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Data Harmonization: Challenge, Options, Strategy

Digital Data Priorities for Continuous Learning in Health and Heath care
IOM Workshop, March 23, 2012

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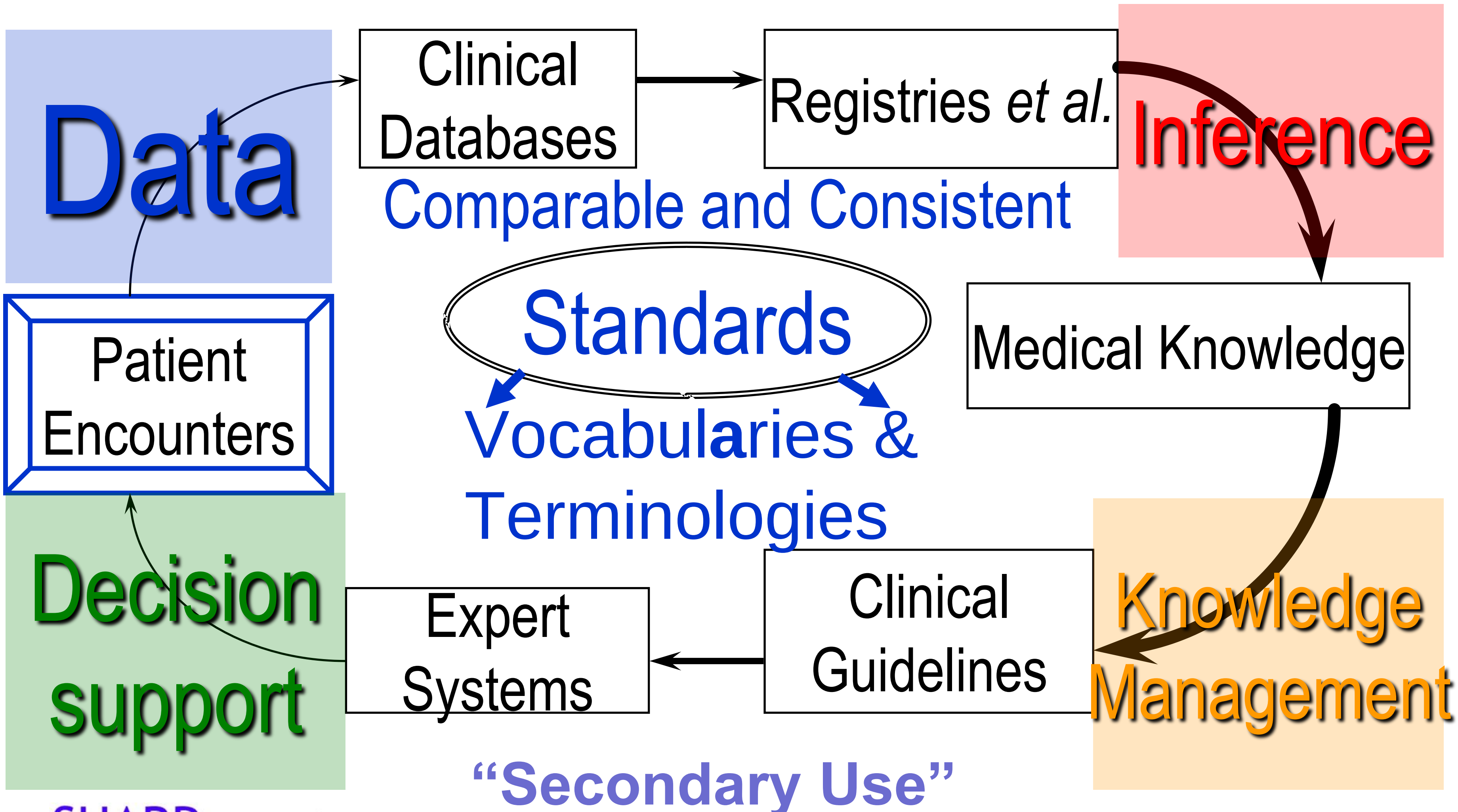
Strategic Health IT Advanced Research Projects (SHARP) Program

