OHDSI NLP WG Monthly Meeting

02/13/2019

Agenda

- Introduction of New Members
- Criteria2Query: a natural language interface to OMOP CDM databases for cohort identification – Chunhua Weng and Chi Yuan
- Ongoing projects
- Other issues

PRESENTATION

Criteria2Query: a natural language interface to OMOP CDM databases for cohort identification

Chunhua Weng and Chi Yuan

Criteria2Query: a natural language interface to OMOP CDM databases for cohort identification

Chi Yuan[1], Patrick B Ryan[1,2], Casey Ta[1], Yixuan Guo[1], Ziran Li[1], Jill Hardin[2], Rupa Makadia[2], Peng Jin[1], Ning Shang[1], Tian Kang[1], Chunhua Weng[1]

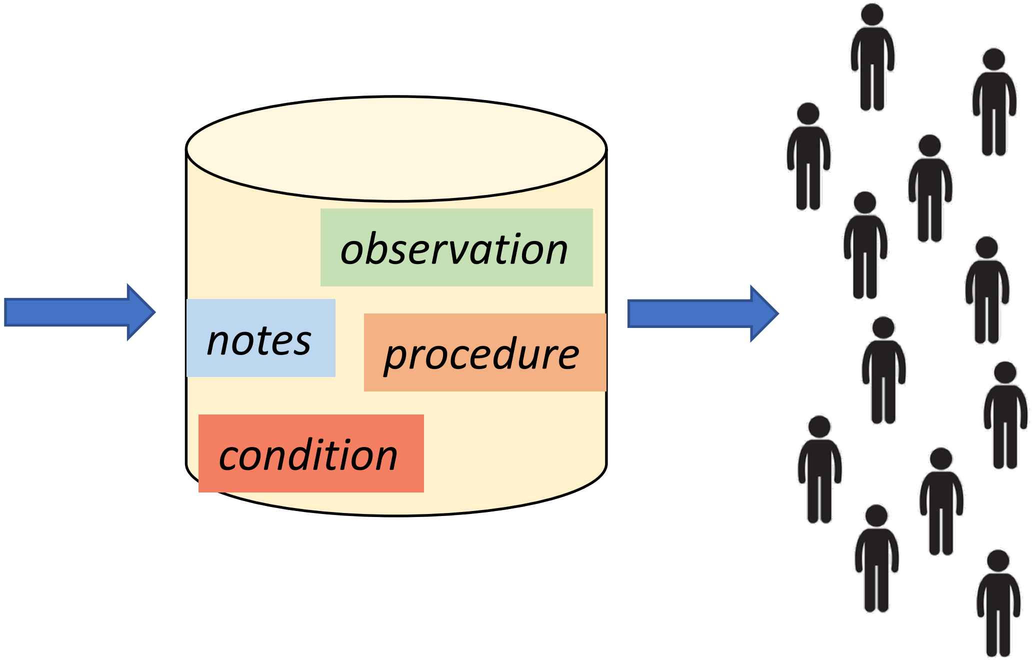
[1]Columbia University; [2]Janssen Inc.

February 12, 2019

Cohort identification

- Clinical diagnosis of ST-segment elevation acute myocardial infarction
- Must be treated within 12 hours after symptom onset
- Must be able to walk
- Must receive successful primary percutaneous coronary intervention

NCT01484158



Task breakdown

- Entity recognition: what is being searched for?
- Concept specification: what does it mean here?
- Concept mapping/normalization: how is it coded in a database?
- Phenotyping: what if the concept is implicitly represented?
- Data location: is it in the database? If yes, where? Which source is more reliable or convenient if there is > 1 source?
- Query formulation

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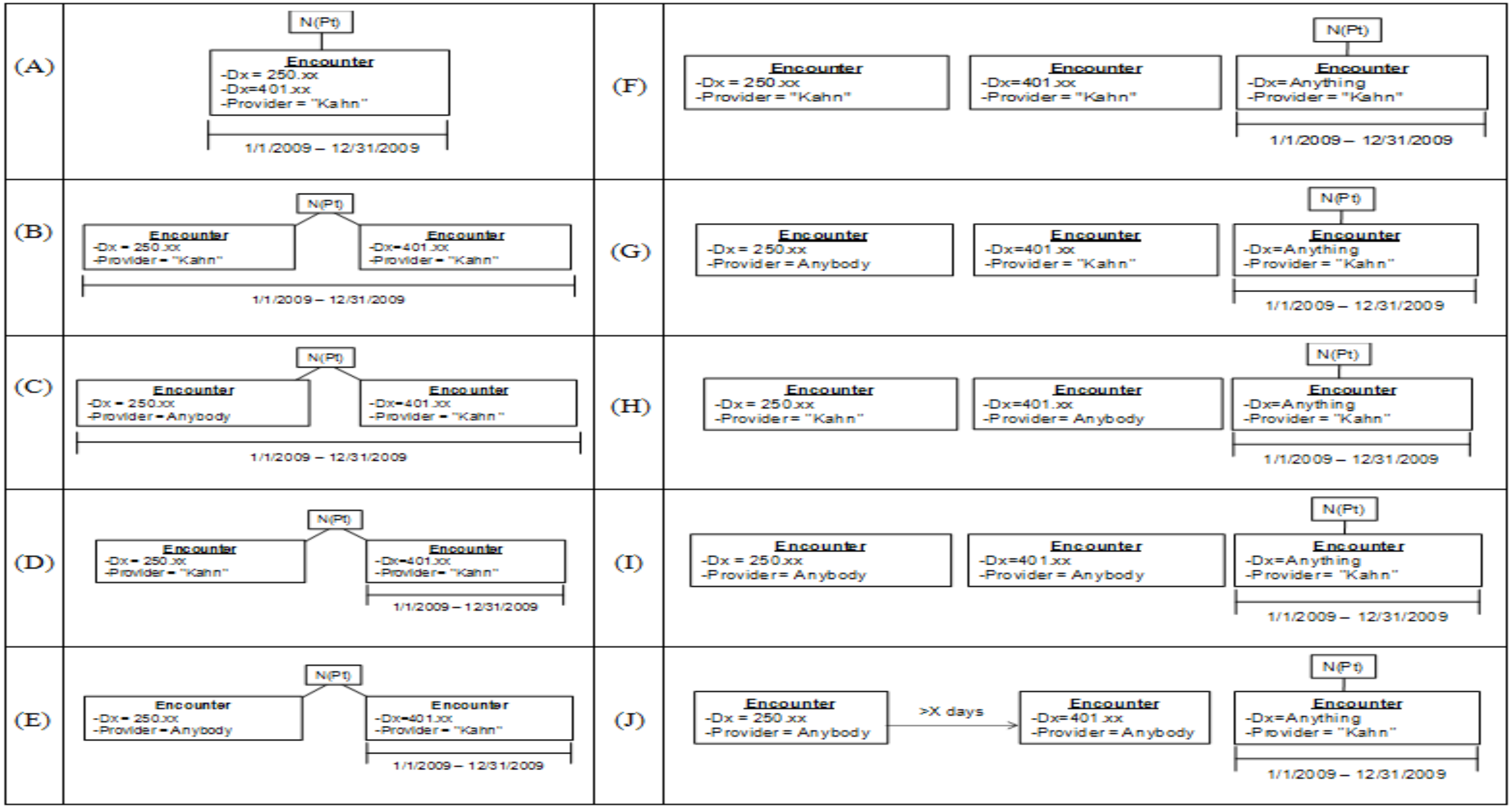
Ten Translations for One Criterion

e.g., "*ambulatory patients seen by Dr. Michael Kahn with diabetes mellitus and essential hypertension between 1/1/2009 and 12/31/2009?*"

