Introduction to Health (Clinical) Informatics

MSCR 597: Big Data to Knowledge (BD2K) in CTR Research

Mark Braunstein, MD

Professor of the Practice

School of Interactive Computing

Georgia Tech

mark.braunstein@cc.gatech.edu

Introduction to Health (Clinical) Informatics

US Healthcare

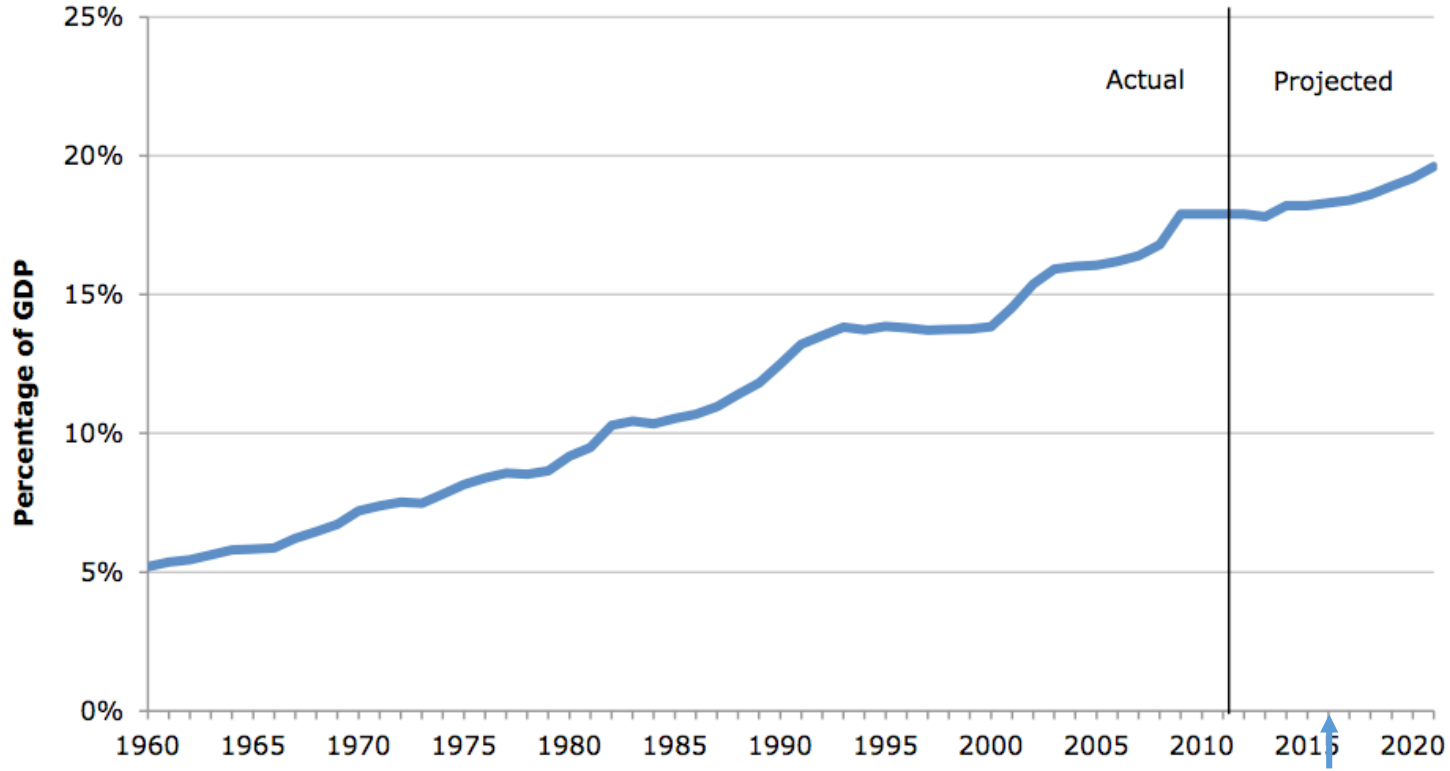
Brief History of Informatics

Early History of Interoperability Standards

Exciting Times


What, me worry?

US Healthcare
Approaching 20% of GDP



2016: $3.4 trillion
2025: $5.5 trillion (19.9%)

The Growing Burden of Chronic Disease in America

In 2000, approximately 125 million Americans (45% of the population) had chronic conditions and 61 million (21% of the population) had multiple chronic conditions. The number of people with chronic conditions is projected to increase steadily for the next 30 years. While current health care financing and delivery systems are designed primarily to treat acute conditions, 78% of health spending is devoted to people with chronic conditions. Quality medical care for people with chronic conditions requires a new orientation toward prevention of chronic disease and provision of ongoing care and care management to maintain their health status and functioning. Specific focus should be applied to people with multiple chronic conditions.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1497638/pdf/15158105.pdf

