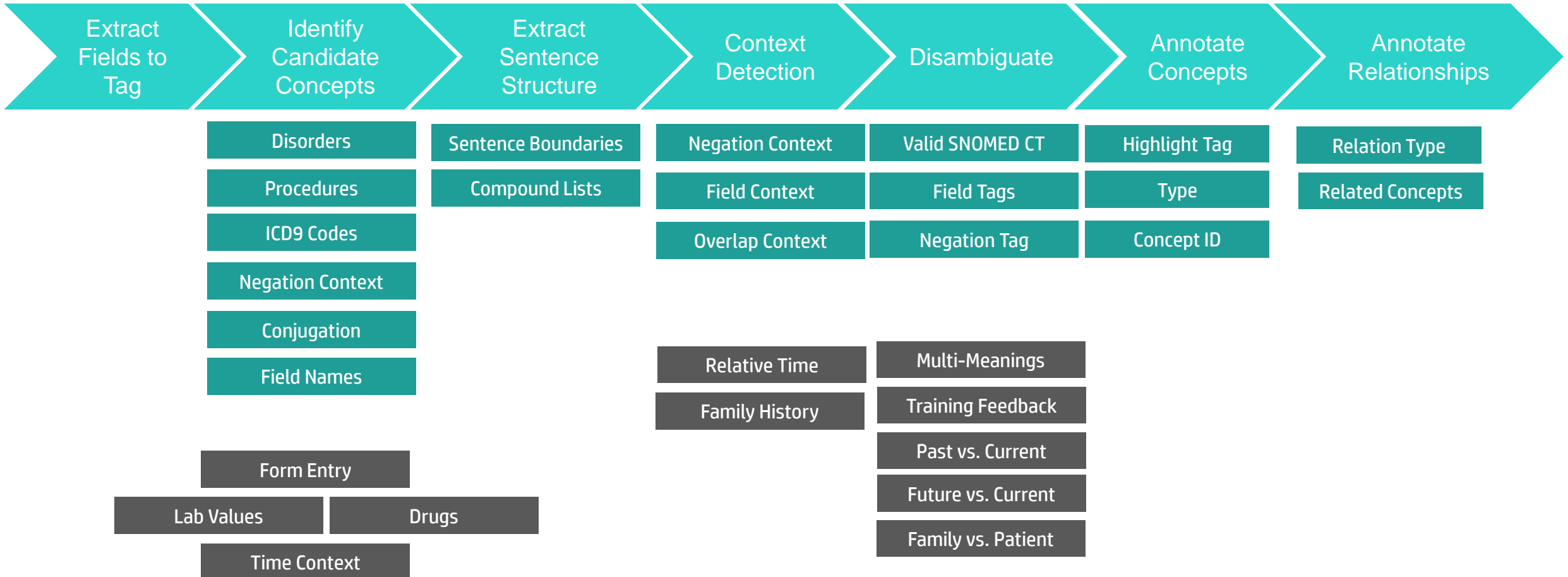


Use of SNOMED CT

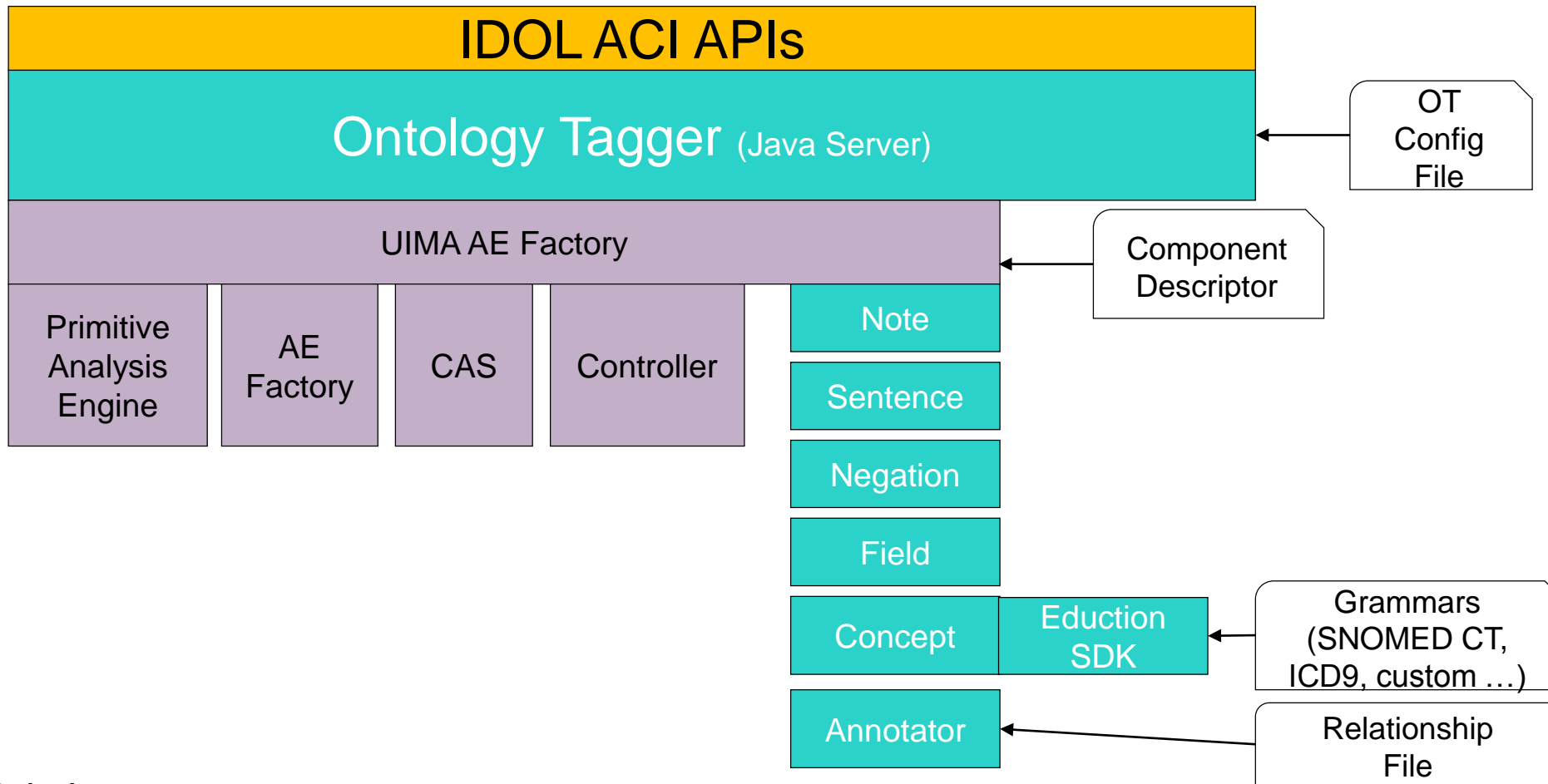
- HCAS uses SNOMED CT as a foundational ontology; it is applied to parametric text fields and free-text unstructured clinical data to enable full text indexing of clinical content within each record
- Annotation occurs automatically on specific data elements; users do not need to have any explicit knowledge of SNOMED CT
- Primary processing pipeline is **context classification, negation, and concept entity identification**
- Enables search capabilities based on key words, medical concepts, clinical codes, and colloquial terms
- Data, documents, and patients are quickly located, with relevant text highlighted for quick identification and review (computer assisted chart abstraction)



