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AND MASSACHUSETTS GENERAL HOSPITAL

Importing Continuity of Care Documents into i2b2 and SMART

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- **Disclosure**

- The speaker discloses that he has no relationships with commercial interests.
- The speaker receives funding from the NIH and ONC.

- **Learning Objective**

- After participating in this activity the learner should be better able to:
 - Use standards-based clinical documents for “live refresh” of patient information for clinical research.

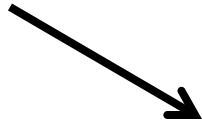
Outline

- **Introduction**
- **Methods**
- **Results**
- **Discussion / Conclusion**

Consolidated Clinical Document Architecture



C-CDA



MU2 CCD Profile

- Demographics
- Vitals
- Current List Of...
 - Problems
 - Medications
 - Allergies
 - Immunizations
- Procedures
- Family History
- Plan of Care
- Smoking, cognitive, and functional status

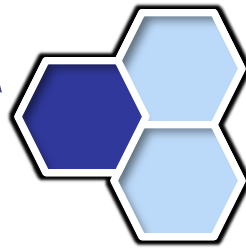
...



75,000/day

The i2b2 Clinical Data Analytics Software

**EHR
Product**



i2b2

Query Tool

Query Name: _____

Temporal Constraint:

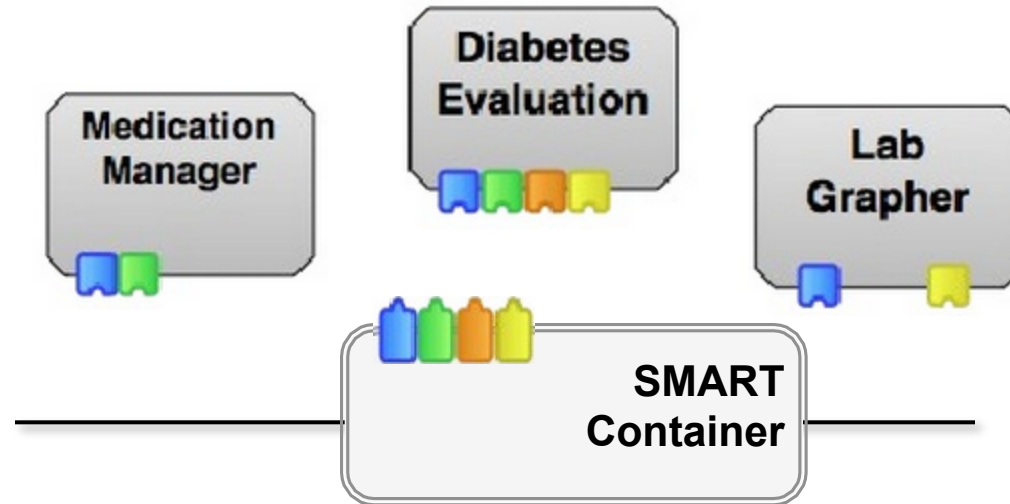
Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		
18-34 years old 35-44 years old 45-54 years old 55-64 years old			Diabetes mellitus					

one or more of these AND one or more of these AND drop a term on here

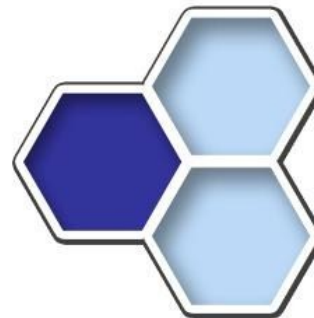
Run Query Clear Print Query 2 Groups New Group



- Substitutable Medical Apps, Reusable Technologies



EHR Product



i2b2

SMART-i2b2

SMART-i2b2

View Patient with SMART Apps

SMART EMR View

Problems List

Q	NAME	▲ START DATE ▼	END DATE
	Acute bronchitis (disorder)	2009-11-17	2009-11-17
	Aftercare for healing traumatic fracture of other bone	2008-11-24	2008-11-24
S	Alopecia, unspecified	2001-09-13	2001-09-13
	Fracture of metatarsal bone(s), closed	2008-11-25	2008-11-26
M	Pernicious anemia (disorder)	2009-11-17	2009-11-17
O	Seizure (finding)	2008-11-25	2008-11-25
	Seizure (finding)	2008-11-24	2008-11-24
S	Urinary incontinence (finding)	2009-11-17	2009-11-17