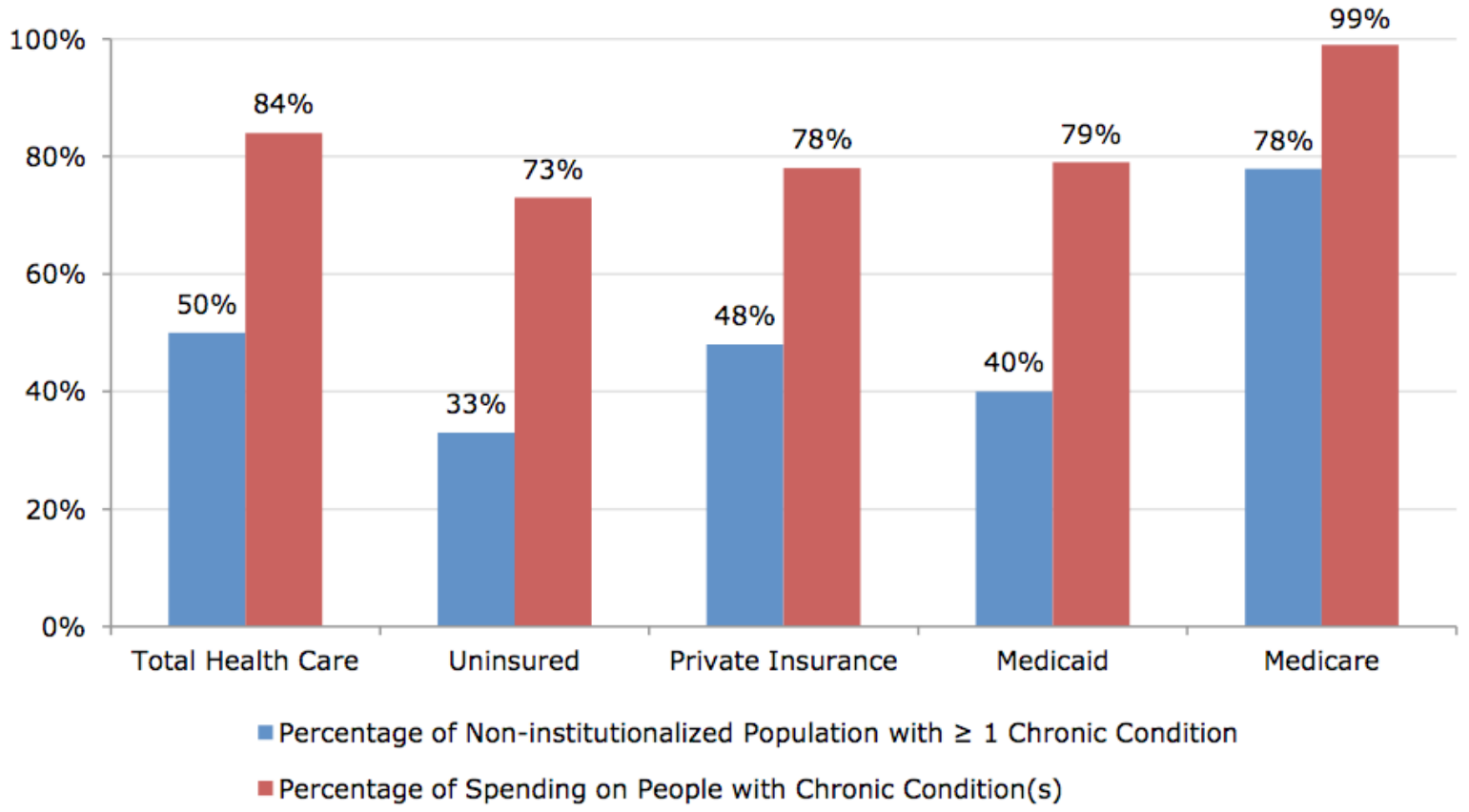
US Healthcare
Poor at Managing Chronic Diseases …

The AAFP reported in 2011 that "as primary care physicians, we spend the majority of our time caring for patients with chronic diseases, but data suggest we achieve the standard of care for chronic diseases and preventive care only 50 percent to 60 percent of the time".*

The Assessing Care of Vulnerable Elders (ACOVE) study published by RAND and Pfizer in 2004 concluded "vulnerable elders receive about half of the recommended care, and the quality of care varies widely from one condition and type of care to another".**

** http://www.aafp.org/fpm/2011/0500/p27.html*
*** http://www.rand.org/content/dam/rand/pubs/research_briefs/2005/RB9051.pdf*

US Healthcare
… That Account for Most Costs



http://www.pbs.org/newshour/rundown/seven-factors-driving-your-health-care-costs/

US Healthcare
Suboptimal Cancer Care

1 in 4 cancer patients have treatment plans that do not conform to evidence-based cancer care

Inappropriate deviations from the standards of care for cancer cost more than **$25,000 per patient**

https://www.optum.com/thought-leadership/cancer-cost-drivers.html

Forastiere, et al Abramson Cancer Center of the University of Pennsylvania and The Johns Hopkins Carey Business School

US Healthcare
Unsafe

"Three recent reports on deaths due to medical error in US hospitals have estimated the figure to be greater than 200,000 deaths per year"

https://www.sciencedaily.com/releases/2017/02/170213125617.htm

US Healthcare
A Major Reason is Poor at Sharing Data

"An estimated 80 percent of serious medical errors involve miscommunication between caregivers when responsibility for patients is transferred or handed-off, according to the Joint Commission."

--- Health IT News 10/22/10

http://www.hibeacon.org/index.php/beacon_nation/package_details/learning_guide_Transitions_Disease_Management