Awardee of The Office of the National Coordinator for Health Information Technology

From Practice-based Evidence to Evidence-based Practice



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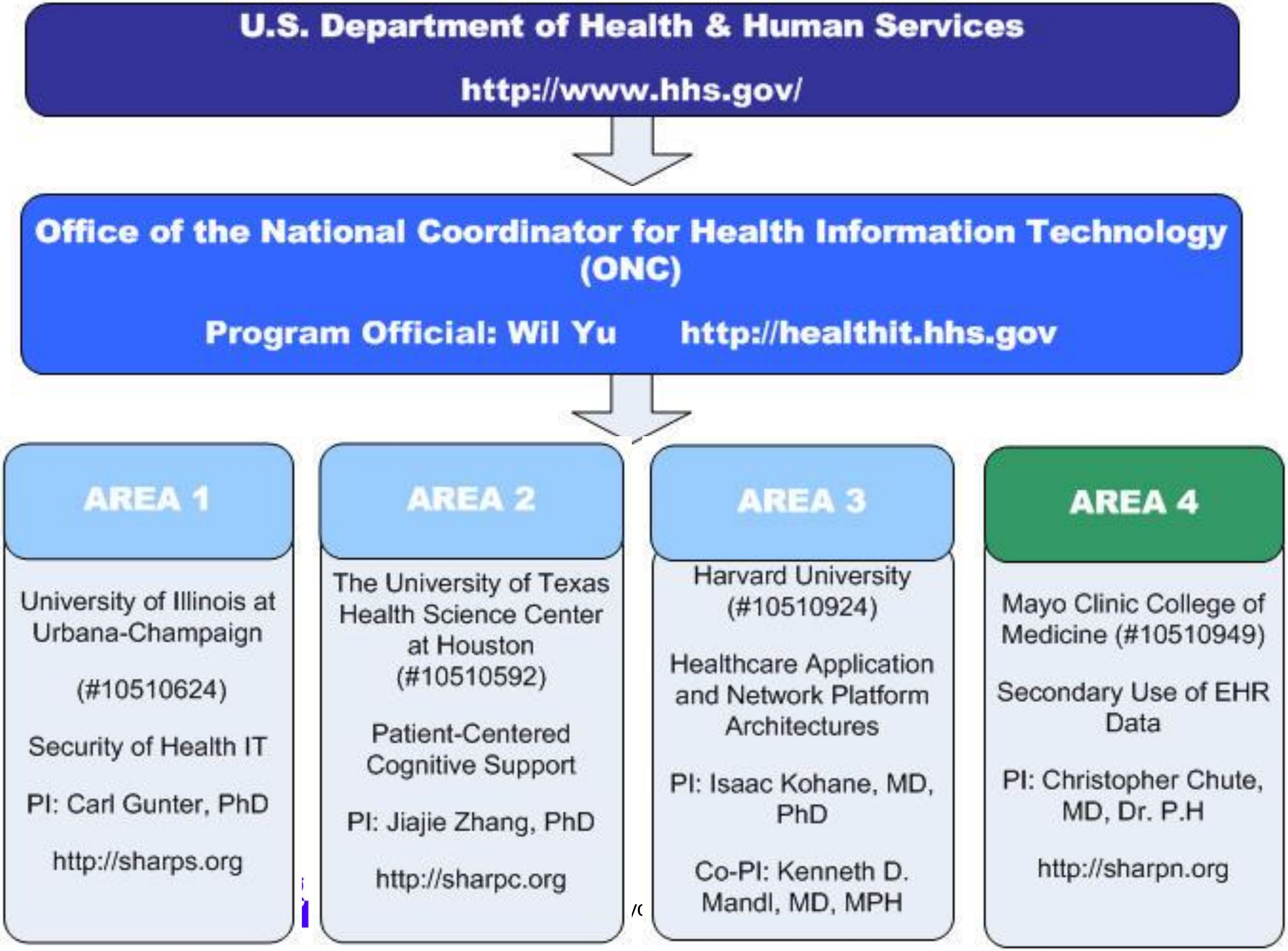
The Challenge