Meds List

Q	DRUG NAME	START DATE	END DATE
▶	lamotrigine 100 MG Oral Tablet [Lamictal]	2000-07-26	2001-04-20
▶	ProStep 22 mg/24 hr film extended release Lederle Laboratories	2001-05-29	2001-05-29
▶	lamotrigine 100 MG Oral Tablet [Lamictal]	2001-06-08	2001-06-08
▶	Aminophylline 200 MG Oral Tablet	2001-08-07	2001-08-07
▶	lamotrigine 100 MG Oral Tablet [Lamictal]	2001-08-07	2001-08-07
▶	Oxybutynin chloride 5 MG Oral Tablet	2001-11-04	2001-11-04

Labs List

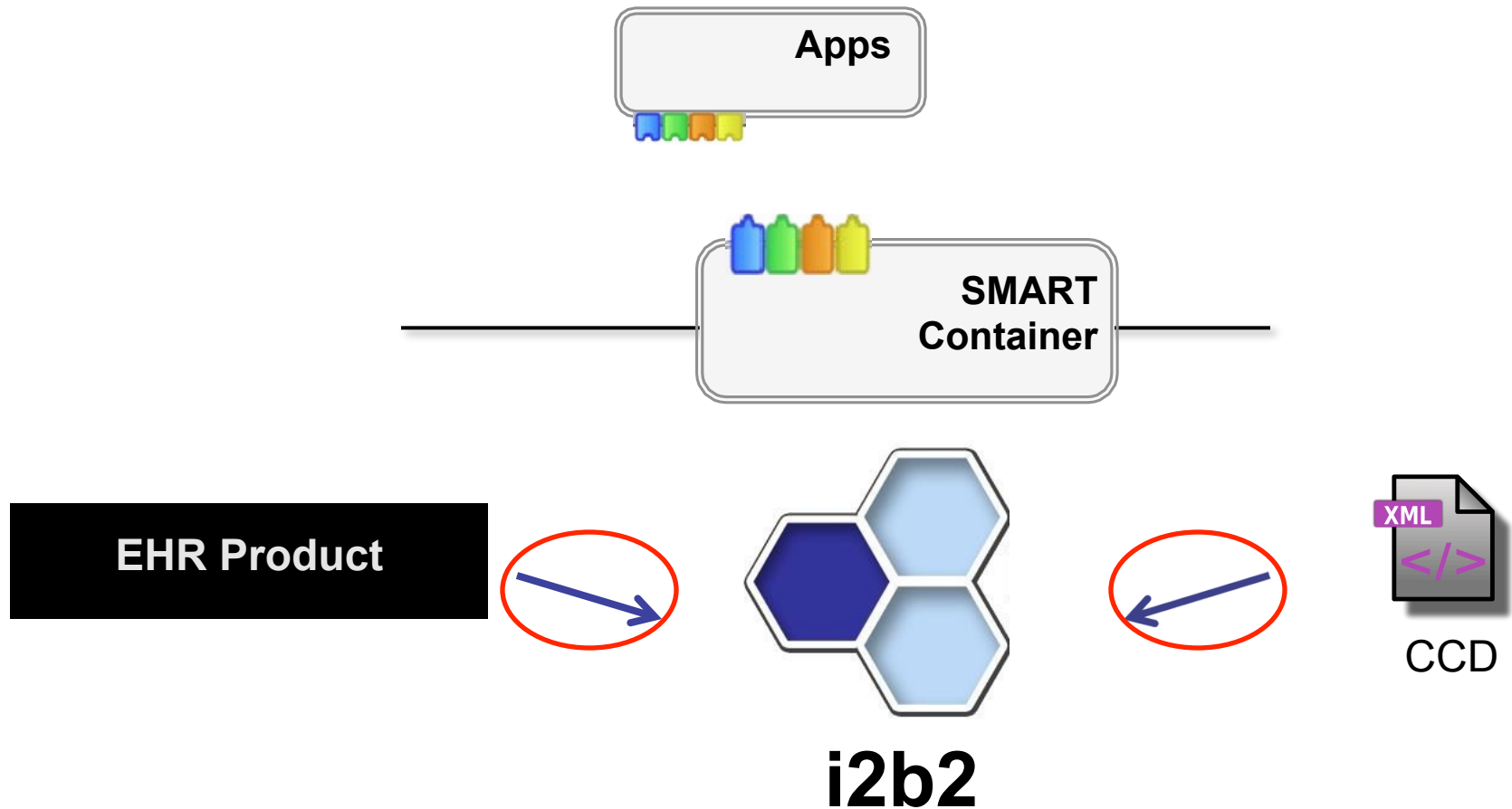
Q	NAME	▲ DATE ▼	◆ VALUE	UNIT
	HCT (Group:HCT)	2001-08-21	39	%
	HCT (Group:HCT)	2001-10-16	39	%
	HCT (Group:HCT)	2003-01-31	33	%
	HCT (Group:HCT)	2006-02-27	37	%

Drop a new patient record here to load it.