US Healthcare
Poor ROI

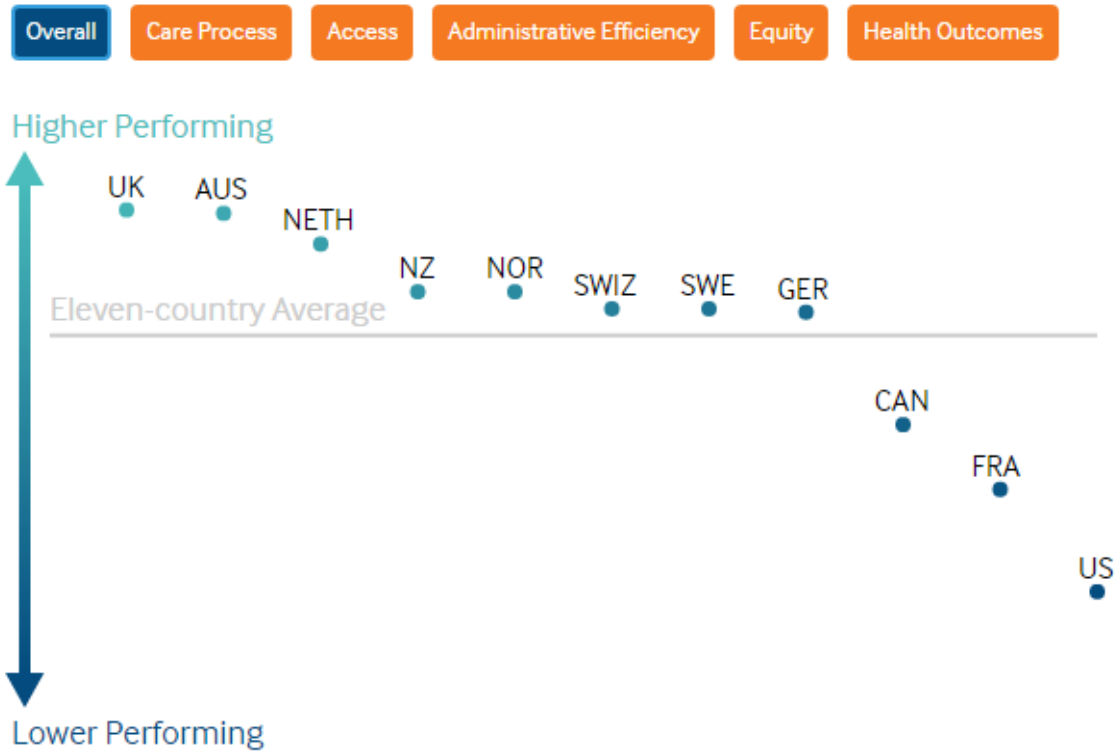
COUNTRY RANKINGS

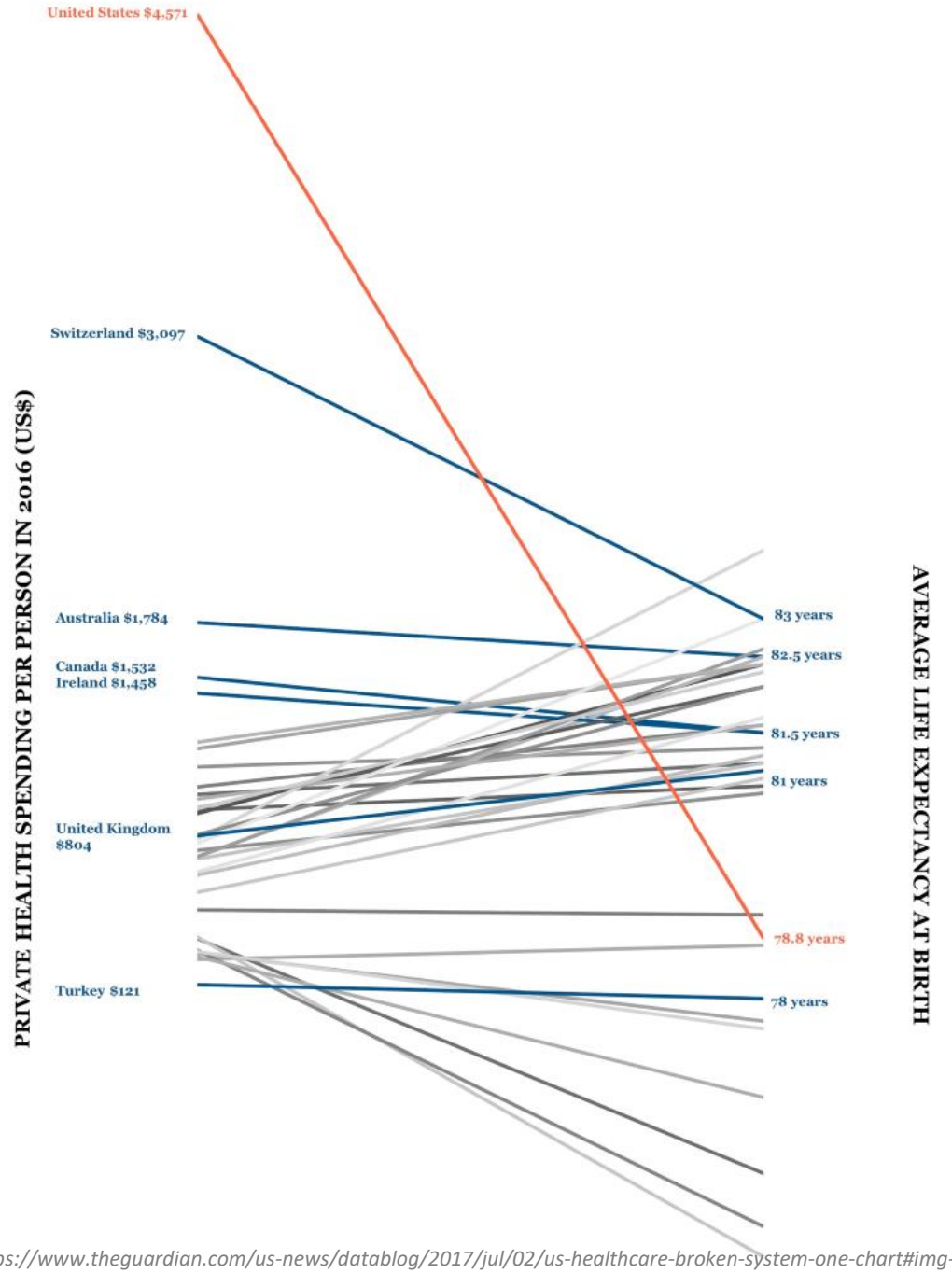
Top 2*
Middle
Bottom 2*

	AUS	CAN	FRA	GER	NETH	NZ	NOR	SWE	SWIZ	UK	US
OVERALL RANKING (2013)	4	10	9	5	5	7	7	3	2	1	11
Quality Care	2	9	8	7	5	4	11	10	3	1	5
Effective Care	4	7	9	6	5	2	11	10	8	1	3
Safe Care	3	10	2	6	7	9	11	5	4	1	7
Coordinated Care	4	8	9	10	5	2	7	11	3	1	6
Patient-Centered Care	5	8	10	7	3	6	11	9	2	1	4
Access	8	9	11	2	4	7	6	4	2	1	9
Cost-Related Problem	9	5	10	4	8	6	3	1	7	1	11
Timeliness of Care	6	11	10	4	2	7	8	9	1	3	5
Efficiency	4	10	8	9	7	3	4	2	6	1	11
Equity	5	9	7	4	8	10	6	1	2	2	11
Healthy Lives	4	8	1	7	5	9	6	2	3	10	11
Health Expenditures/Capita, 2011**	$3,800	$4,522	$4,118	$4,495	$5,099	$3,182	$5,669	$3,925	$5,643	$3,405	$8,508

http://www.commonwealthfund.org/publications/press-releases/2014/jun/us-health-system-ranks-last