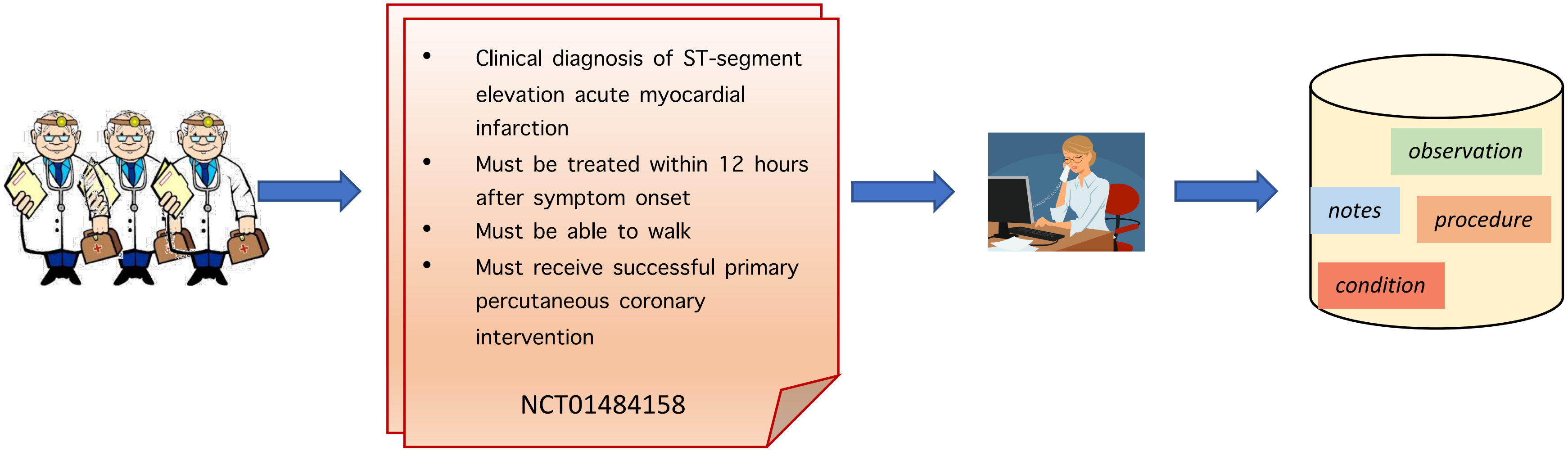
Table 1: Ten graphical diagrams representing the question: "How many ambulatory patients did I ("Provider = Kahn") see with diabetes mellitus (ICD-9 = 250.xx) and essential hypertension (ICD-9 = 401.xx) between January 1, 2009 and December 31, 2009?" Each diagram, when converted into a database query, returns a different result. N(Pt) = number of patients.



(A)	N(Pt) Encounter -Dx = 250.xx -Dx=401.xx -Provider = "Kahn" 1/1/2009 – 12/31/2009	(F)	Encounter -Dx = 250.xx -Provider = "Kahn" Encounter -Dx=401.xx -Provider = "Kahn" N(Pt) Encounter -Dx= Anything -Provider = "Kahn" 1/1/2009 – 12/31/2009
(B)	N(Pt) Encounter -Dx = 250.xx -Provider = "Kahn" Encounter -Dx=401.xx -Provider = "Kahn" 1/1/2009 – 12/31/2009	(G)	Encounter -Dx = 250.xx -Provider = Anybody Encounter -Dx=401.xx -Provider = "Kahn" N(Pt) Encounter -Dx=Anything -Provider = "Kahn" 1/1/2009 – 12/31/2009
(C)	N(Pt) Encounter -Dx = 250.xx -Provider = Anybody Encounter -Dx=401.xx -Provider = "Kahn" 1/1/2009 – 12/31/2009	(H)	Encounter -Dx = 250.xx -Provider= "Kahn" Encounter -Dx=401.xx -Provider= Anybody N(Pt) Encounter -Dx=Anything -Provider = "Kahn" 1/1/2009 – 12/31/2009
(D)	N(Pt) Encounter -Dx = 250.xx -Provider = "Kahn" Encounter -Dx=401.xx -Provider = "Kahn" 1/1/2009 – 12/31/2009	(I)	Encounter -Dx = 250.xx -Provider= Anybody Encounter -Dx=401.xx -Provider = Anybody N(Pt) Encounter -Dx=Anything -Provider= "Kahn" 1/1/2009 – 12/31/2009
(E)	N(Pt) Encounter -Dx = 250.xx -Provider = Anybody Encounter -Dx=401.xx -Provider = "Kahn" 1/1/2009 – 12/31/2009	(J)	Encounter -Dx = 250.xx -Provider = Anybody >X days Encounter -Dx=401.xx -Provider = Anybody N(Pt) Encounter -Dx=Anything -Provider = "Kahn" 1/1/2009 – 12/31/2009

--material from Dr. Michael G Kahn
Michael.Kahn@childrenscolorado.org

State of the art



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NCT01484158

observation

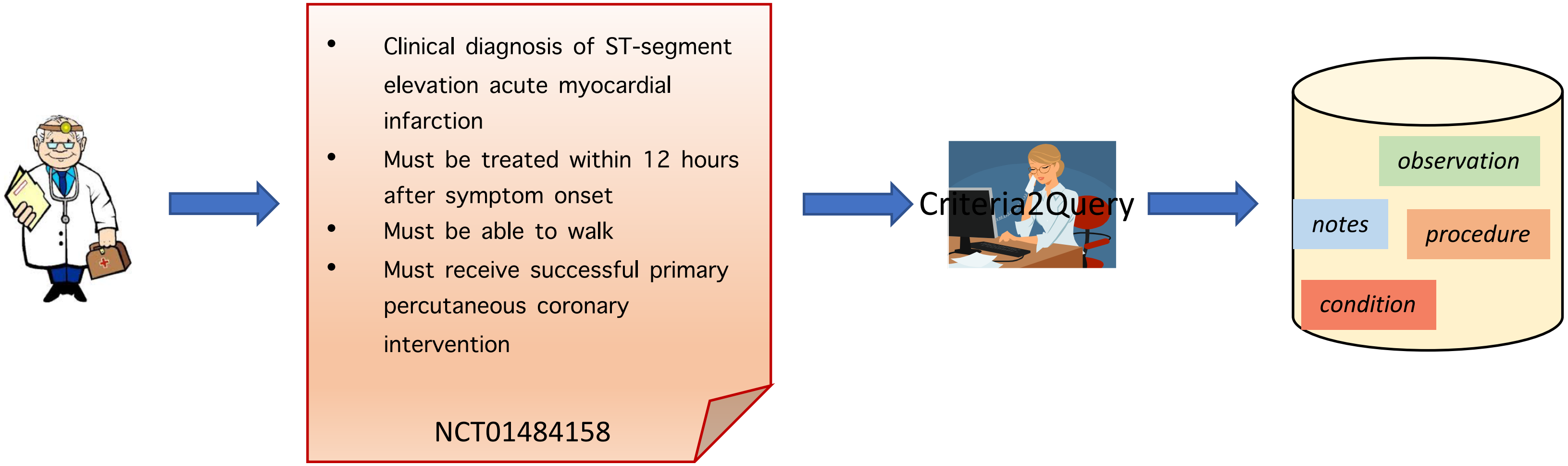
notes

procedure

condition

- High cost
- Long waiting time
- Fragmented knowledge
- Limited query reuse and knowledge sharing
- No autonomy for clinician scientist