▼ WBC (Group:WBC) (6690-2)

CCD “Live Refresh”

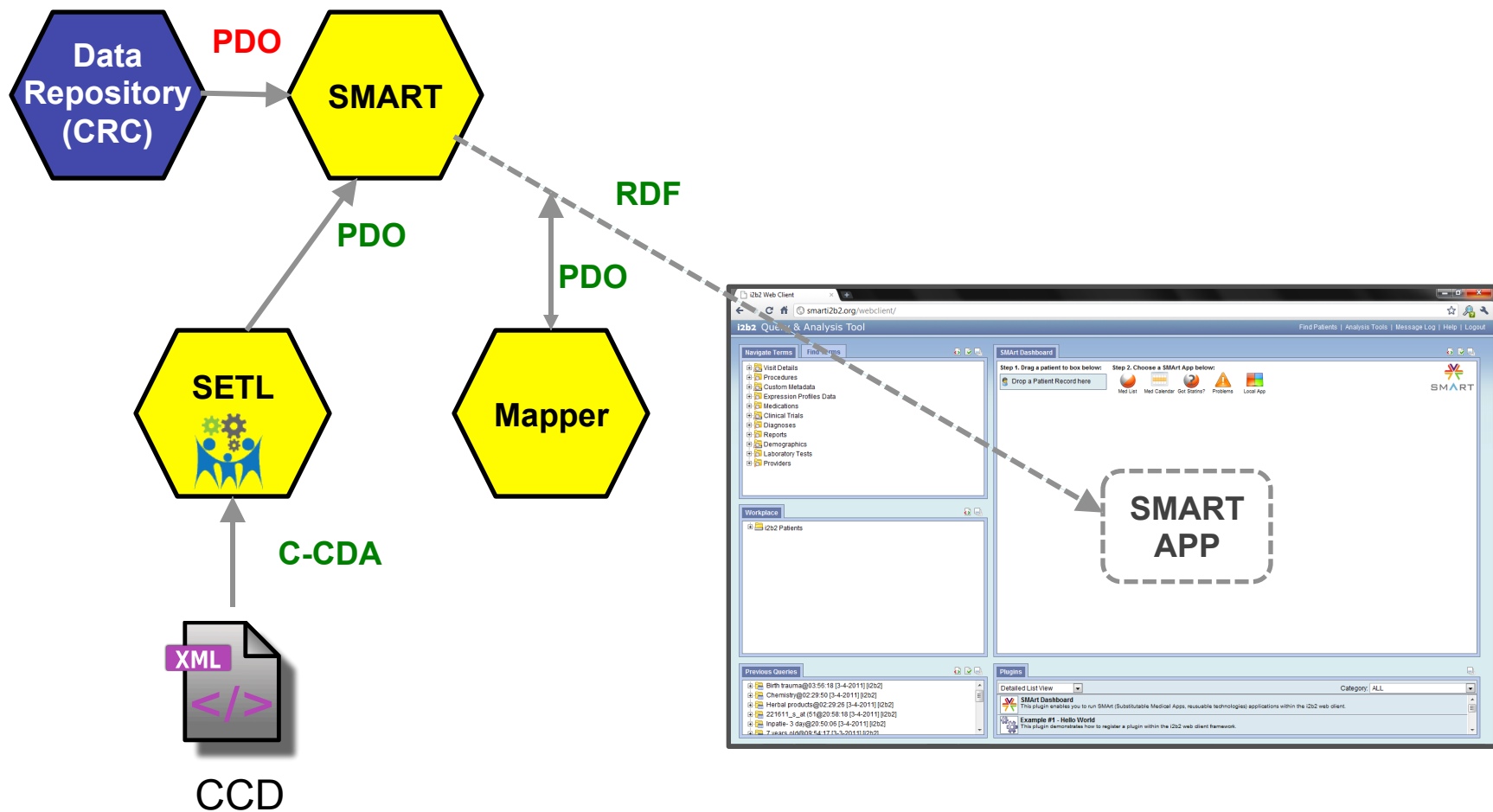
- Combine ETL with on-demand update



Outline

- Introduction
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i2b2 and SMART with Standards ETL