Ontology Tagger Approach



OT 2.0 Architecture



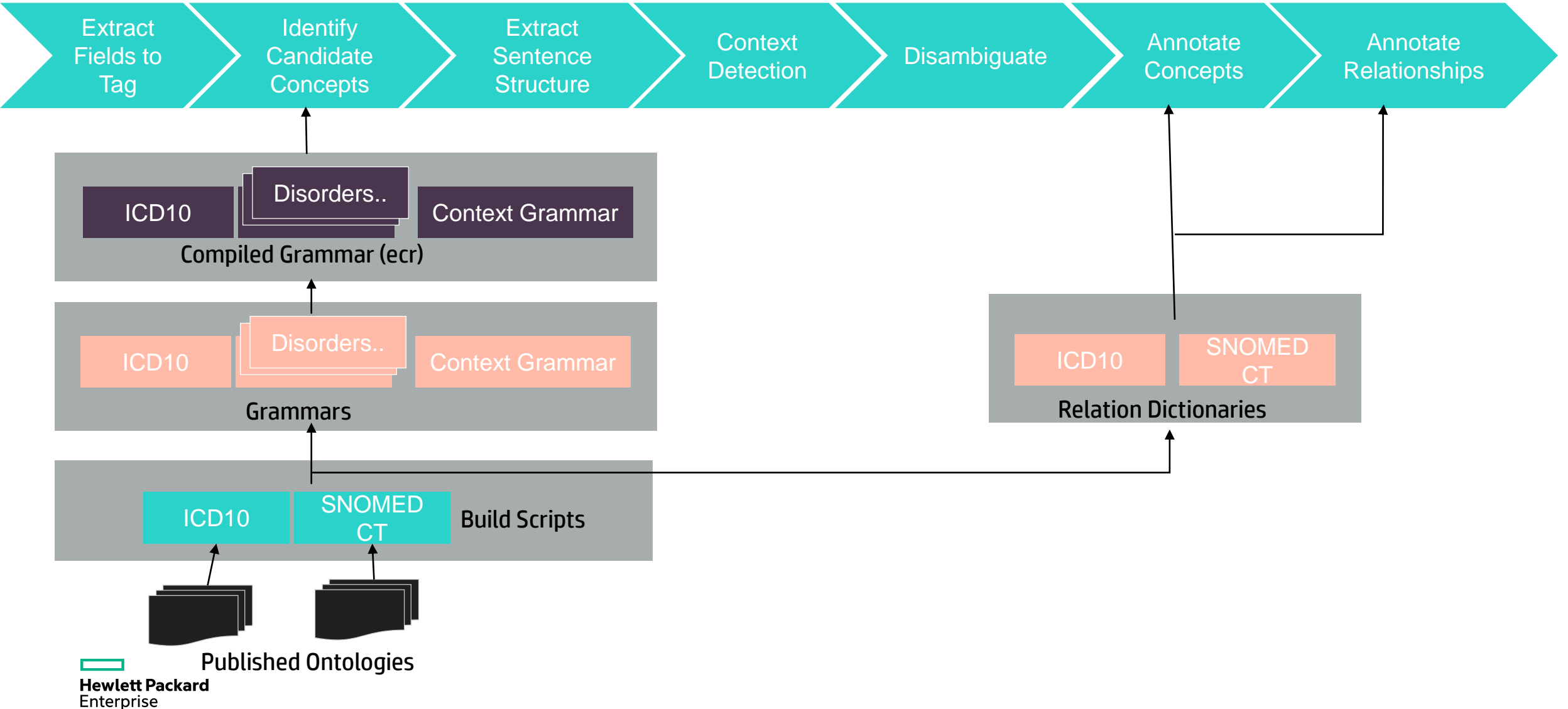
Example Tagged XML

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Current Ontology Publishing Architecture



Encounter Info Patient Info Diagnosis Codes Procedures Codes ICU Visits POE Events Lab Events Notes

Type: Nursing/Other

Chart Time: 2009-07-29 17:30:00

Care Unit: FICU

Care Giver: RRT

Note: Resp Care Pt remains vented on CPAP/PS 5/5 35%, ABGs WNL, TVs 390 RR 15, Sxn bld tinged secr + oral secr. BS coarse exp. Plan to cont to diuresis and work towards weaning and extub.

Title: None

Type: RADIOLOGY_REPORT

Chart Time: 2009-07-30 00:00:00

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Care Giver: None

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Type: RADIOLOGY_REPORT

Chart 16 out of 1213

Query Filters

Dropdown menu: All
Concept+
ABDOMINAL STRUCTURE (BOD)
Expired in Hospital
Y

BODY STRUCTURE

- ABD
Abdomen and/or pelvis structure
Abdominal aorta structure
Abdominal structure
Airway structure
All extremities
Aortic structure
Arterial structure
Ascending colon structure
Back structure, excluding neck
Bilateral adrenal glands
Bone structure of coccyx
Bone structure of cranium
Bone structure of face
Brainstem structure
Brain structure
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Query Filters

All

Concept+

ABDOMINAL STRUCTURE (BODY STRUCTURE)

Expired in Hospital

Y

BODY STRUCTURE

- ABD
- Abdomen and/or pelvis structure
- Abdominal aorta structure
- Abdominal structure
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Encounter Info Patient Info Diagnosis Codes Procedures Codes ICU Visits POE Events Lab Events **Notes**

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All

Concept+

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Expired in Hospital

Y

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All

Concept+

ABDOMINAL STRUCTURE (BOD

Expired in Hospital

Y

BODY STRUCTURE

ABD

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Abdominal aorta structure

Abdominal structure

Airway structure

All extremities

Aortic structure

Arterial structure

Ascending colon structure

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Bone structure of cranium

Bone structure of face

Brainstem structure

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Encounter Info Patient Info Diagnosis Codes Procedures Codes ICU Visits POE Events Lab Events Notes

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All
Concept+
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Expired in Hospital
Y

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Concept+

ABDOMINAL STRUCTURE (BOD

Expired in Hospital

Y

BODY STRUCTURE

- ABD
- Abdomen and/or pelvis structure
- Abdominal aorta structure
- Abdominal structure
- Airway structure
- All extremities
- Aortic structure
- Arterial structure
- Ascending colon structure
- Back structure, excluding neck
- Bilateral adrenal glands
- Bone structure of coccyx
- Bone structure of cranium
- Bone structure of face
- Brainstem structure
- Brain structure
- Chest wall structure

Encounter Info Patient Info Diagnosis Codes Procedures Codes ICU Visits POE Events Lab Events Notes

Chart 16 out of 1213

Type: Nursing/Other

Chart Time: 2009-07-29 17:30:00

Care Unit: FICU

Care Giver: RRT

Note: Resp Care Pt remains vented on CPAP/PS 5/5 35%, ABGs WNL, TVs 390 RR 15, Sxn bld tinged secr + oral secr. BS coarse exp. Plan to cont to diuresis and work towards weaning and extub.