The Bottom Line





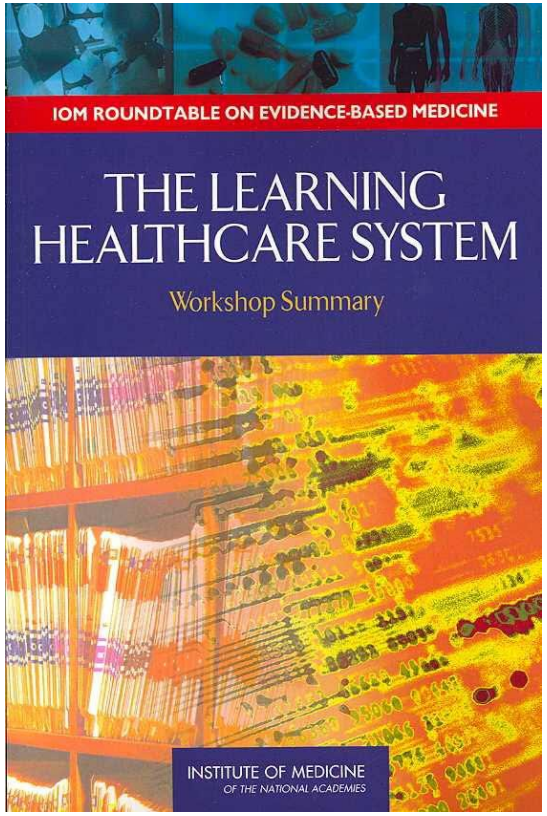
http://www.commonwealthfund.org/interactives/2017/july/mirror-mirror/

https://www.theguardian.com/us-news/datablog/2017/jul/02/us-healthcare-broken-system-one-chart#img-2

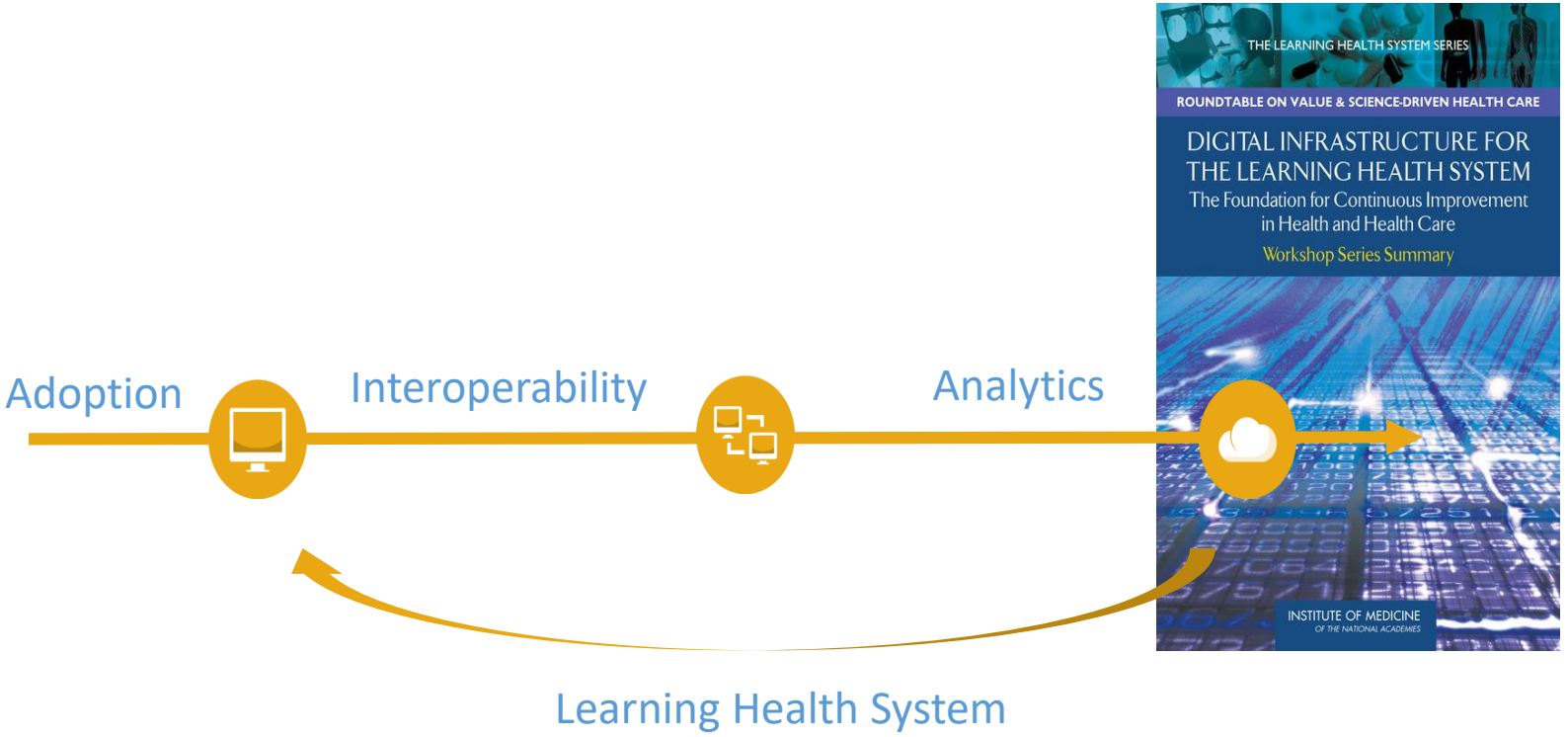
IOM
2007: Learning Healthcare System

The IOM will consider the issues and urgent actions necessary to foster the development of a learning healthcare system designed to:

- generate and apply the best evidence for the collaborative healthcare choices of each patient and provider;
- drive the process of discovery as a natural outgrowth of patient care;
- ensure innovation, quality, safety, and value in health care.