The goal of Criteria2Query:
clinician autonomy with minimal effort



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NCT01484158

Criteria2Query

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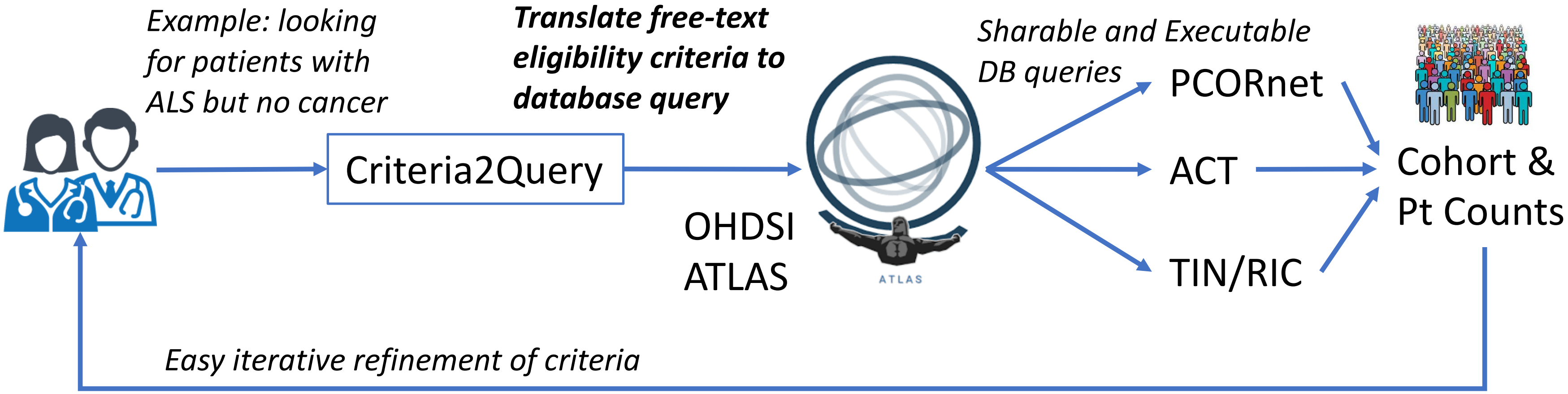
Currently focus on information retrieval (anything queryable),
not on phenotype knowledge engineering (anything that needs knowledge or inference)

Criteria2Query for reusable and sharable queries

Goal: minimize time needed from clinicians to translate English concepts to codes in ICD-9, SNOMED, LOINC, RxNorm, and etc., used by databases and enables rapid iterative feasibility assessment