Title: None

Type: RADIOLOGY_REPORT

Chart Time: 2009-07-30 00:00:00

Care Unit: None

Care Giver: None

Note: DATE: [**2989-7-30**] 10:27 AM CT ABDOMEN W/ CONTRAST; CT PELVIS W/CONTRAST Clip # [**Clip Number (Radiology) 14664**] CT 150CC NONIONIC CONTRAST Reason: Please assess for fluid collection/abscess, colitis, etc Admitting Diagnosis: GASTROINTESTINAL BLEED Field of view: 48 Contrast: OPTIRAY Amt: 150

UNDERLYING MEDICAL CONDITION: 73 year old woman s/p R hemicolectomy w/ hypothermia, WBC 24, and abd pain REASON FOR THIS EXAMINATION: Please assess for fluid collection/abscess, colitis, etc No contraindications for IV contrast

FINAL REPORT CLINICAL HISTORY: Patient with recent right hemicolectomy with

hypothermia, leukocytosis, abdominal pain. STUDY: CT abdomen and pelvis with contrast. TECHNIQUE: Axial multidetector CT was obtained of the abdomen and pelvis after the administration of intravenous and oral contrast. No comparisons are available. ABDOMEN CT WITH CONTRAST: There are bilateral pleural effusions and compressive atelectasis. Heart size is within normal limits. NG tube is in expected position. There is moderate amount of ascites, mostly within the upper abdomen. Two large gallstones are calcified within the gallbladder, though no gallbladder wall separate from the stones is seen and the possibility of porcelain gallbladder exists. There is fluid within the gallbladder fossa. No intrahepatic or extrahepatic biliary ductal dilatation. Pancreas is normal in appearance. Bilateral adrenal glands, and kidneys are normal in appearance. The bowel within the abdomen is within normal limits with the ileocolonic anastomosis having a normal appearance. No small bowel dilatation. No lymphadenopathy. CT PELVIS WITH CONTRAST: There is free fluid within the pelvis. No loculated collections to suggest abscess. Bowel within the pelvis is normal in appearance, though there is a fair amount of fluid within the colon, which would be consistent with diarrhea. Below the patient's midline skin incision, is a small mildly heterogeneous fluid collection without abnormal enhancement likely representing a seroma. There is sigmoid diverticula without evidence of diverticulitis. Much of the pelvis is obscured by streak artifact from the right hip prosthesis. Foley catheter is within the urinary bladder. ONE WINDOWS: The L5 vertebral body is mildly collapsed but markedly sclerotic, raising the (Over) DATE: [**2989-7-30**] 10:27 AM CT ABDOMEN W/ CONTRAST; CT PELVIS W/CONTRAST Clip # [**Clip Number (Radiology) 14664**] CT 150CC NONIONIC CONTRAST Reason: Please assess for fluid collection/abscess, colitis, etc Admitting Diagnosis: GASTROINTESTINAL BLEED Field of view: 48 Contrast: OPTIRAY Amt: 150

FINAL REPORT (Cont) question of a sclerotic metastasis. Superior aspect of the L4 vertebral body is sclerotic, but this may relate to disc generation. The L1 vertebral body is markedly collapsed and sclerotic. IMPRESSION: 1. No evidence for abscess and the patient is status post right hemicolectomy with normal-appearing anastomosis and no bowel obstruction. There is free ascites. 2. Likely large gallstones, though separate wall of the gallbladder cannot be seen and porcelain gallbladder is a consideration. The ascites limit the specificity for the pericholecystic fluid. If there is clinical concern for acute cholecystitis, ultrasound could be performed. 3. L1 and L5 vertebral compression fractures with more sclerosis within L5 than expected for the compression. Bone scan could be performed as clinically indicated.