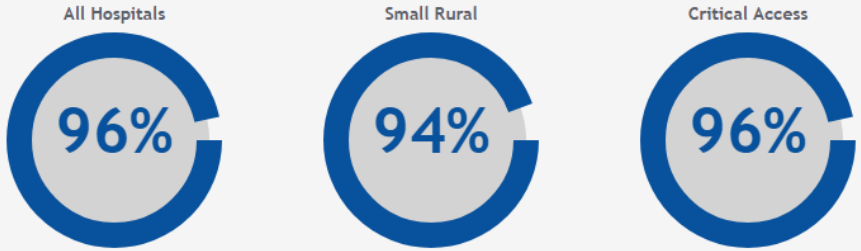


2011: An Informatics Perspective



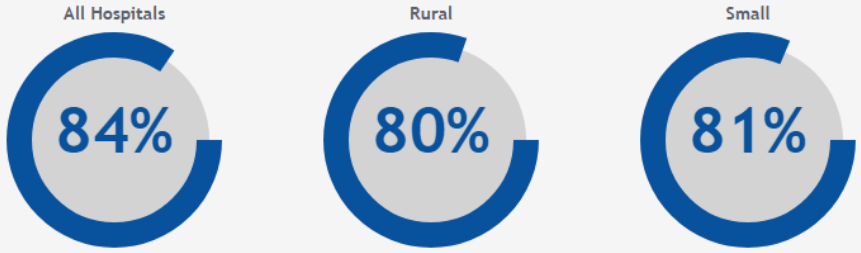
Adoption Has Happened

Percent of U.S. Hospitals that Adopted *Certified* EHRs: 2015



Note: a *certified* EHR meets the technological capability, functionality, and security requirements adopted by the U.S. Department of Health and Human Services. *Rural* hospitals are located in CBSA non-metropolitan areas, *small* hospitals are those with fewer than 100 beds, and *Critical Access* hospitals are rural hospitals with fewer than 25 beds and 35 miles away from any other general or Critical Access hospital.

Percent of U.S. Hospitals that Adopted *Basic* EHRs: 2015



Note: a *Basic* EHR is a system with these capabilities: patient demographics, physician notes, nursing assessments, patient problem lists, electronic lists of medications taken by patients, discharge summaries, advanced directives, orders for medications, viewing laboratory results, and viewing radiology results. *Rural* hospitals are located in CBSA non-metropolitan areas, and *small* hospitals are those with fewer than 100 beds.

Interoperability in Now the Challenge

Data

Technology

Organizations

Economics

Public Policy

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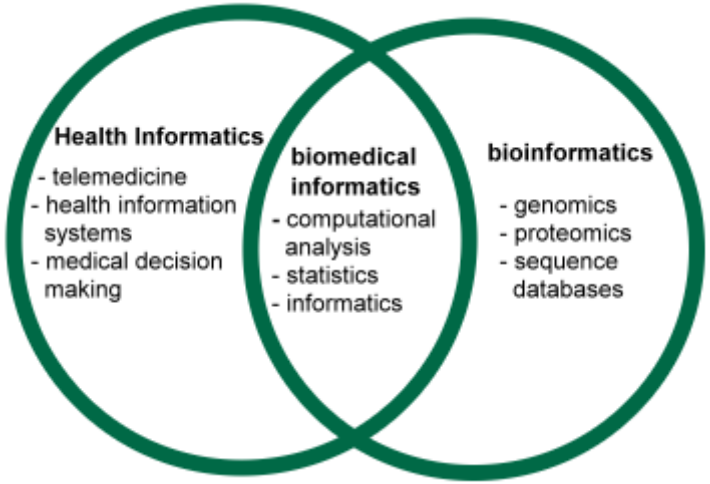
US Healthcare

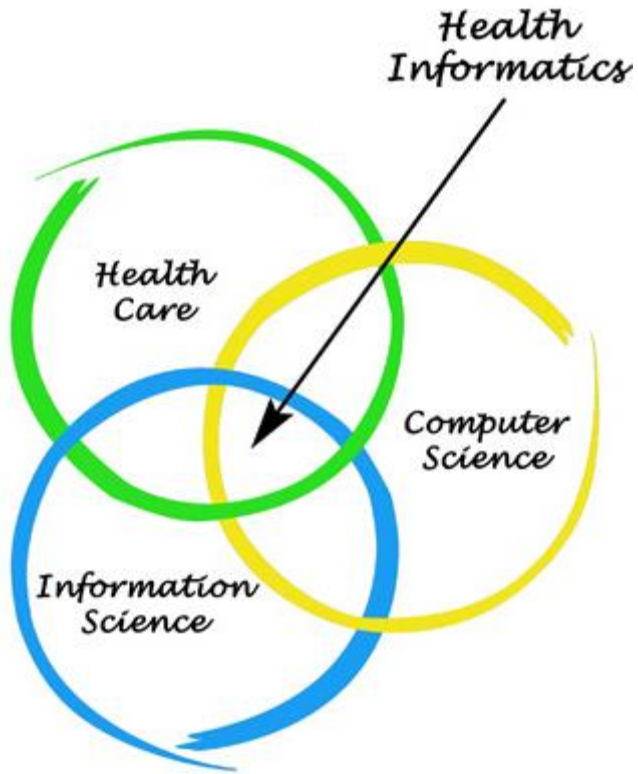
Brief History of Health Informatics

Early History of Interoperability Standards

Exciting Times

Definition of Terms




Health
Informatics
Health
Care
Computer
Science
Information
Science

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Brief History of Health Informatics: EMR

Early History of Interoperability Standards

Exciting Times

1863
Florence Nightingale

"In attempting to arrive at the truth, I have applied everywhere for information, but in **scarcely an instance have I been able to obtain hospital records fit for any purpose of comparison**. If they could be obtained...they would show subscribers how their money was being spent, what amount of good was really being done with it, or whether the money was not doing mischief rather than good..."