Red = Local Codes

Green = Standard Terminologies

C-CDA to PDO

```
<ClinicalDocument>
  <recordTarget>
    <patientRole>
      → <id root="1.3.6.1.4.1.16517.1" extension="100001"/>
    </patientRole>
  </recordTarget>
  <component>
    <structuredBody>
      <component>
        <section>
          <templateId
            root="2.16.840.113883.10.20.22.2.5.1"/>
          <entry>
            <act>
              <effectiveTime>
                → <low value="19960420"/>
              </effectiveTime>
              <entryRelationship>
                <observation>
                  <templateId
                    root="2.16.840.113883.10.20.22.4.4"/>
                  <value>
                    → code="22298006"
                      codeSystem="2.16.840.1.113883.6.96"/>
                </observation>
              </entryRelationship>
            </act>
          </entry>
        </section>
      </component>
    </structuredBody>
  </component>
</ClinicalDocument>
```

```
<observation>
  <event_id></event_id>
  <patient_id></patient_id>
  <concept_cd></concept_cd>
  <observer_cd></observer_cd>
  <start_date></start_date>
  <end_date></end_date>
  <location_cd></location_cd>
</observation>
```

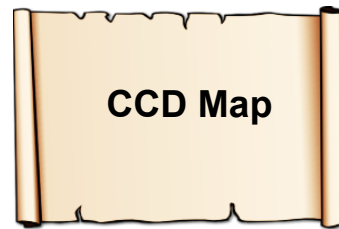
```
<observation>
  <event_id></event_id>
  <patient_id>100001</patient_id>
  <concept_cd>SNOMED:22298006</concept_cd>
  <observer_cd></observer_cd>
  <start_date>1996-04-20</start_date>
  <end_date></end_date>
  <location_cd></location_cd>
</observation>
```

Model Driven Message Interoperability



**Open Health
Tools**

**MDMI
Engine**



CCD Map



i2b2 Map



**Common
Index**



**Continuity of
Care Documents**



**I2b2 PDO
Message**

MDMI CCD Map

The screenshot displays the MDMI Map Editor interface. The title bar reads "MDMI Map Editor - /Users/jklann/Dropbox/MDMI-i2b2/Ken-prototype/032714/ccda327-jgk.xml". The menu bar includes "File", "Edit", "View", "Tools", and "Help". A toolbar with various icons is located below the menu bar.

The left pane shows a hierarchical tree view of the CCD map structure. The tree is expanded to show the following elements under "component":

- component : Component [Container]
 - AllergiesSection : AllergiesSection [Container]
 - problemSection : ProblemSection [Container]
 - templatedId : ProblemSectiontemplatedId [InstanceIdentifier]
 - code : ProblemSection_code [CodedElement]
 - title : ProblemSectionTitle [String]
 - ProblemAct : ProblemAct [Container]
 - ProblemActClassCode : ProblemActClassCode [String]
 - ProblemActMoodCode : ProblemActMoodCode [String]
 - ProblemActTemplatedId : ProblemActTemplatedId [InstanceIdentifier]
 - ProblemActId : ProblemActId [InstanceIdentifier]
 - ProblemActCode : ProblemActCode [CodedElement]
 - ProblemActStatusCode : ProblemActStatusCode [CodedElement]
 - ProblemConcernEffectiveTime : ProblemConcernEffectiveTime [DateRange]
 - low : low [DateTime]
 - ProblemPerformerEntityId : ProblemPerformerEntityId [InstanceIdentifier]
 - ProblemPerformerEntityAddress : ProblemPerformerEntityAddress [Address]
 - ProblemPerformerEntityTelecom : ProblemPerformerEntityTelecom [Telecom]
 - ProblemParticipantTemplatedId : ProblemParticipantTemplatedId [InstanceIdentifier]
 - ProblemAwarenessPatientCode : ProblemAwarenessPatientCode [CodedElement]
 - ProblemParticipantId : ProblemParticipantId [InstanceIdentifier]
 - ProblemParticipantAddress : ProblemParticipantAddress [Address]
 - ProblemParticipantTelecom : ProblemParticipantTelecom [Telecom]
 - participantTypeCode : ProblemParticipantTypeCode [String]
 - ProblemObservation : ProblemObservation [Container]
 - typeCode : ProblemObservationtypeCode [String]
 - classcode : ProblemObservationclasscode [String]
 - moodcode : ProblemObservationmoodcode [String]
 - ProblemObservationTemplatedId : ProblemObservationTemplatedId [InstanceIdentifier]
 - ProblemObservationID : ProblemObservationID [InstanceIdentifier]
 - ProblemObservationCode : ProblemObservationCode [CodedElement]
 - FreeText : ProblemNameFreeText [String]
 - ProblemObservationStatusCode : ProblemObservationStatusCode [CodedElement]
 - ProblemObservationEffectiveTime : ProblemObservationEffectiveTime [DateRange]