Title: None

Type: RADIOLOGY_REPORT

Query Filters

Concept+

- ABDOMINAL STRUCTURE (BOD

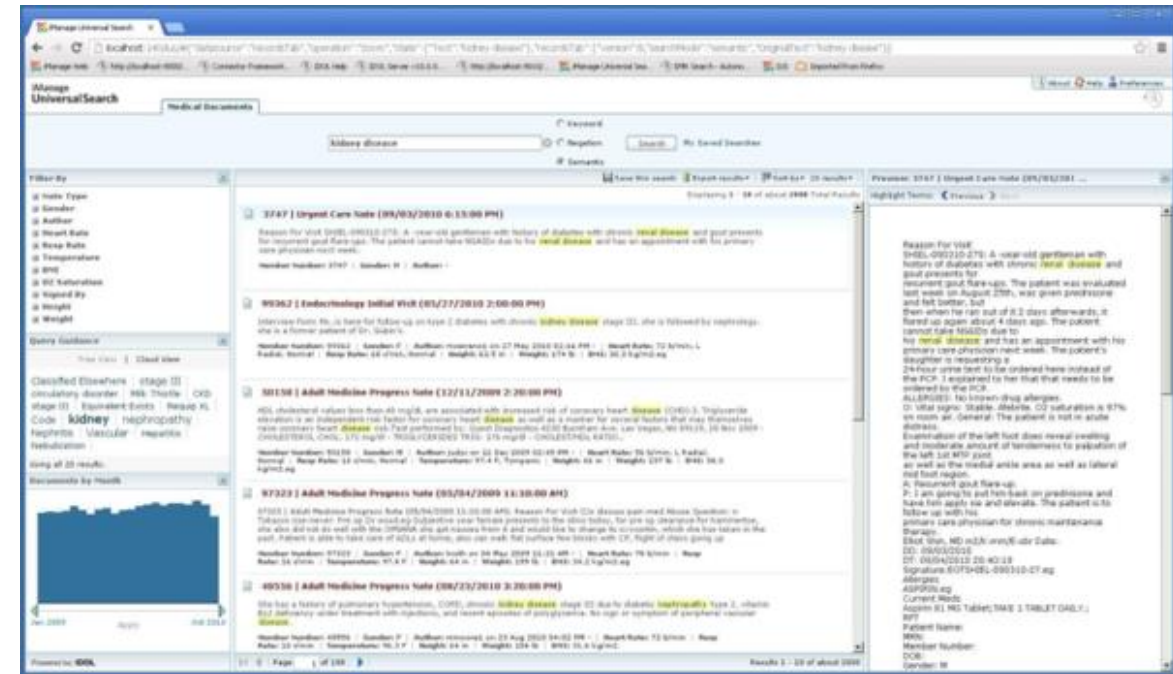
 Expired in Hospital

BODY STRUCTURE

- ABD
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2012-2013: Stanford Children's Health Multi-patient Semantic Search (MPSS)

- Data
 - 5 years of radiology reports and general clinical notes
- System features
 - Metadata mapping of patient data
 - Limited preset filter capabilities for structured data including date-time
 - Cross-patient keyword/regex free-text searching
 - Cohort generation
 - Concept tag-cloud display, but no ontologies
 - EMR document preview from within MPSS



2013-2014: Stanford Children's Health US News and World Report (USNWR) Pilot

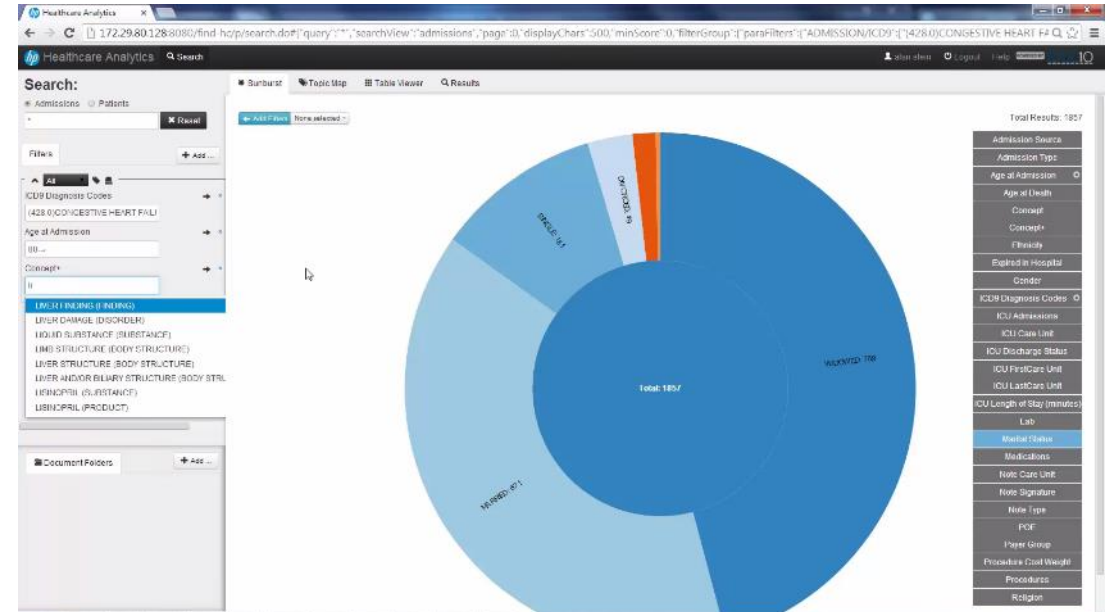
– Data:

- ~115k patients, ~390k encounters, ~3 million documents from EMR (2011-2013)
- Structured
 - Patient ID, age, Encounter ID, location, Diagnosis (ICD) and Procedure (CPT) codes, Document metadata (e.g. provider)
- Unstructured
 - Clinical documents, Radiology reports

– Features:

- Cross-patient search for cohort identification
- Graphical user interface for query construction
- Text search, concept search, application of filters
- Note review
- Term/concept highlighting, navigation, other concepts present
- Ability to save queries
- Input and export search results (lists of patients/encounters)
- Overnight re-indexing performance

– Owner: Quality and Clinical Effectiveness Team



USNWR: Kasai Procedure: Cohort Discovery

- How many unique patients received a Kasai procedure (ICD-9-CM codes 51.37, OR CPT code 47701) from your Pediatric GI program in 2011?
 - Querying by ICD-9 and CPT yielded 12 unique patients
 - Querying by SNOMED concept yielded 1 additional patient
- Of this group, how many are considered a success (i.e., improvement total in bilirubin <10 mg/dL, no synthetic dysfunction, no surgical complications, and delayed need for liver transplant) in 2013 (i.e., two years after initial diagnosis)?
 - Historically required tedious chart review
 - Now able to search for concepts of liver transplant, surgical complications, and terms indicating failed Kasai procedure (“failed kasai”, “BAFK”) -> identified 4 patients

2014-2015: Stanford Children's Health Venous Thromboembolus (VTE) Pilot

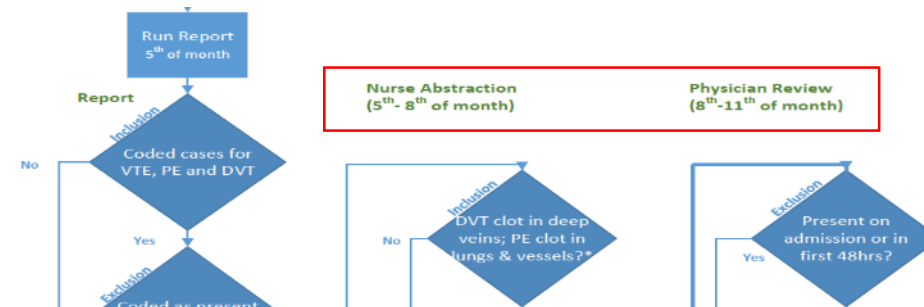
– Data

- Addressed EMR conversion (Cerner to Epic) in May, 2014
- 750k encounters, 155k patients, ~1M notes
- Weekly batch ingestion update

– Business Owners: Quality and Clinical Effectiveness Team

– Challenge: Venous Thromboembolism (VTE)

- Hospital Acquired Condition (HAC), incidence about 4/1000 in pediatrics
- Difficult to identify for reporting, much less for mitigation and prevention
- Current process is inefficient, and lacks sensitivity