*Florence Nightingale (Notes on Hospitals, London: Longmans, Green and Company; **1863**:176.)*

Electronic Medical Records
The Earliest Application of Computing

1962: Akron Children's Hospital/IBM

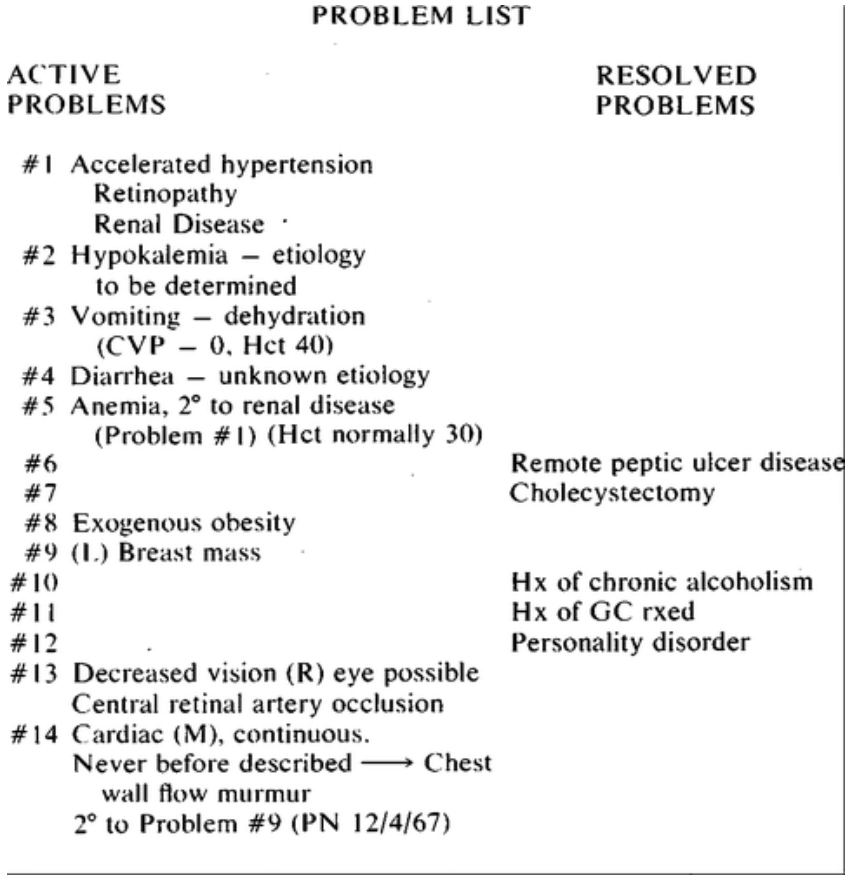
Centralize patient records

Share patient information
Eliminate paperwork

Alert nurses when patients needed their medication.

1968: Larry Weed, MD
Medical Records That Guide and Teach

THE beginning clinical clerk, the house officer and the practicing physician are all confronted with conditions that are frustrating in every phase of medical action. The purpose of this article is to identify and discuss these conditions and point out solutions. To deal effectively with these frustrations it will be necessary to develop a more organized approach to the medical record, a more rational acceptance and use of paramedical personnel and a more positive attitude about the computer in medicine. Eventually, for every physician all three areas will be an obligatory part of his professional environment if he is to . .



PROBLEM LIST

ACTIVE PROBLEMS	RESOLVED PROBLEMS
#1 Accelerated hypertension Retinopathy Renal Disease	
#2 Hypokalemia – etiology to be determined	
#3 Vomiting – dehydration (CVP – 0, Hct 40)	
#4 Diarrhea – unknown etiology	
#5 Anemia, 2° to renal disease (Problem #1) (Hct normally 30)	
#6	Remote peptic ulcer disease
#7	Cholecystectomy
#8 Exogenous obesity	
#9 (L) Breast mass	
#10	Hx of chronic alcoholism
#11	Hx of GC rxed
#12	Personality disorder
#13 Decreased vision (R) eye possible Central retinal artery occlusion	
#14 Cardiac (M), continuous. Never before described ⟶ Chest wall flow murmur 2° to Problem #9 (PN 12/4/67)	

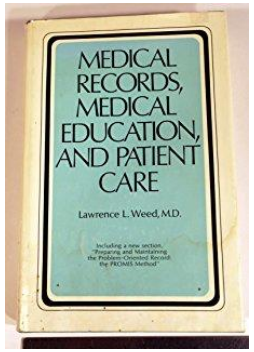
http://www.nejm.org/doi/full/10.1056/NEJM196803142781105
http://imed.stanford.edu/curriculum/session17/content/NEJM%20-%20Medical%20record%20that%20guide%20and%20teach%20(Weed%20-%201968).pdf

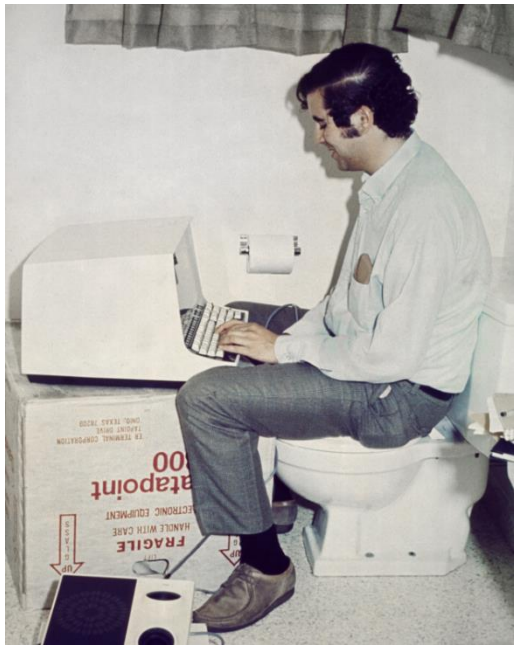
1971: Emory Medical Grand Rounds

https://youtu.be/qMsPXSMTpFI

1970: An Early Ambulatory "EHR"

Medicine
Pharmacy
Dentistry
Social Work





28!