Example: looking for patients with ALS but no cancer

Criteria2Query

Translate free-text eligibility criteria to database query

OHDSI ATLAS

Sharable and Executable DB queries

PCORnet

ACT

TIN/RIC

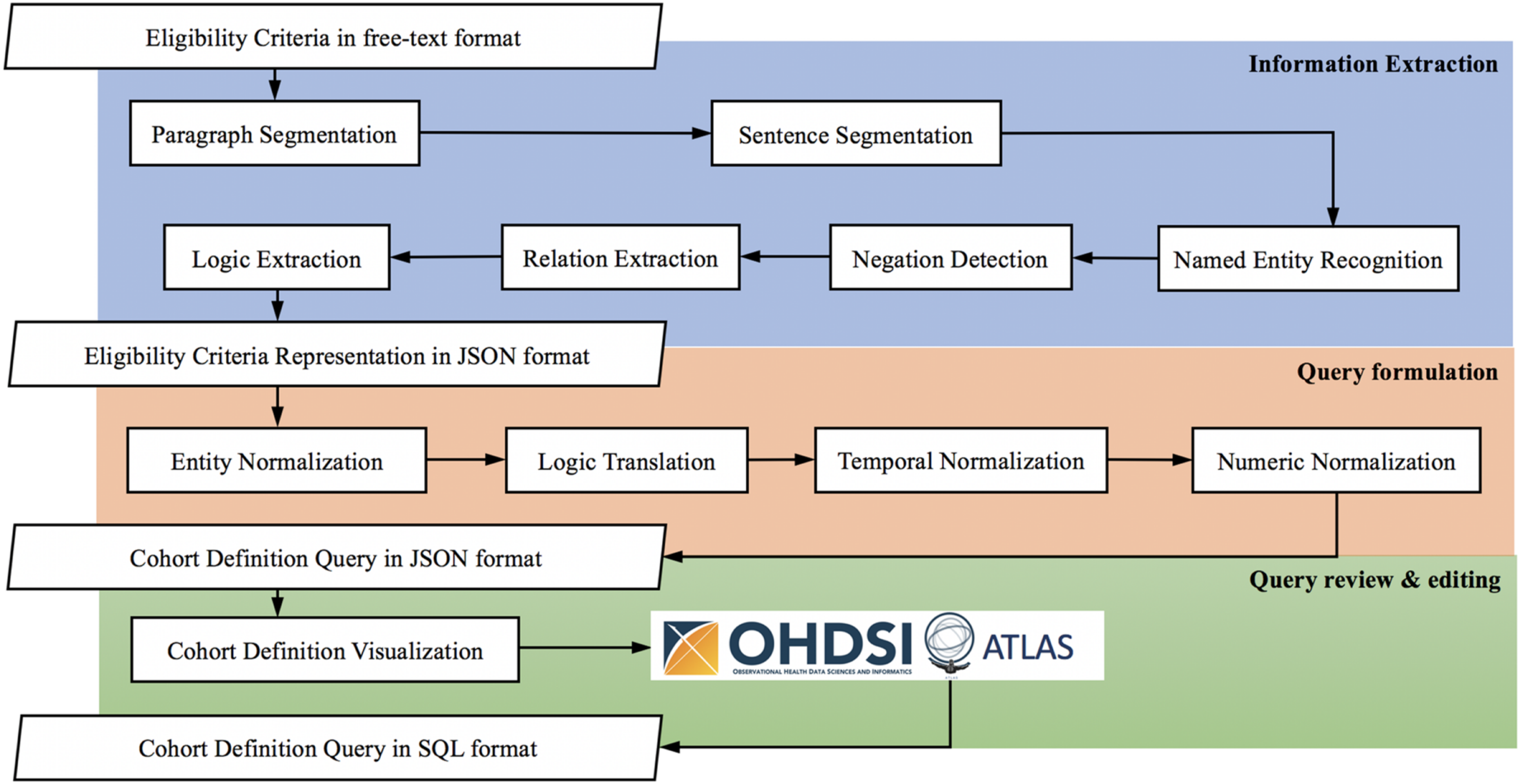
Cohort & Pt Counts

Easy iterative refinement of criteria

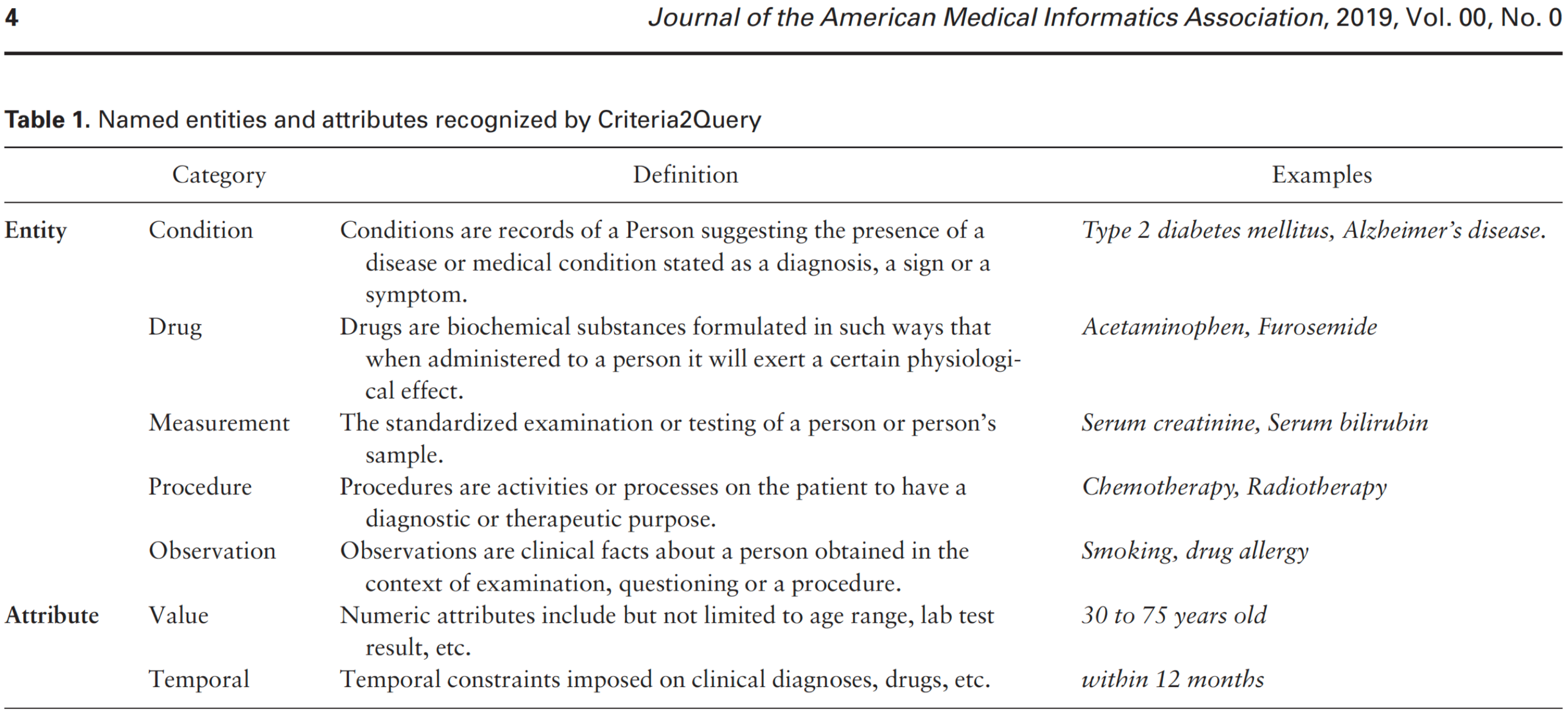
Brief demo

https://www.youtube.com/watch?v=EYN2Md-DCR8

The modular pipeline



NER (Named Entity Recognition)



4 *Journal of the American Medical Informatics Association*, 2019, Vol. 00, No. 0

Table 1. Named entities and attributes recognized by Criteria2Query

	Category	Definition	Examples
Entity	Condition	Conditions are records of a Person suggesting the presence of a disease or medical condition stated as a diagnosis, a sign or a symptom.	*Type 2 diabetes mellitus, Alzheimer's disease.*
	Drug	Drugs are biochemical substances formulated in such ways that when administered to a person it will exert a certain physiological effect.	*Acetaminophen, Furosemide*
	Measurement	The standardized examination or testing of a person or person's sample.	*Serum creatinine, Serum bilirubin*
	Procedure	Procedures are activities or processes on the patient to have a diagnostic or therapeutic purpose.	*Chemotherapy, Radiotherapy*
	Observation	Observations are clinical facts about a person obtained in the context of examination, questioning or a procedure.	*Smoking, drug allergy*
Attribute	Value	Numeric attributes include but not limited to age range, lab test result, etc.	*30 to 75 years old*
	Temporal	Temporal constraints imposed on clinical diagnoses, drugs, etc.	*within 12 months*