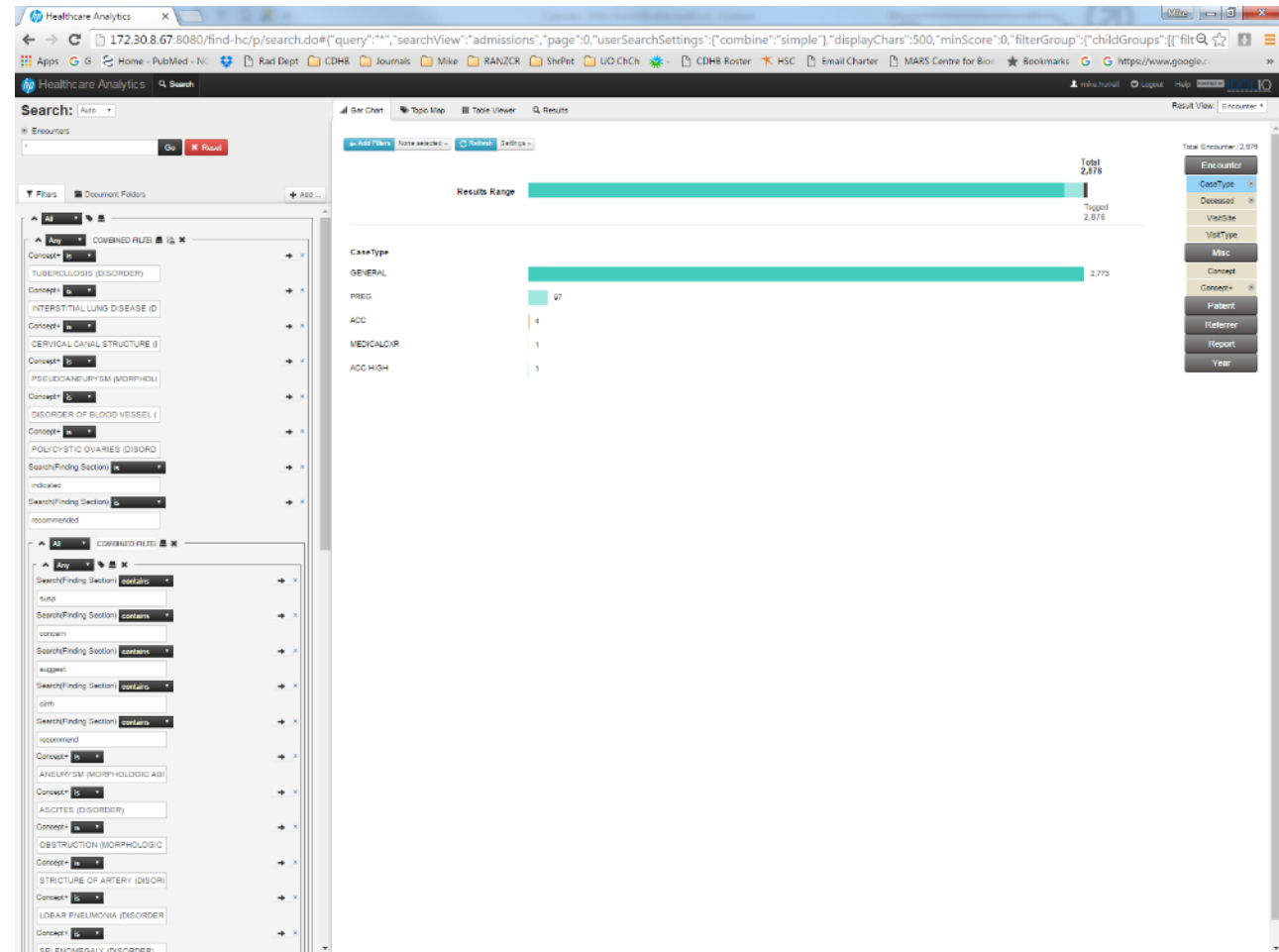
2016: Healthcare Analytics Solution CDHB Radiology Pilot

– Data

- 5 years of selected radiology reports (13601 records)

– System features

- SNOMED CT ontology
- Seamless structured/free-text filter creation
- Cohort generation of reports with actionable findings
- Collaborative workflow
 - Cohort assignment
 - Computer assisted chart abstraction
- Cohort export for interoperability with other IT systems



Healthcare Analytics Solution

CDHB Radiology Pilot

- 13000+ reports “printed” to non-existent printer due to incorrect setup
- Concern over non-acute ACR category 3 abnormalities
 - Non-acute
 - Require communication within days/weeks
 - Possible morbidity/mortality if ignored
 - eg aneurysm, malignancy
- Benefits
 - Reliability
 - Efficiency
 - Transparency
- Risks
 - Requires hypothesis driven use
 - Dynamic accuracy

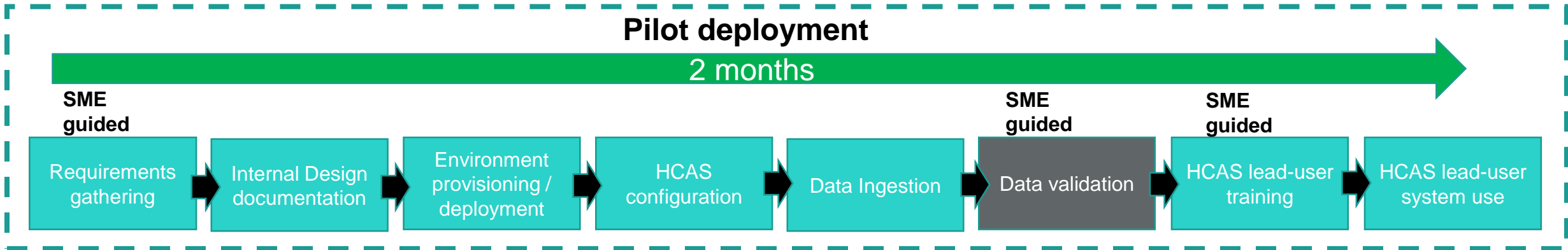
	ACR category 3 abnormalities
Body System	Term
General	Neoplastic disease (Disorder)
	Proliferation (Morphologic abnormality)
	Aneurysm (Morphologic abnormality)
	Stricture of artery (Disorder)
	Lymphadenopathy (Disorder)
	Tuberculosis (Disorder)
Chest	Cardiomegaly (Disorder)
	Lobar pneumonia (Disorder)
	Collapse (Morphologic abnormality)
	Interstitial Lung Disease (Disorder)
Abdomen	Ascites (Disorder)
	Splenomegaly (Disorder)
	Upper urinary tract dilatation and obstruction (Disorder)
	Dilatation of ureter (Disorder)
	Kidney stone (Disorder)
	Calculus (Morphologic abnormality)
	Malformation of urachus (Disorder)
	Intestinal obstruction (Disorder)
	Obstruction (Morphologic abnormality)
	Polycystic Ovaries (Disorder)
Musculo-Skeletal	Congenital skeletal dysplasia (Disorder)