PATIENT SUMMARY

PROBLEM LIST

9/9/76 BRAUNSTEIN,MARK PATIENT: DOE,JOHN OPD #:
UNIT#: AGE: 41

** PERMANENT PROBLEMS **

	DATE OF DEF	DATE OF RES	PROBLEM
A	6/30/75		MEDICAL EXAM, NO DISEASE DETECTED 1 VISIT ICHPPC = Y00
B	6/30/75		TOBACCO ABUSE 1 VISIT ICHPPC = 3049
C	6/30/75		EMPHYSEMA, BRONCHIECTASIS, & COPD 1 VISIT ICHPPC = 492

** TEMPORARY PROBLEMS **

	DATE OF DEF	DATE OF RES	PROBLEM
1	7/10/75 10/27/75	7/17/75	ACUTE UPPER RESPIR TRACT INFECTION 3 VISITS ICHPPC = 460

Early “PopHealth” …

JUN 28, 1976 DR. C[redacted]'S PRACTICE

DISTRIBUTION BY CENSUS TRACT

TRACT	#PAT'S	TRACT	#PAT'S	TRACT	#PAT'S	TRACT	#PAT'S
1	1	3	1	4	2	5	9
6	3	8	7	9	5	10	8
11	1	14	2	16	2	17	13
19	2	20	36	21	5	26	27
27	3	29	1	30	13	31	16
32	7	33	5	36	10	37	4
39	4	43	2	44	4	46	5
47	13						

DISTRIBUTION BY SEX AND AGE

AGE GRP	#FEM'S	#MALES	TOTAL
0-9	19	16	35
10-19	32	27	59
20-29	29	14	43
30-39	21	15	36
40-49	6	8	14
50-59	7	3	10
60-69	6	4	10
70-79	2		2
80-89			
90-99			
100-109			
TOTAL	122	87	209

DISTRIBUTION BY HOUSEHOLD SIZE

SIZE	# OF HOUSEHOLDS	# OF PEOPLE
1	13	13
2	13	26
3	11	33
4	5	20
5	13	65
6	5	30
7	2	14
9	1	9
11	1	11
TOTAL	64	221

DISTRIBUTION BY FAMILY INCOME(EST. BY CENSUS TRACT)

INCOME <4000	INCOME 4K-5K	INCOME 5K-6K	INCOME 6K-7K	INCOME 7K-8K
12	15	13	8	

INCOME 8K-9K	INCOME 9K-10K	INCOME 10K-11K	INCOME 11K-12K	INCOME >12K
52	34	38	40	

7 PAT'S WITHOUT CENSUS TRACT
1 PAT'S WITHOUT SEX DATA
8 PAT'S WITHOUT BIRTHDATE

PRACT. ANALYSIS PART 2: PRACTICE MORBIDITY BY AGE/SEX AND DISEASE SYSTEM FOR DR C

SEPT. 13, 1976

PROBLEM CLASS / PROBLEM	AGE:	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	TOTAL
INFECTIVE AND PARASITIC DISEASES												
CHICKENPOX												
	MALE	1										1
	FEMALE											
DERMATOPHYTOSIS & DERMATOMYCOSIS												
	MALE	1		1/1								2/1
	FEMALE		1/1	1	1			1				4/1
PRESUMED INFECTIOUS INTESTIN DISEAS												
	MALE	1	1									2
	FEMALE	2/1			1			1				4/1
HERPES ZOSTER												
	MALE	1										1
	FEMALE	1/1					1					2/1
OXYURIASIS, PINWORMS, HELMINTH NEC												
	MALE											
	FEMALE	2	1									3
SCABIES & OTHER ACARIASIS												
	MALE											
	FEMALE			1								1
SYPHILIS, ALL SITES & STAGES												
	MALE						1/2					1/2
	FEMALE					1/1		2/2				3/3
TUBERCULOSIS												
	MALE			2/4	1		2	1/1				6/5
	FEMALE											
WARTS, ALL SITES												
	MALE	2/3		1	2/7		1/1					6/11
	FEMALE			1		1						2
OTHER INFECT/PARASITIC DISEASES NEC												
	MALE	1	1/1									2/1
	FEMALE	2/1										2/1
VIRAL CONJUNCTIVITIS												
	MALE		1	1			1/1					3/1
	FEMALE	2/1			2/2							4/3
STREP THROAT, SCARLET FEV, ERYSIPELAS												
	MALE	3										3
	FEMALE	2/1	1	1								4/1
MONILIASIS EXCL UROGENITAL												
	MALE											
	FEMALE	1/1										1/1

NUMBER BEFORE "/"=PATIENTS NUMBER AFTER "/"=VISITS IN LAST YEAR

NUMBER WITHOUT "/"=PATIENTS, BUT NO VISITS IN LAST YEAR

1970's: CoStAR (MUMPS)

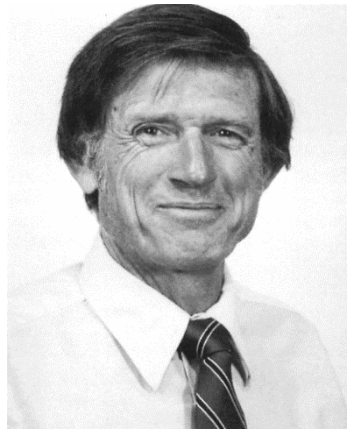
Directory/Data dictionary

Modular design/User configuration

Structured encounter form for data capture

Queryable database

Integrated administrative, financial and clinical data



Octo Barnett, MD

Others …

The **M**edical **R**ecord – Duke (Problem-oriented, multiple input techniques)

Regenstrief **M**edical **R**ecord **S**ystem – Regenstrief Institute

(Reminders, CDS, Device interfaces)

Clem McDonald, MD

Bill Stead, MD
Ed Hammond, PhD

Introduction to Health (Clinical) Informatics

US Healthcare

Brief History of Health Informatics: CDS

Early History of Interoperability Standards

Exciting Times

1967: Health Evolution through Logic Processing (HELP)
First EMR with CDS

Homer Warner, MD, PhD

Knowledge engineering

Lung consolidation

a. PE shows abnormal chest percussion with dullness
b. PE shows abnormal pulmonary auscultation with bronchial breath sounds
c. PE shows abnormal pulmonary auscultation with egophony (E-to-A changes)
d. PE shows abnormal chest palpation with increased vocal fremitus
e. PE shows abnormal pulmonary auscultation with rales
f. PE shows abnormal pulmonary auscultation with pectoriloquy

True if (a or b) and 2 of (c,d,e,f)