The right pane shows the detailed configuration for the selected "ProblemObservationType" element. The "Bag" container is visible with a search field containing "ProblemObservationType". The configuration fields are:

- Name: ProblemObservationType
- Field Name: [Empty]
- Description: [Empty]
- Location: observation/value
- Location Expression Language: XPath
- Unique
- Ordered
- Min Occurs: 0
- Max Occurs: [Empty] Unbounded
- Semantic Element: ProblemObservationType
- Parent Node: ProblemObservation

At the bottom of the right pane, there are tabs for "Console" and "Errors".

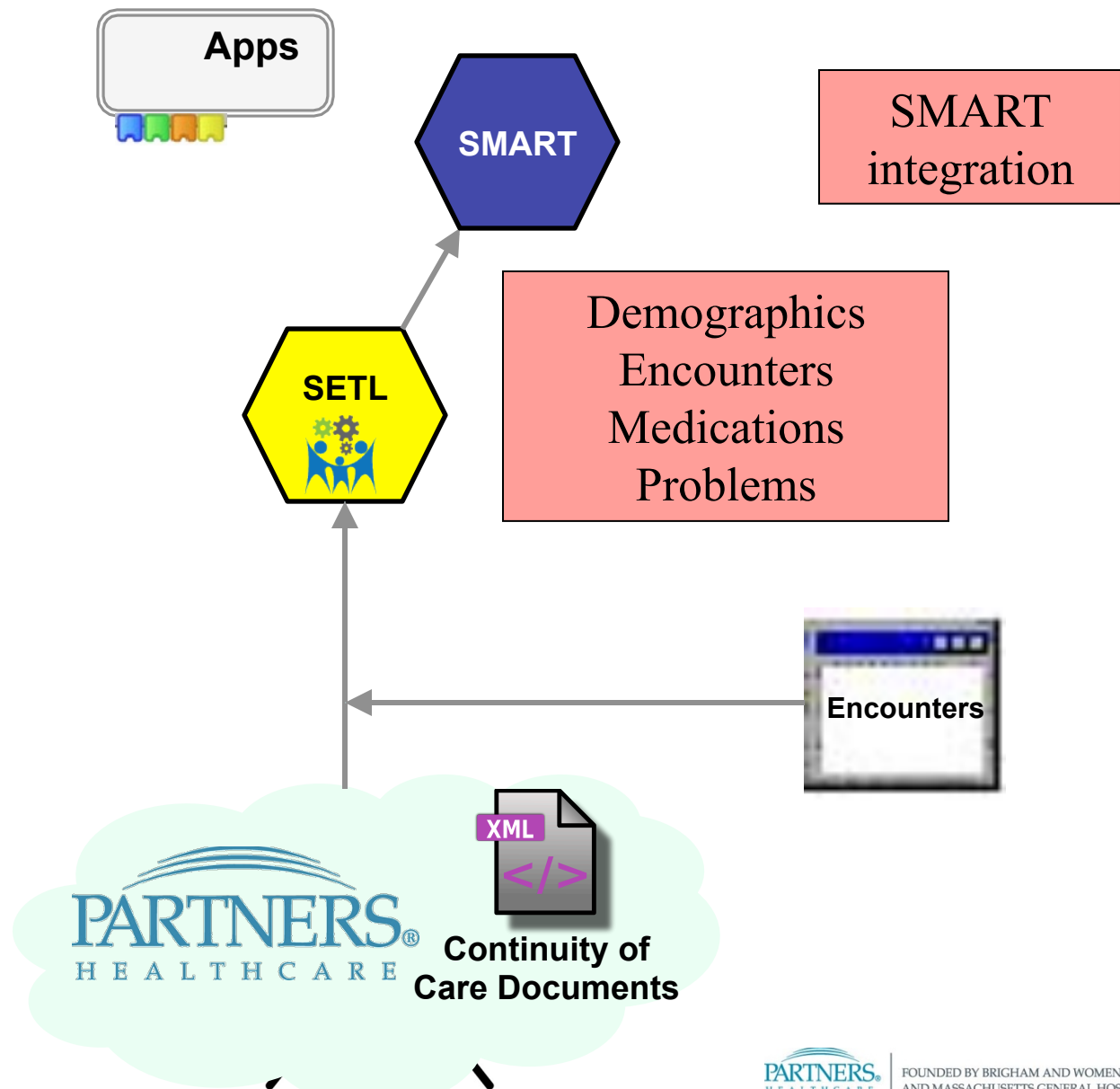
MU2 CCD Profile

- **Demographics**
- Vitals
- Current List Of...
 - **Problems**
 - **Medications**
 - Allergies
 - Immunizations
- Procedures
- Family History
- Plan of Care