- Most clinical data in the United States is heterogeneous – non-standard
  - Within Institutions
  - Between Institutions
- Meaningful Use is mitigating, but has not yet “solved” the problem
  - Achieving standardization in Meaningful Use is sometimes minimized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AREA 4
Mayo Clinic College of Medicine (#10510949)
Secondary Use of EHR Data
PI: Christopher Chute, MD, Dr. P.H
http://sharpn.org

SHARP Area 4: Secondary Use of EHR Data

- Agilex Technologies
- CDISC (Clinical Data Interchange Standards Consortium)
- Centerphase Solutions
- Deloitte
- Group Health, Seattle
- IBM Watson Research Labs
- University of Utah
- University of Pittsburgh
- Harvard Univ.
- Intermountain Healthcare
- Mayo Clinic
- Mirth Corporation, Inc.
- MIT
- MITRE Corp.
- Regenstrief Institute, Inc.
- SUNY
- University of Colorado

Cross-integrated suite of projects and products

Themes			Projects	Players
Data Normalization	Phenotype Recognition	Data Quality & Evaluation Frameworks	Clinical Data Normalization	IBM, Mayo, Utah, Agilex, Regenstrief
			Natural Language Processing	Harvard, Group Health, IBM, Utah, Mayo, MIT, SUNY, i2b2, Pittsburgh, Colorado, MITRE
			High-Throughput Phenotyping	CDISC, Centerphase, Mayo, Utah
			UIMA & Scaling Capacity	IBM, Mayo, Agilex, Mirth
			Data Quality	Mayo, Utah
			Evaluation Framework	Agilex, Mayo, Utah

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Mission

To enable the use of EHR data for secondary purposes, such as clinical research and public health.

Leverage health informatics to:

- *generate new knowledge*
- *improve care*
- *address population needs*

To support the community of EHR data consumers by developing:

- *open-source tools*
- *services*
- *scalable software*

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Normalization Options

- Normalize data at source
  - Fiat, regulation, patient expectations
- Transformation and mapping
  - Soul of “ETL” in data warehousing
- Hybrid (graceful evolution to source)
  - “New” systems normalize at source
  - Transformation of legacy system data

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Modes of Normalization

- Generally true for both *structured* and *un-structured* data
- Syntactic transformation
  - Clean up message formats
  - HL7 V2, CCD/CDA, tabular data, etc
  - Emulate Regenstrief HOSS pipeline
- Semantic normalization
  - Typically vocabulary mapping

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Transformation Target?

- Normalization begs a “normal form”
- Extant national and international standards do not fully specify
  - Focus on HIE or internal messaging
  - Canonical data representation wanting
  - Require fully machine manageable data

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Clinical Data Normalization

- Dr. Huff on Data Normalization

  Stanley M. Huff, M.D.; SHARPn Co-Principal Investigator; Professor (Clinical) - Biomedical Informatics at University of Utah - College of Medicine and Chief Medical Informatics Officer Intermountain Healthcare. Dr. Huff discusses the need to provide patient care at the lowest cost with advanced decision support requires structured and coded data.

Clinical Data Normalization

- Data Normalization
  - Comparable and consistent data is foundational to secondary use
- Clinical Data Models – Clinical Element Models (CEMS)
  - Basis for retaining computable meaning when data is exchanged between heterogeneous computer systems.
  - Basis for shared computable meaning when clinical data is referenced in decision support logic.