Lessons Learned (a study in med-tech commercialization)

- Clearly defined use-case
- Clearly defined system user(s)
- Careful selection of available data sources / data elements
- Healthcare technology adoption issues
- Objective ROI
- Ownership and subject matter expertise at both vendor and client
- The importance of usability



Sample HCAS deployment stages



Data source / element selection decision analysis

–CDHB Radiology Pilot

- address single use-case
- 1 data source, 16 data elements

–CDHB enterprise deployment in-process

- address specific 3 use-case templates
- assess broader reusability
- 7 data sources, 107 data elements

8	conform to warehouse	Demographic	Patient NHI	erms..dim_patient.patient_nhi warehouse..bridge_ip_clinical_coding.clinical_code + warehouse..bridge_ip_clinical_coding.clinical_coding_sys tem_code WHERE principal_diagnosis_flag = 'N' AND record_type = 'D'	ERMS data - CDHB Data Warehouse CDHB Data Warehouse
9	ICD10	Coding	Diagnosis: Additional Diagnoses	warehouse..bridge_ip_clinical_coding.alternative_descri ption WHERE principal_diagnosis_flag = 'N' AND record_type = 'D'	CDHB Data Warehouse
10	Free Text	Coding	Diagnosis: Document Diagnosis Description	diagnosis.description	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
11	Free Text	Coding	Diagnosis: Document Diagnosis Primary	diagnosis.isprimary	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
12	Free Text	Coding	Diagnosis: Document Diagnosis Primary	warehouse..bridge_ip_clinical_coding.clinical_code + warehouse..bridge_ip_clinical_coding.clinical_coding_sys tem_code WHERE principal_diagnosis_flag = 'Y' AND record_type = 'D'	CDHB Data Warehouse
13	ICD10 + descr	Coding	Diagnosis: Principal Diagnosis + coding system code	warehouse..bridge_ip_clinical_coding.alternative_descri ption WHERE principal_diagnosis_flag = 'Y' AND record_type = 'D'	CDHB Data Warehouse
14	Free Text	Coding	Diagnosis: Principal Diagnosis alternative description	diagnosis.description	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
15		Document	Document Content		MSCHCCISSQLRSP1.OH_SMT_CDR_RS
16	headings from EDW	Document	Document Heading	textType	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
17		Document	Document Responsible Clinician/Team	document.extprovidername	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
18		Document	Document last edited by user	Documentcontributor.documentcontributor.[userName]+ ISNULL(''+[userRole]+'','')	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
19		Document	Document Status	Document.status	MSCHCCISSQLRSP1.OH_SMT_CDR_RS
				[Document].templateCode + [Document].templateDescription +	MSCHCCISSQLRSP1.OH_SMT_CDR_RS

9	Limited to Scenario?							
10	REUSABILITY (10= very reusable, 1= case specific)	6	6	10	10	10	6	6
11	PRIORITY (10= need, 1= don't need)	9	10	10	10	10	10	10
12	LEVEL of EFFORT (10 = not collected, 0=immediately collected)	0	0	0	0	0	0	0
13	Data Element Type	Source/UI	Source/UI	Source/UI	Source/UI	Source/UI	UI (concatenated)	UI (concatenated)
14	Comments							
15	Data Field	ReferralID	ReferralDate	NHI	Gender	DOB	ReferrerFacility	ReferrerName • Identifier
16		erms..fact_erms.referral_i d	erms..fact_erms.referral_d ate_time	erms..dim_patient.patient_ nhi	erms..dim_patient.patient_ gender	erms..dim_patient.patient_ dob	erms..dim_referrer_facility. referrer_facility_name • referrer_facility_hpi	erms..dim_referrer_person. referrer_person_full_name • referrer_person_registratio n
17	Data Source	ERMS data - CDHB Data Warehouse 4 to 8 digit number	ERMS data - CDHB Data Warehouse date time	ERMS data - CDHB Data Warehouse eg ABC1234	ERMS data - CDHB Data Warehouse eg M, F, U	ERMS data - CDHB Data Warehouse dd/mm/yyyy	ERMS data - CDHB Data Warehouse eg ACME Medical Centre	ERMS data - CDHB Data Warehouse eg Dr Joe Bloggs

Future directions

- CDHB expansion
 - Use cases
 - Users
 - Data source data element selection
 - Knowledge capture

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