- Smoking, cognitive, and functional status
- ...
- **Encounter notes**

Outline

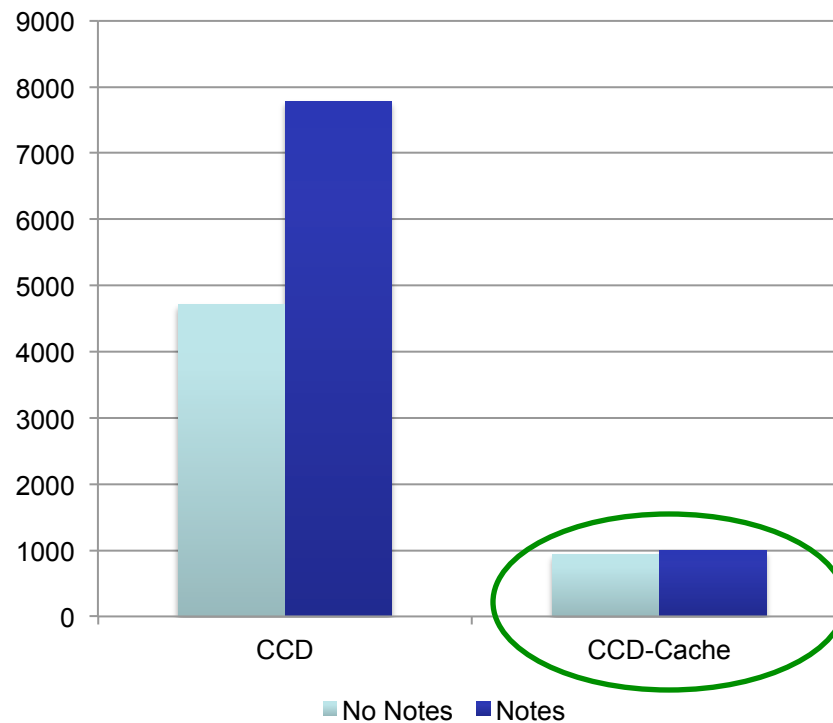
- Introduction
- Methods
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Results: Pipeline





Results: speed

- Once a CCD is cached, retrieval speed is ~1s




Result Screenshots

Problems List 			
NAME	START DATE	END DATE	
Alzheimer's disease	2012-10-24	2012-10-24	
Ankle pain	2013-05-24	2013-05-24	
Arthritis	2013-05-24	2013-05-24	
Asthma	2013-05-24	2013-05-24	
Type 2 diabetes mellitus	2013-05-24	2013-05-24	

Meds List 			
DRUG NAME	START DATE	END DATE	
▶ Aspirin 325 MG Enteric Coated Tablet	2012-11-29	2012-11-29	
▶ Amoxicillin 250 MG Oral Capsule	2013-05-24	2013-05-24	
▶ prednisolone 5 MG/ML Oral Solution	2013-05-24	2013-05-24	
▶ Acetaminophen 325 MG Oral Tablet	2013-05-24	2013-05-24	