Relations Extraction

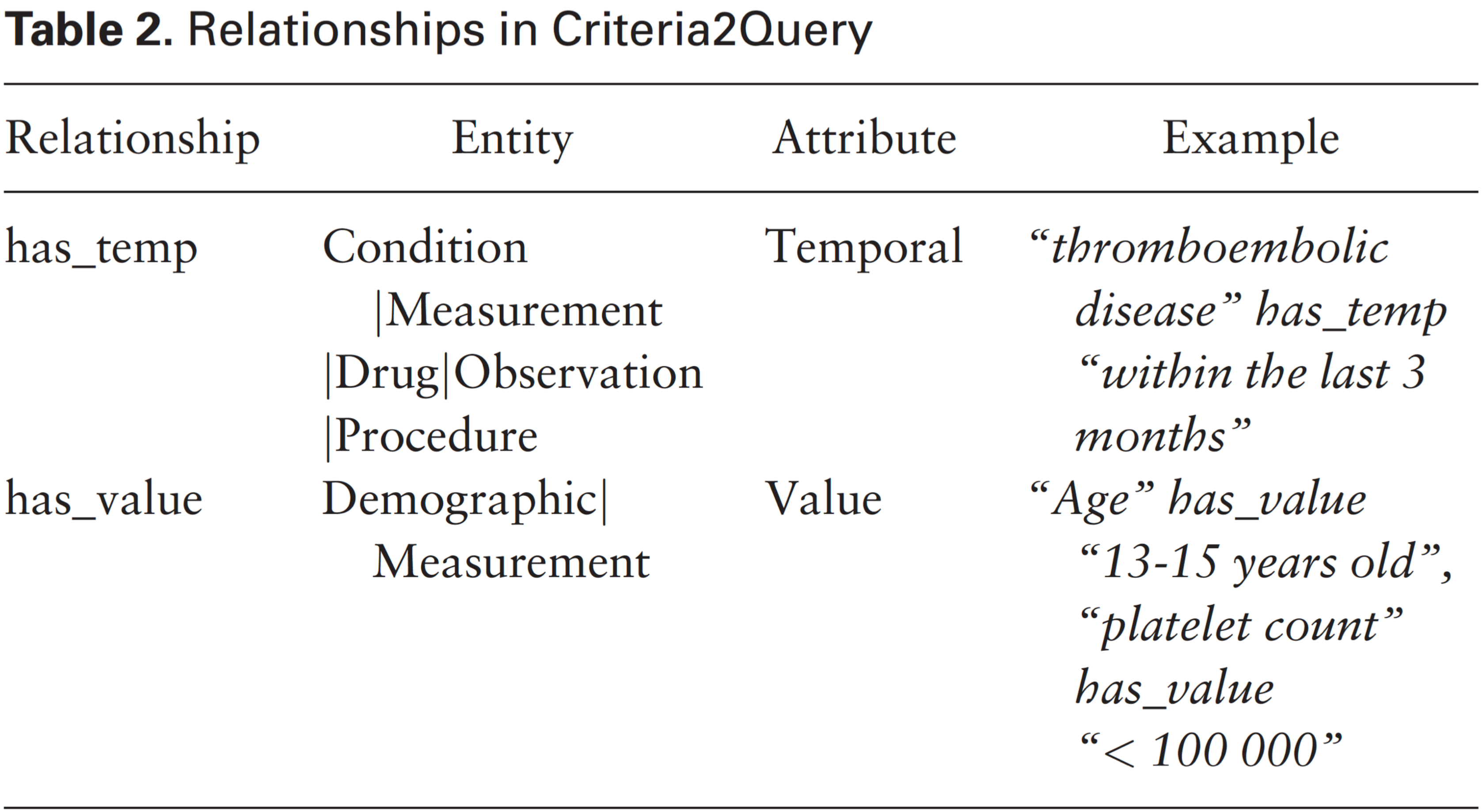
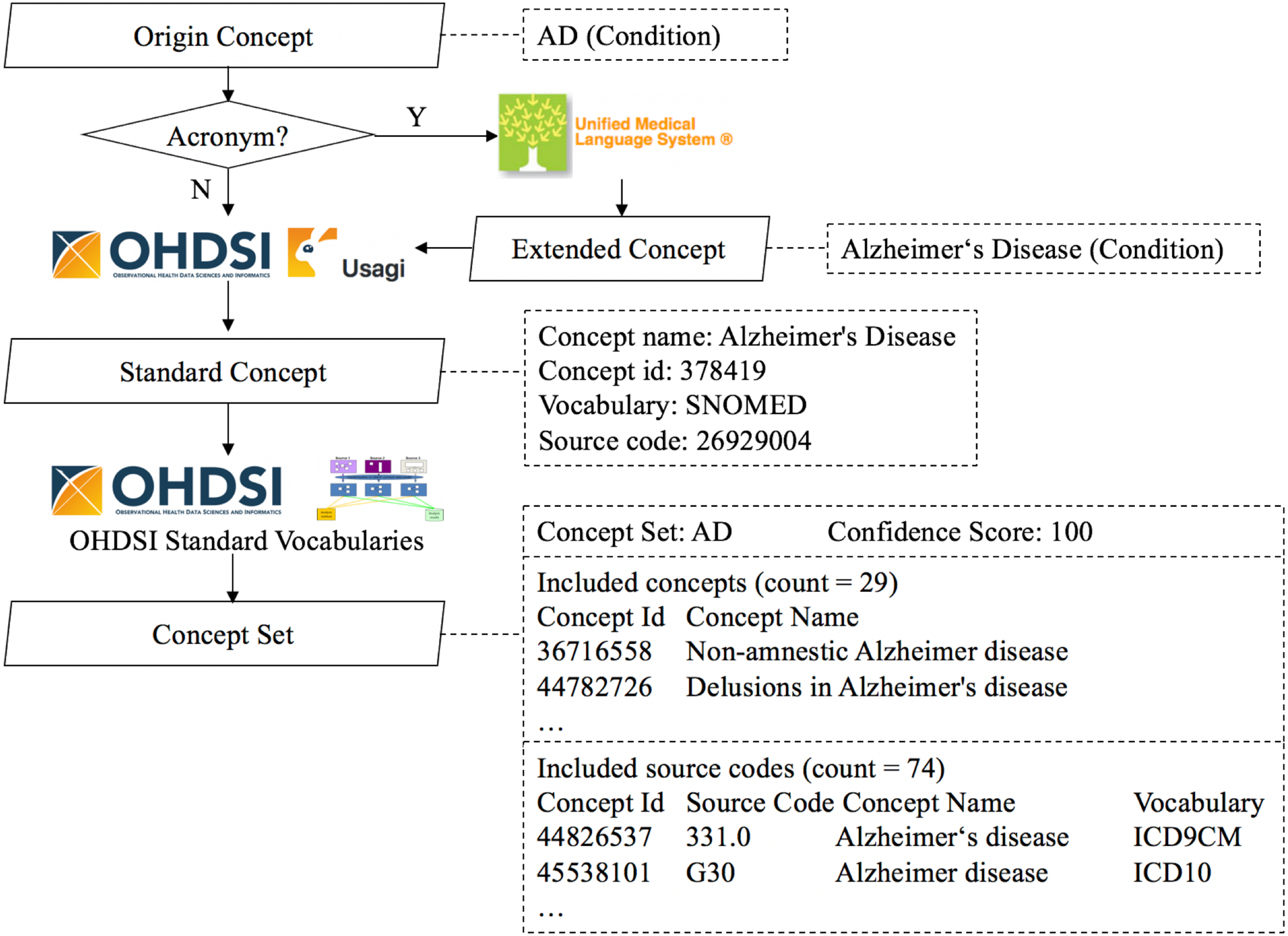


Table 2. Relationships in Criteria2Query

Relationship	Entity	Attribute	Example
has_temp	Condition |Measurement |Drug|Observation |Procedure	Temporal	*"thromboembolic disease" has_temp "within the last 3 months"*
has_value	Demographic| Measurement	Value	*"Age" has_value "13-15 years old", "platelet count" has_value "< 100 000"*

Entity normalization



Origin Concept
AD (Condition)
Acronym?
Y
Unified Medical Language System ®
N
OHDSI
Observational Health Data Sciences and Informatics
Usagi
Extended Concept
Alzheimer‘s Disease (Condition)
Standard Concept
OHDSI
Observational Health Data Sciences and Informatics
OHDSI Standard Vocabularies
Concept Set

Concept name: Alzheimer's Disease
Concept id: 378419
Vocabulary: SNOMED
Source code: 26929004

Concept Set: AD Confidence Score: 100

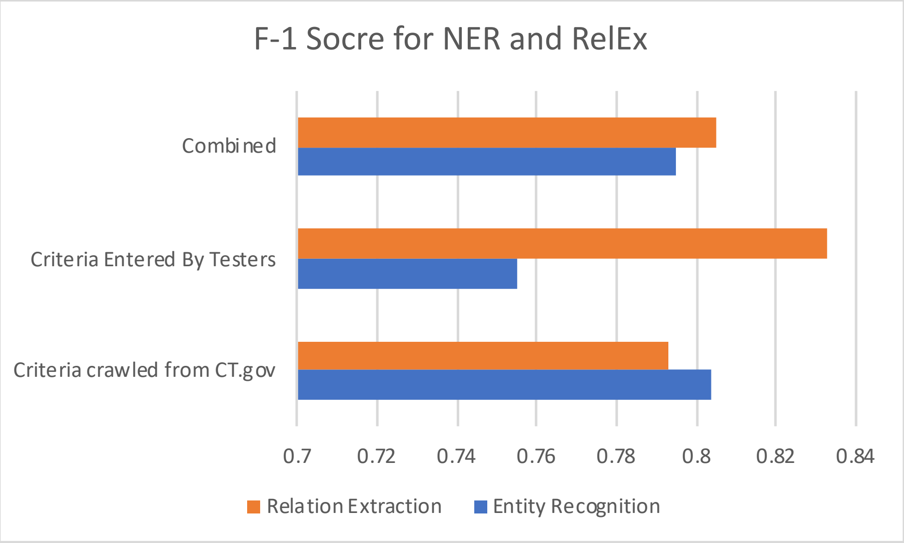
Included concepts (count = 29)