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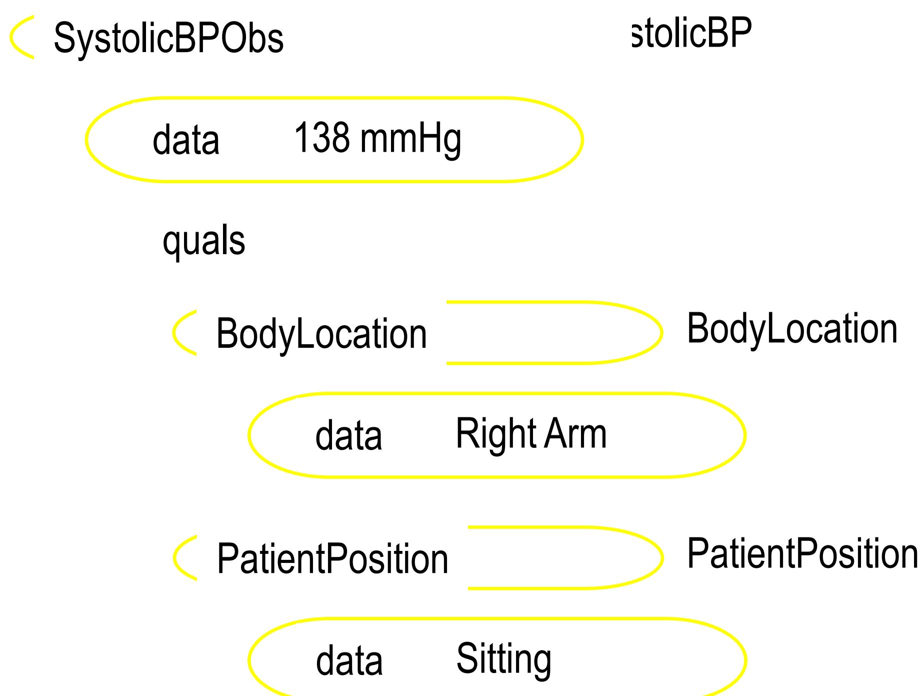
A diagram of a simple clinical model

Clinical Element Model for Systolic Blood Pressure



Intermountain Healthcare

GE/Intermountain Clinical Element Model Search

View License Agreement | Site Information | Download All XML Models | Model Value Sets | View Current Model XML Source

Contact Us

Model Search | Model List | Model Detail

BloodPressurePanel

- SystolicBloodPressureMeas
  - PQ
  - MethodDevice
  - BodyLocationPrecoord
  - BodyPosition
  - AbnormalInterpretation
  - DeltaFlag
  - ReferenceRangeNar
  - RelativeTemporalContext
- DiastolicBloodPressureMeas
- MeanArterialPressureMeas
- MethodDevice
- BodyLocationPrecoord
- BodyPosition
- RelativeTemporalContext
- PatientPrecondition
- Subject
- Observed
- ReportedReceived
- Verified

Description / Status:

Name:	BloodPressurePanel
Definition:	BloodPressurePanel is an Associated CEM Panel that groups a systolic blood pressure, diastolic blood pressure, and mean arterial pressure all obtained at the same time.
Status:	proposed

Details | XML View

RAW XML


```
<cetype kind="panel" name="BloodPressurePanel" xmlns="">
<key code="BloodPressurePanel_KEY_ECID" />
<item card="0-1" name="systolicBloodPressureMeas" type="SystolicBloodPressureMeas" />
<item card="0-1" name="diastolicBloodPressureMeas"
type="DiastolicBloodPressureMeas" />
<item card="0-1" name="meanArterialPressureMeas" type="MeanArterialPressureMeas" />
<qual card="0-1" name="methodDevice" type="MethodDevice" />
<qual card="0-1" name="bodyLocationPrecoord" type="BodyLocationPrecoord" />
<qual card="0-1" name="bodyPosition" type="BodyPosition" />
<qual card="0-M" name="relativeTemporalContext" type="RelativeTemporalContext" />
<qual card="0-M" name="patientPrecondition" type="PatientPrecondition" />
<mod card="0-1" name="subject" type="Subject" />
```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Data Element Harmonization

http://informatics.mayo.edu/CIMI/

- Stan Huff – CIMI
  - Clinical Information Model Initiative
- NHS Clinical Statement
- CEN TC251/OpenEHR Archetypes
- HL7 Templates
- ISO TC215 Detailed Clinical Models
- CDISC Common Clinical Elements
- Intermountain/GE CEMs