Result Screenshots

Notes Viewer 

Display note in results below

Date	Title	Type
2013-11-20	Office Note by SMITH,BELLA on 2013-11-20T00:00:00.000-05:00	text/plain
2010-04-01	Patient Note by TEST,LMR_LCS13,M.D. on 2010-04-01T00:00:00.000-04:00	text/plain
2010-09-01	Patient Note by TEST,LMR_LCS13,M.D. on 2010-09-01T00:00:00.000-04:00	text/plain
2010-10-26	Pedi Neurosurgery Consult Note by SMITH,ANN,M.D. on 2010-10-26T00:00:00.000-04:00	text/plain
2010-11-16	Patient Note by TEST,VIEW_M.D. on 2010-11-16T00:00:00.000-05:00	text/plain
2010-11-22	Correspondence:Scanned by TEST,VIEW_M.D. on 2010-11-22T00:00:00.000-05:00	text/plain
2011-10-07	Office Note by SMITH,MATTHEW on 2011-10-07T00:00:00.000-04:00	text/plain

Result Screenshots

Patient Centric View Patient Number: 100000001

Notes Viewer

Chief Complaint

Advised patient to monitor the condition for 24 to 48 hours using the prescribed medication. Told patient to schedule an office visit.

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testPhysical Exam General Appearance

NormalSkin

NormalHead

testEyes

testTanner Stage 2

Testes descended? N

Circumcised? N

Assessment and Plan

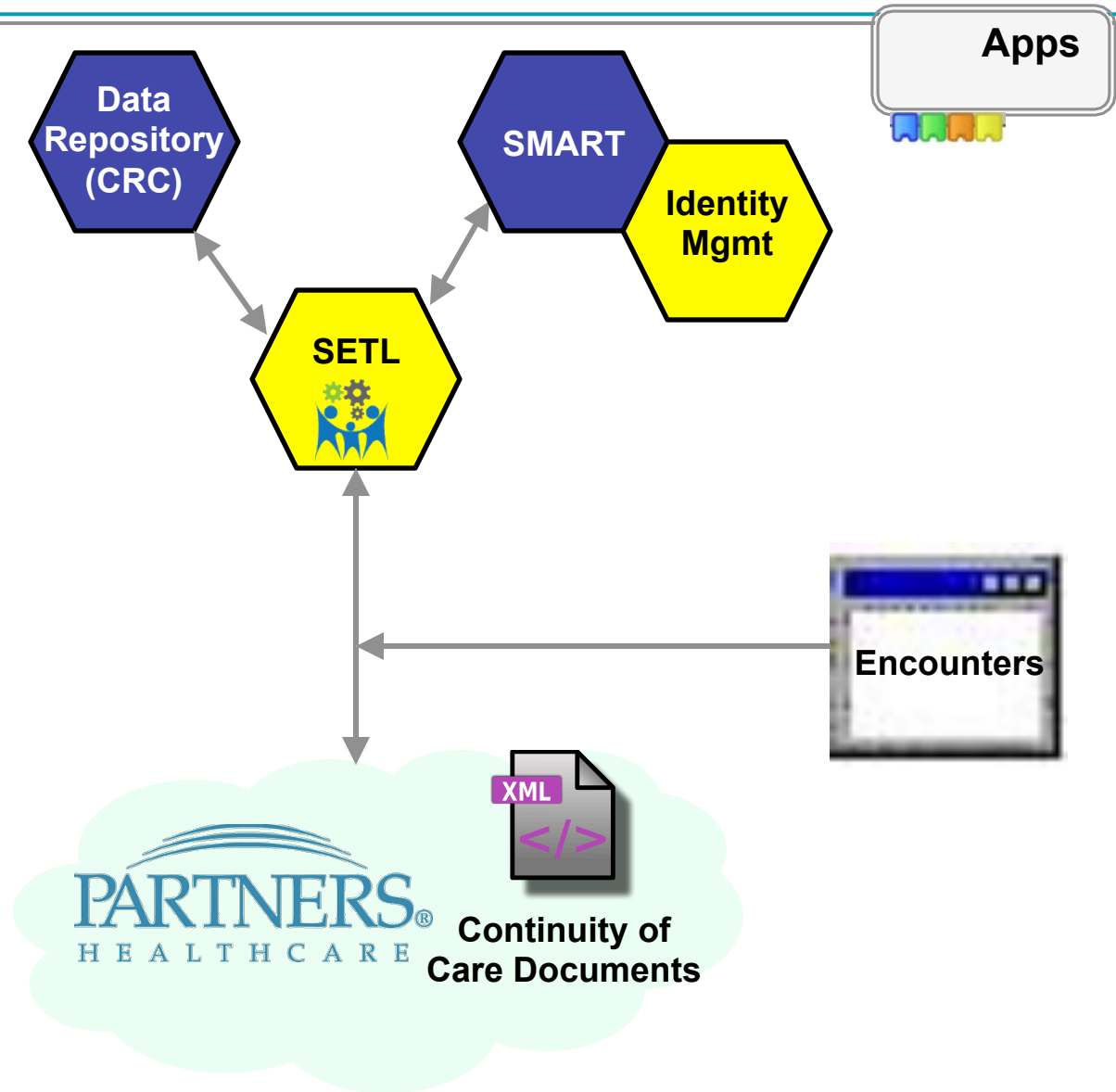
Advised patient to monitor the condition for 24 to 48 hours using the prescribed medication. Told patient to schedule an office visit.