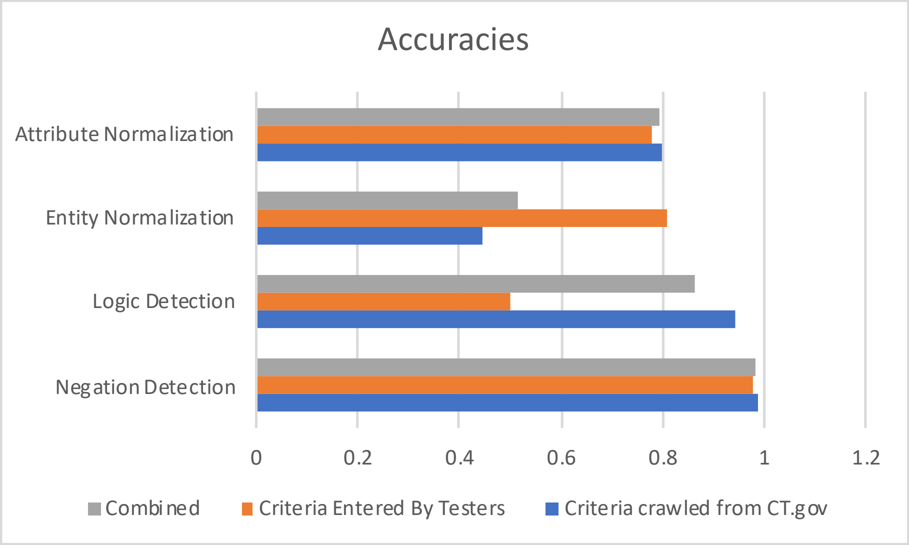
Concept Id	Concept Name
36716558	Non-amnestic Alzheimer disease
44782726	Delusions in Alzheimer's disease
…	

Included source codes (count = 74)

Concept Id	Source Code	Concept Name	Vocabulary
44826537	331.0	Alzheimer‘s disease	ICD9CM
45538101	G30	Alzheimer disease	ICD10
…			

Evaluation





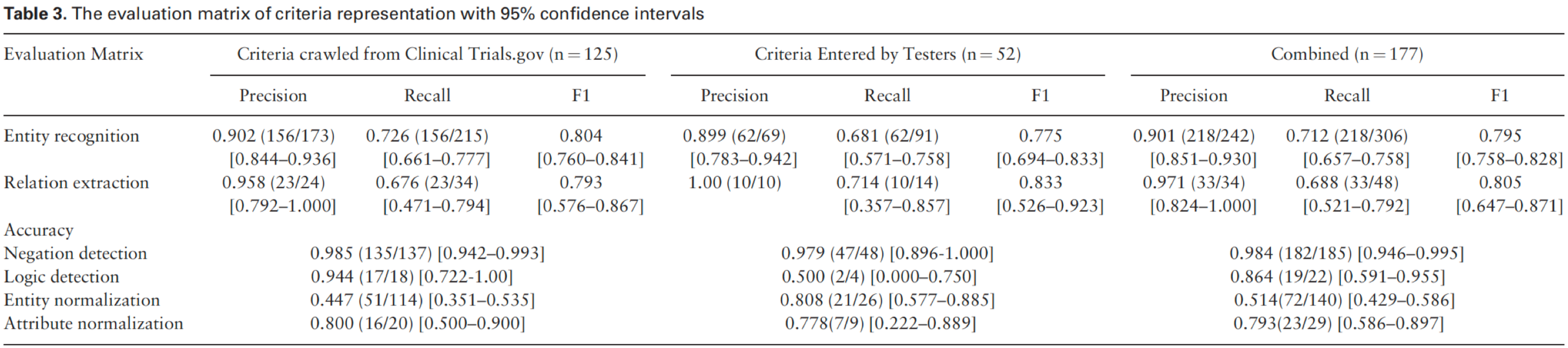


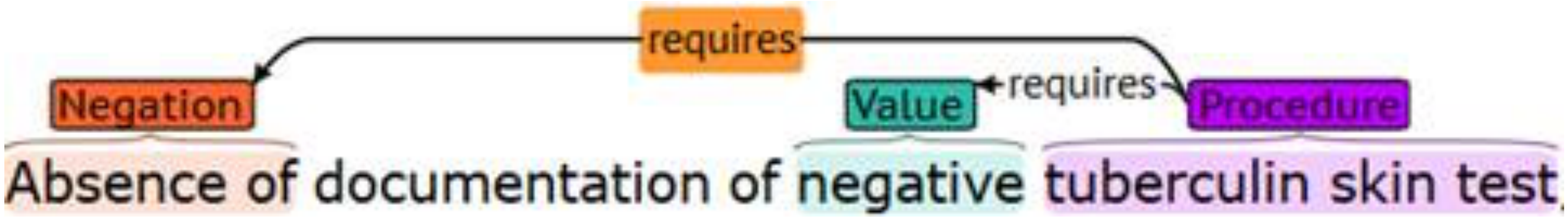
Table 3. The evaluation matrix of criteria representation with 95% confidence intervals

Evaluation Matrix	Criteria crawled from Clinical Trials.gov (n = 125)			Criteria Entered by Testers (n = 52)			Combined (n = 177)		
	Precision	Recall	F1	Precision	Recall	F1	Precision	Recall	F1
Entity recognition	0.902 (156/173) [0.844–0.936]	0.726 (156/215) [0.661–0.777]	0.804 [0.760–0.841]	0.899 (62/69) [0.783–0.942]	0.681 (62/91) [0.571–0.758]	0.775 [0.694–0.833]	0.901 (218/242) [0.851–0.930]	0.712 (218/306) [0.657–0.758]	0.795 [0.758–0.828]
Relation extraction	0.958 (23/24) [0.792–1.000]	0.676 (23/34) [0.471–0.794]	0.793 [0.576–0.867]	1.00 (10/10)	0.714 (10/14) [0.357–0.857]	0.833 [0.526–0.923]	0.971 (33/34) [0.824–1.000]	0.688 (33/48) [0.521–0.792]	0.805 [0.647–0.871]
Accuracy									
Negation detection	0.985 (135/137) [0.942–0.993]			0.979 (47/48) [0.896-1.000]			0.984 (182/185) [0.946–0.995]		
Logic detection	0.944 (17/18) [0.722-1.00]			0.500 (2/4) [0.000–0.750]			0.864 (19/22) [0.591–0.955]		
Entity normalization	0.447 (51/114) [0.351–0.535]			0.808 (21/26) [0.577–0.885]			0.514(72/140) [0.429–0.586]		
Attribute normalization	0.800 (16/20) [0.500–0.900]			0.778(7/9) [0.222–0.889]			0.793(23/29) [0.586–0.897]		