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Core CEMs

- Recognize that use-case specific work-flow enters into CEM-like objects
  - Clinical EHR implementation
  - CLIA or FDA regulatory overhead
- Secondary Use tends to focus on data
- Create “core” CEMs
  - Labs, Rxs, Dxs, Pxs, demographics

That Semantic Bit…

- Canonical semantics reduce to Value-set Binding to CEM objects
- Value-sets should obviously be drawn from “standard” vocabularies
  - SNOMED-CT and ICD
  - LOINC
  - RxNorm
  - But others required: HUGO, GO, HL7

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Value-sets: Few or Many

- Everybody wants "manageable" number of value-sets
  - Estimates of 6-12
- Likely we will require thousands
- Raises requirement for terminology services and national repository
  - Once and future "US Realm"

On Mapping

- Semantic mapping from local codes to “standard” codes is required
  - Not magic, humanly curated
- Reality of idiosyncratic local codes is perverse
  - Why does every clinical lab in the country insist on making up its own lab codes?

Normalization Pipelines

- Input heterogeneous clinical data
  - HL7, CDA/CCD, structured feeds
- Output Normalized CEMs
  - Create logical structures within UIMA CAS
- Serialize to a persistence layer
  - SQL, RDF, “PCAST like”, XML
- Robust Prototypes exist
  - Early version production Q3 2012

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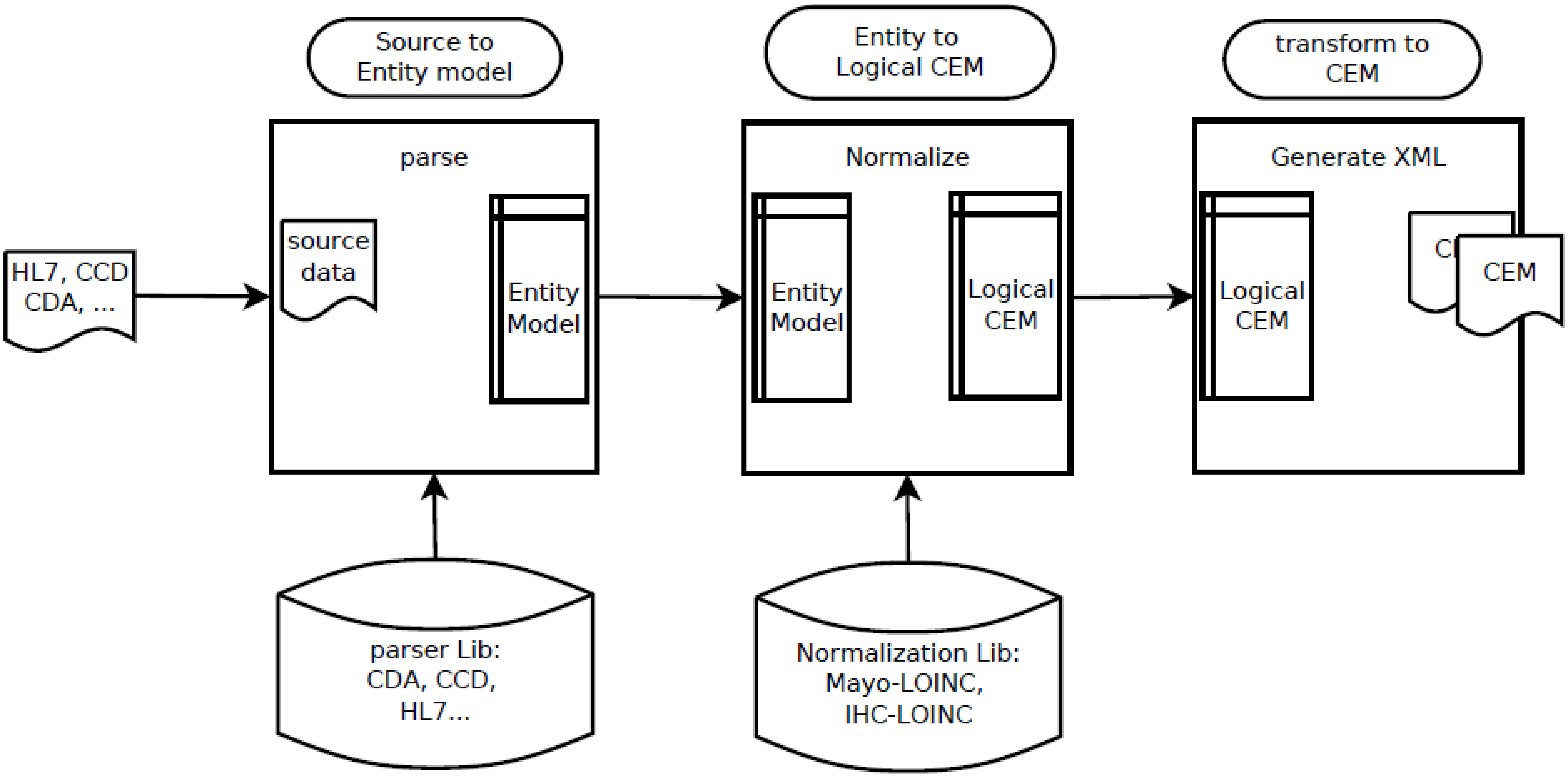
Normalization Flow