Allergies

Discussion

- Up-to-the-minute data refresh of i2b2 patients in SMART apps using readily-available CCDs.
- Tested at Partners for meds, problems, demographics, and notes.
- Extensible to other sites and to the rest of CCD.
- Required no modifications of MDMI source map.
- Future part of i2b2 clinical trials platform.
- Open source, shortly available on the i2b2 wiki.

Next Steps



Ontology Development

- ▼ RxNorm
 - ▶ [AA000] Introduction
 - ▶ [AD000] Antidotes, deterrents and poison control
 - ▶ [AH000] Antihistamines
 - ▶ [AM000] Antimicrobials
 - ▶ [AN000] Antineoplastics
 - ▶ [AP000] Antiparasitics
 - ▶ [AS000] Antiseptics/disinfectants
 - ▶ [AU000] Autonomic medications
 - ▶ [BL000] Blood products/modifiers/volume expanders
 - ▼ [CN000] Central nervous system medications
 - ▼ [CN100] Analgesics
 - ▶ [CN101] Opioid analgesics
 - ▶ [CN102] Opioid antagonist analgesics
 - ▼ [CN103] Non-opioid analgesics
 - ▶ Acetaminophen
 - ▶ Acetaminophen/aluminum hydroxide/aspirin/caffeine/magnesium hydr
 - ▶ Acetaminophen/aluminum hydroxide/aspirin/salicylamide
 - ▶ Acetaminophen/aspirin
 - ▶ Acetaminophen/aspirin/caffeine
 - ▶ Acetaminophen/aspirin/caffeine/calcium gluconate
 - ▶ Acetaminophen/aspirin/caffeine/salicylamide
 - ▶ Acetaminophen/aspirin/calcium carbonate
 - ▶ Acetaminophen/butalbital
 - ▶ Acetaminophen/butalbital/caffeine
 - ▶ Acetaminophen/caffeine
 - ▶ Acetaminophen/caffeine/hyoscyamus
 - ▶ Acetaminophen/caffeine/phenyltoloxamine/salicylamide
 - ▶ Acetaminophen/caffeine/pyrilamine
 - ▶ Acetaminophen/caffeine/salicylamide
 - ▶ Acetaminophen/calcium carbonate
 - ▶ Acetaminophen/calcium carbonate/magnesium carbonate/magnesium ox
 - ▶ Acetaminophen/cinnamedrine/pamabrom
 - ▶ Acetaminophen/pamabrom
 - ▶ Acetaminophen/pamabrom/pyridoxine
 - ▶ Acetaminophen/pamabrom/pyrilamine
 - ▶ Acetaminophen/phenobarbital
 - ▶ Acetaminophen/pyrilamine maleate
 - ▶ Acetaminophen/salicylamide
 - ▶ Acetaminophen/tramadol
 - ▶ Aluminum hydroxide/aspirin/calcium carbonate/magnesium hydroxide
 - ▶ Aluminum hydroxide/aspirin/magnesium hydroxide
 - ▶ Aspirin

How you can explore the SETL cell

- Install i2b2
 - <https://www.i2b2.org/software/>
- Install SETL and SMART
 - <https://community.i2b2.org/wiki>
- Install MDMI (Map Editor, etc)
 - <https://www.projects.openhealthtools.org/sf/projects/mdmi/>
(will be released shortly)
- Other pieces available soon
 - RxNorm ontology
 - Updated SNOMED ontology
 - CCD Import

Acknowledgements

- Members of the OHT-MDMI team:
 - Ken Lord
 - Sean Muir
 - Sally Conway
 - Gabriel Oancea
- Additional members of the i2b2 group:
 - Martin Rees
 - Michael Mendis
 - Lori Phillips
- Other collaborators:
 - Michael Buck (at the New York City Department of Health and Mental Hygiene)
- Supported by ONC 90TR0001/01

Questions?

- Jeff Klann, PhD

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