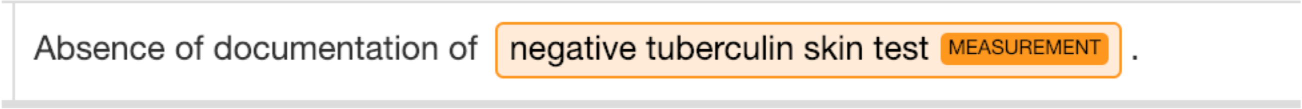
Error Analysis

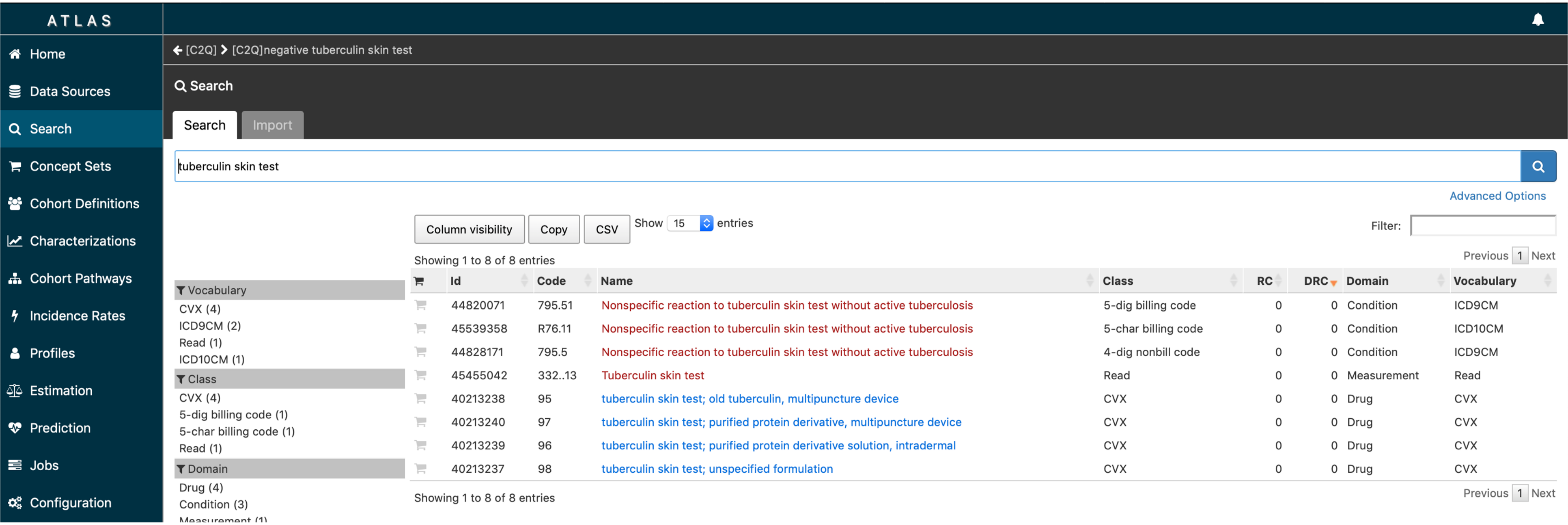
- Imperfect Information extraction results (NER, RelEx, Negation detection)
- Lack of medical knowledge, e.g., anti-inflammatory drugs, for concept normalization
- Incomplete concept coverage in OMOP CDM

Example Errors



Absence of documentation of negative tuberculin skin test


Absence of documentation of negative tuberculin skin test MEASUREMENT .



tuberculin skin test

Show 15 entries

Vocabulary
CVX (4)
ICD9CM (2)
Read (1)
ICD10CM (1)

Class
CVX (4)
5-dig billing code (1)
5-char billing code (1)
Read (1)

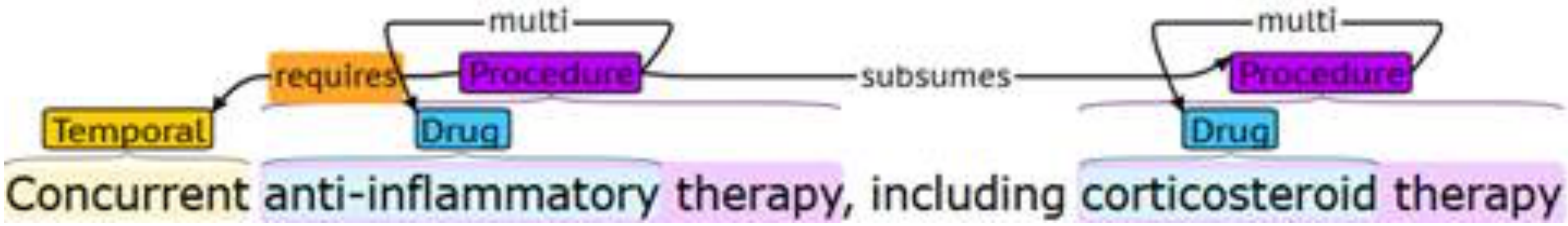
Domain
Drug (4)
Condition (3)
Measurement (1)

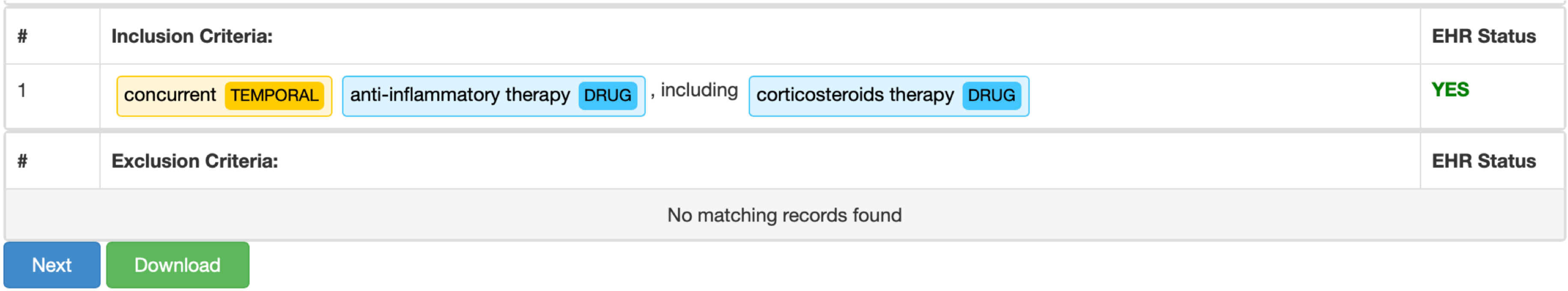
Showing 1 to 8 of 8 entries

Id	Code	Name	Class	RC	DRC	Domain	Vocabulary
44820071	795.51	Nonspecific reaction to tuberculin skin test without active tuberculosis	5-dig billing code	0	0	Condition	ICD9CM
45539358	R76.11	Nonspecific reaction to tuberculin skin test without active tuberculosis	5-char billing code	0	0	Condition	ICD10CM
44828171	795.5	Nonspecific reaction to tuberculin skin test without active tuberculosis	4-dig nonbill code	0	0	Condition	ICD9CM
45455042	332..13	Tuberculin skin test	Read	0	0	Measurement	Read
40213238	95	tuberculin skin test; old tuberculin, multipuncture device	CVX	0	0	Drug	CVX
40213240	97	tuberculin skin test; purified protein derivative, multipuncture device	CVX	0	0	Drug	CVX
40213239	96	tuberculin skin test; purified protein derivative solution, intradermal	CVX	0	0	Drug	CVX
40213237	98	tuberculin skin test; unspecified formulation	CVX	0	0	Drug	CVX

Showing 1 to 8 of 8 entries

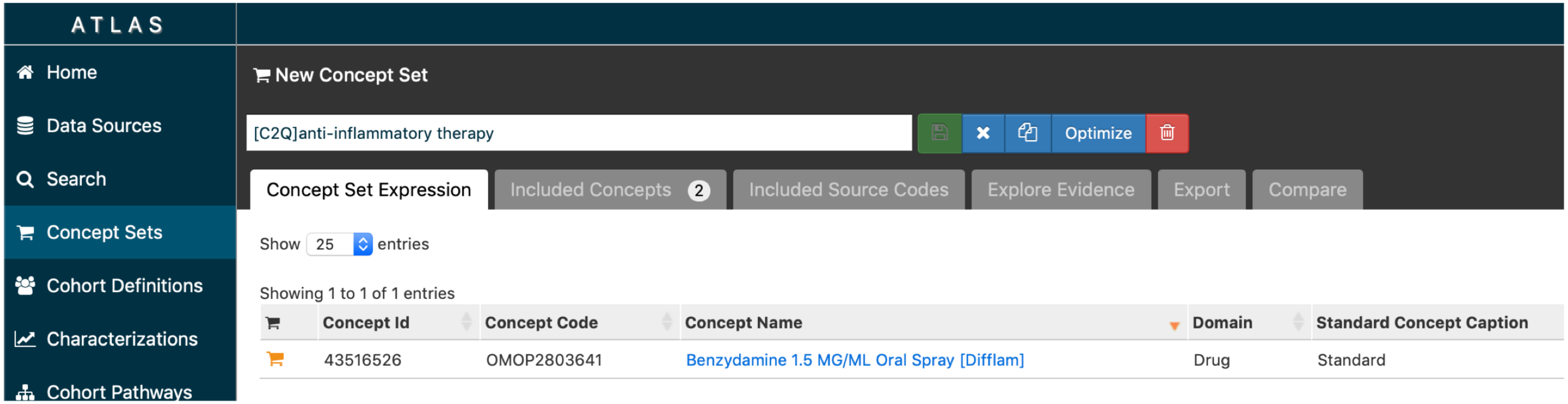
Example Errors


multi
requires
Procedure
subsumes
multi
Procedure
Temporal
Drug
Drug
Concurrent anti-inflammatory therapy, including corticosteroid therapy