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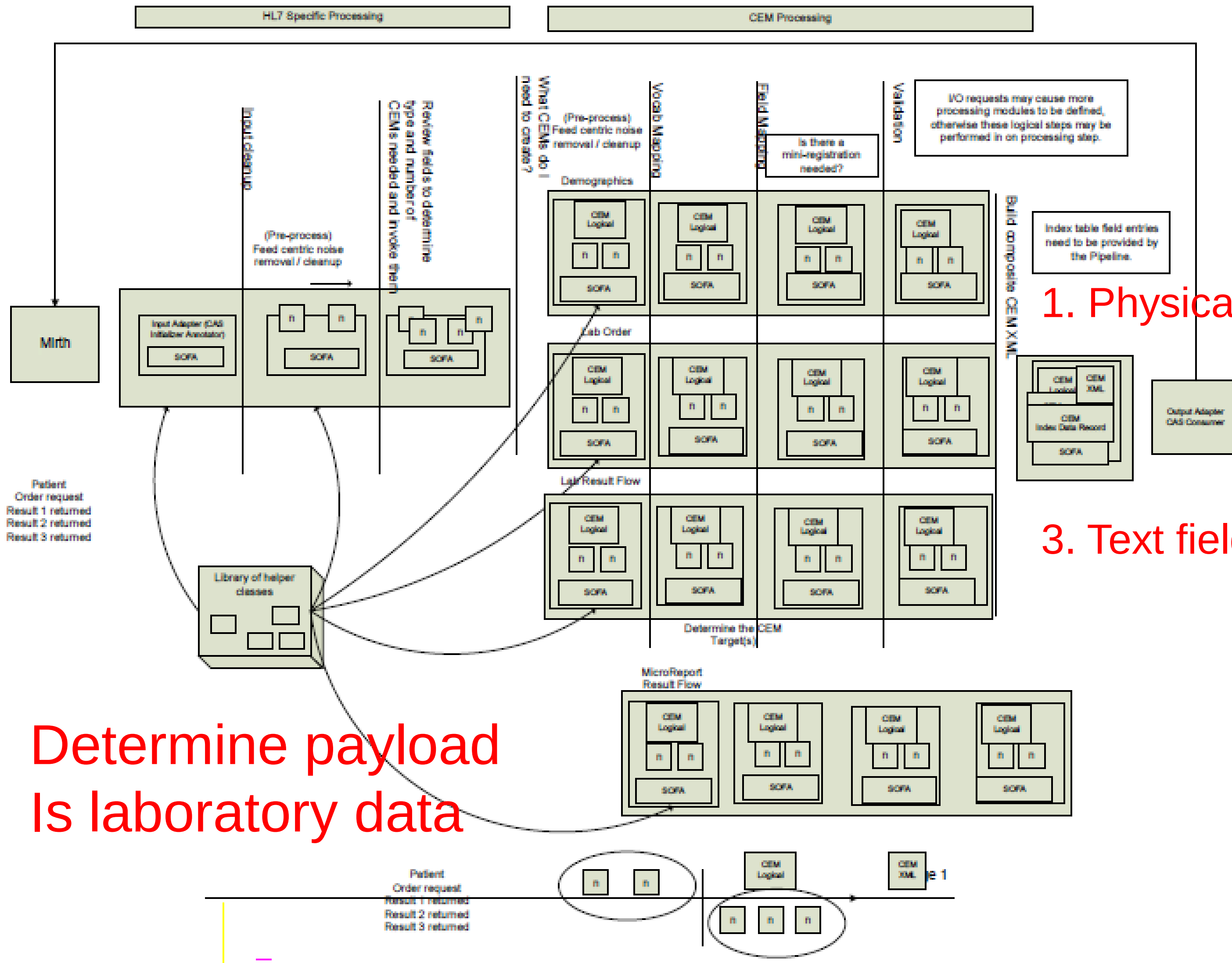
This slide is obvious