#	Inclusion Criteria:	EHR Status
1	concurrent TEMPORAL anti-inflammatory therapy DRUG , including corticosteroids therapy DRUG	YES

#	Exclusion Criteria:	EHR Status
	No matching records found	



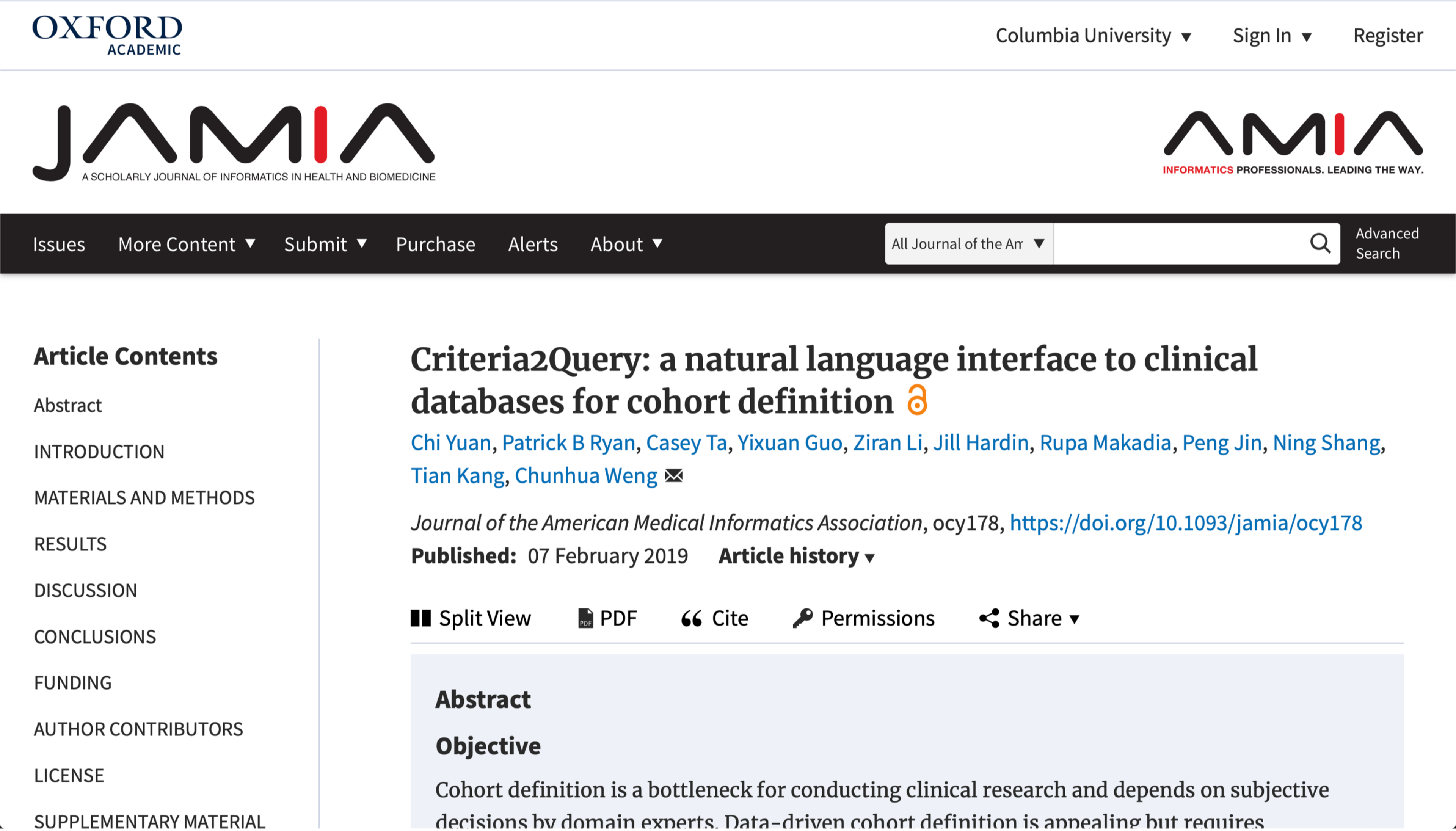
[C2Q]anti-inflammatory therapy

Show 25 entries

Showing 1 to 1 of 1 entries

	Concept Id	Concept Code	Concept Name	Domain	Standard Concept Caption
	43516526	OMOP2803641	Benzydamine 1.5 MG/ML Oral Spray [Difflam]	Drug	Standard

Preliminary Progress



Criteria2Query: a natural language interface to clinical databases for cohort definition

Chi Yuan, Patrick B Ryan, Casey Ta, Yixuan Guo, Ziran Li, Jill Hardin, Rupa Makadia, Peng Jin, Ning Shang, Tian Kang, Chunhua Weng ✉

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Published: 07 February 2019 **Article history** ▾

Abstract

Objective

Cohort definition is a bottleneck for conducting clinical research and depends on subjective decisions by domain experts. Data-driven cohort definition is appealing but requires

https://doi.org/10.1093/jamia/ocy178

Open source resources

- Introduction https://www.youtube.com/watch?v=EYN2Md-DCR8
- Open source: https://github.com/OHDSI/Criteria2Query
- Online system: http://www.ohdsi.org/web/criteria2query/
- Feedback or inquiries: https://gitter.im/Criteria2query/Lobby#

Contributions

- An early natural language interface to clinical database
- An open-source pipeline with modular architecture

Ongoing work for collaboration

- Richer annotated corpus of criterion text
- State of the art NLP methods application
- More intelligent concept set recommendation
- More user-friendly interactive design

Ongoing projects

- Mapping of Note Types to LOINC/standard vocabulary – Karthik Natarajan, Ruth Reeves, and Jon Duke
- Landscape Analysis of section identifier systems and proposal of a standard terminology for use – Hua Xu and Karthik Natarajan
- Mapping of CUIs to standard terminology – Juan Banda
- Standardization of term_modifiers and values – Hua Xu
- Evaluate and revise textual CDM tables by sharing practical issues and lessons learnt during ETL for processing textual data into CDM – Ruth Reeves, others?
- Develop tools (within Atlas) to facilitate uses of NLP data for cohort building/phenotyping : Collaborate with eMERGE consortium:
- Conduct cross-site studies that use textual data
- Continue developing other NLP resources

Other issues

- Meeting formats : Presentation followed by updates on ongoing projects
- Presentation scheduling
  - March 13th – Yuan Luo – eMERGE collaboration
  - April 10th – Jon Duke – ClarityNLP
  - May 8th – Juan Banda - CUI mapping, ongoing work – Juan, Stephan Meyestre – tool to evaluate NLP systems
  - June 12th
  - July 10th
- Please let us know if you can present your related work at any of the above meetings.