1. Physical Quantity

2. Coded Values

3. Text field

Determine payload
Is laboratory data

NLP Deliverables and Tools

http://informatics.mayo.edu/sharp/index.php/Tools

- cTAKES Releases
  - Smoking Status Classifier
  - Medication Annotator
  - cTAKES Side Effects module
  - Modules for relation extraction
- Integrated cTAKES(icTAKES)
  - an effort to improve the usability of cTAKES for end users
- NLP evaluation workbench
  - the dissemination of an NLP algorithm requires performance benchmarking. The evaluation workbench allows NLP investigators and developers to compare and evaluate various NLP algorithms.
- SHARPn NLP Common Type
  - SHARPn NLP Common Type System is an effort for defining common NLP types used in SHARPn; UIMA framework.

High-Throughput Phenotyping

- Phenotype - a set of patient characteristics :
  - Diagnoses, Procedures
  - Demographics
  - Lab Values, Medications
- Phenotyping – overload of terms
  - Originally for research cohorts from EMRs
  - Obvious extension to clinical trial eligibility
  - Quality metric Numerators and denominators
  - Clinical decision support - Trigger criteria

EMR Phenotype Algorithms

- Typical components
  - Billing and diagnoses codes; Procedure codes
  - Labs; Medications
  - Phenotype-specific co-variates (e.g., Demographics, Vitals, Smoking Status, CASI scores)
  - Pathology; Imaging?
- Organized into inclusion and exclusion criteria
- Experience from eMERGE Electronic Medical Records and Genomics Network (http://www.gwas.net)

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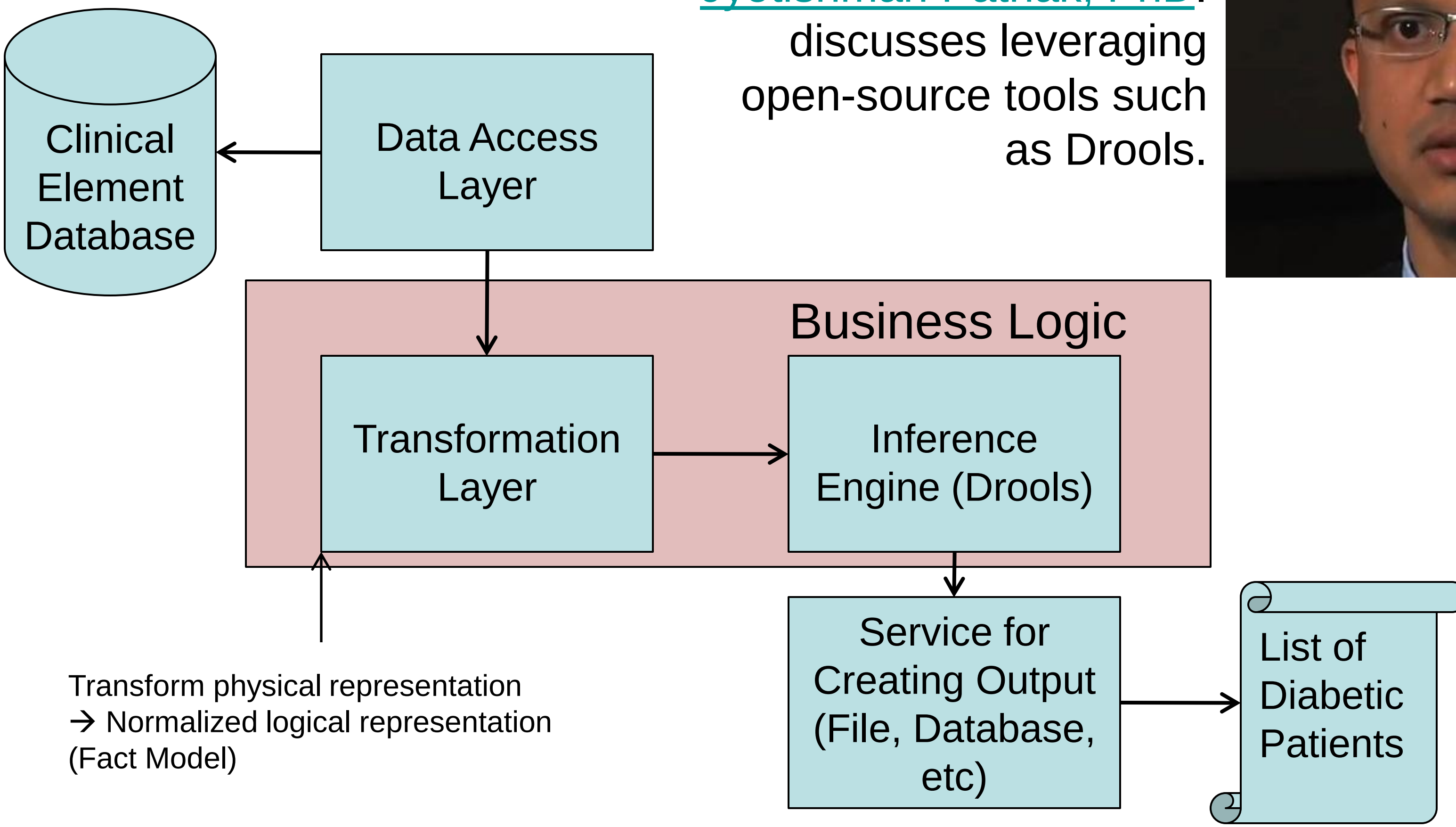
Drools-based Architecture

[Jyotishman Pathak, PhD](). discusses leveraging open-source tools such as Drools.



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Phenotyping Activities

- DROOLS
  - Prioritize “Drools-izing” eMERGE algorithms (Diabetes, PAD and Hypothyroidism) and PGRN algorithms
  - Role of Drools for implementing the quality measures
- Phenotyping Workbench / PhenoPortal
  - develop an implementation independent, phenotyping logic representation template for algorithm design
  - Role of CEMs and NQF Quality Data Model (QDM)
  - Publicly accessible Web-based library for phenotyping algorithms
  - Phenotyping Graphical User Interface or “plug & play” workbench for algorithm design and evaluation
- Just-In Time Phenotyping
  - Apply algorithms as “data sniffers” that can be plugged within an UIMA pipeline
  - Online, real-time phenotyping (e.g., for clinical decision support)
- Machine Learning Phenotyping
  - leverage machine learning methods for rule/algorithm development, and validate against expert developed ones

SHARP and Beacon Synergies

- SHARP will facilitate the mapping of comparable and consistent data into information and knowledge

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- SE MN Beacon will facilitate the population-based generation of best evidence and new knowledge
- SE MN Beacon will allow the application of Health Information Technology to primary care practice
  - Informing practice with population-based data
  - Supporting practice with knowledge

More Information

SHARP Area 4: (SHARPn)

Secondary Use of EHR Data

www.sharpn.org

Southeast Minnesota Beacon Community

www.semnbeacon.org

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