Bayesian statistics

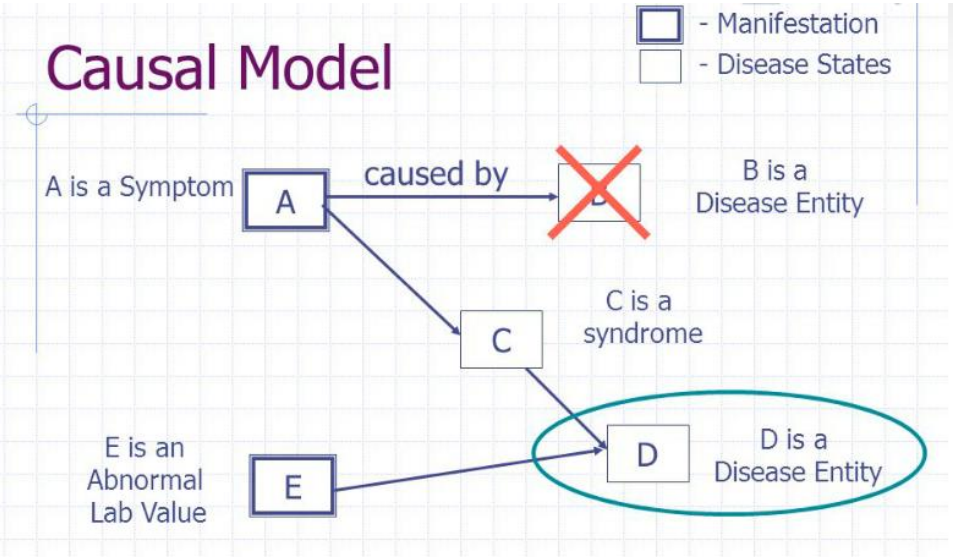
Iron deficiency anemia (a priori = .075)		
a. Anemia	.999	.10
b. Hypochromic and microcytic RBCs	.85	.07
c. Iron deficiency	.9999	.01
xor		
At risk for iron deficiency	.95	.25
xor		
Chronic blood loss	.95	.10
d. Absolute reticulocyte count		
<50,000	.90	.08
50,000–200,000	.10	.84
≥200,000	.001	.08

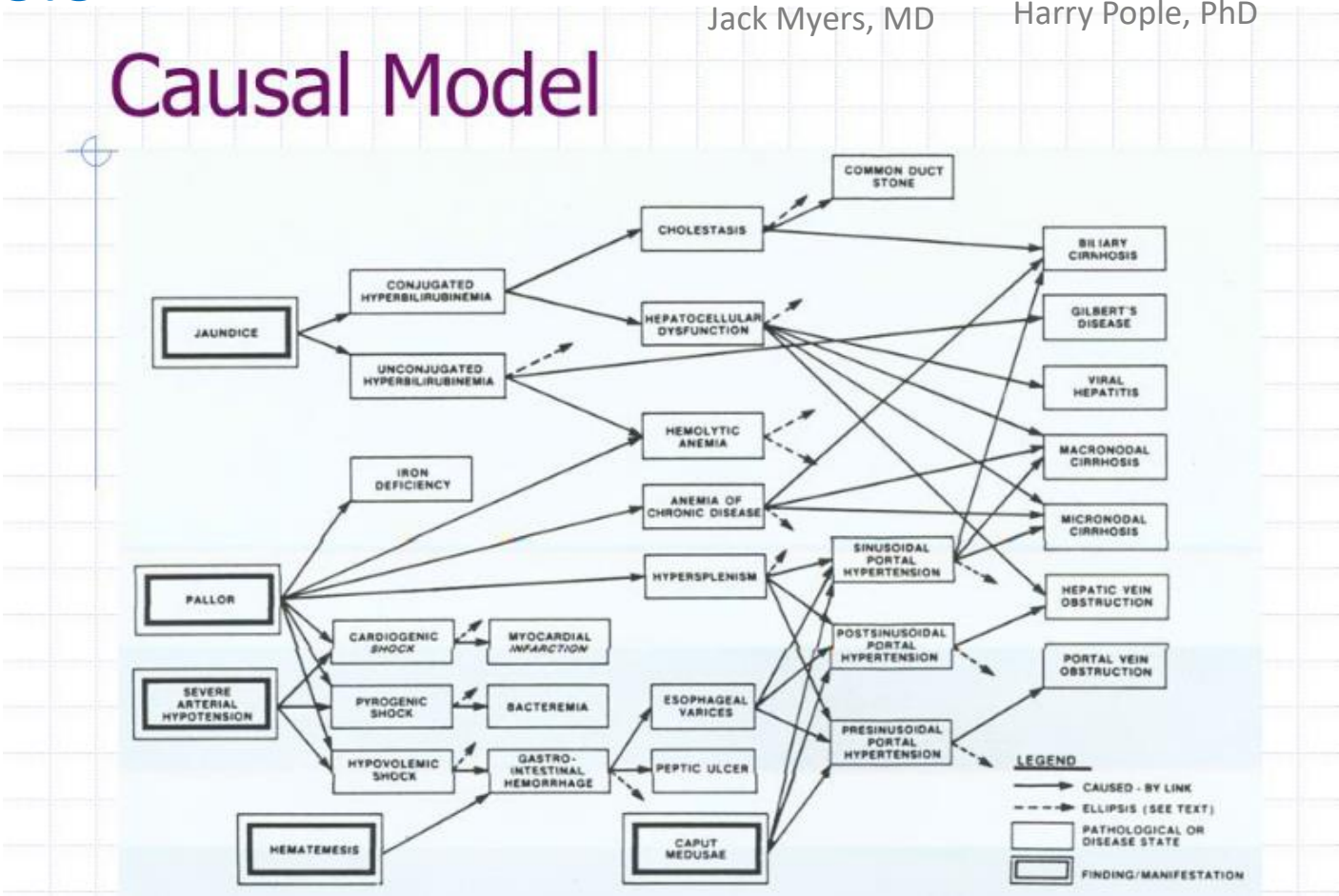
1974: INTERNIST
Computer Aided Diagnosis

Jack Myers, MD

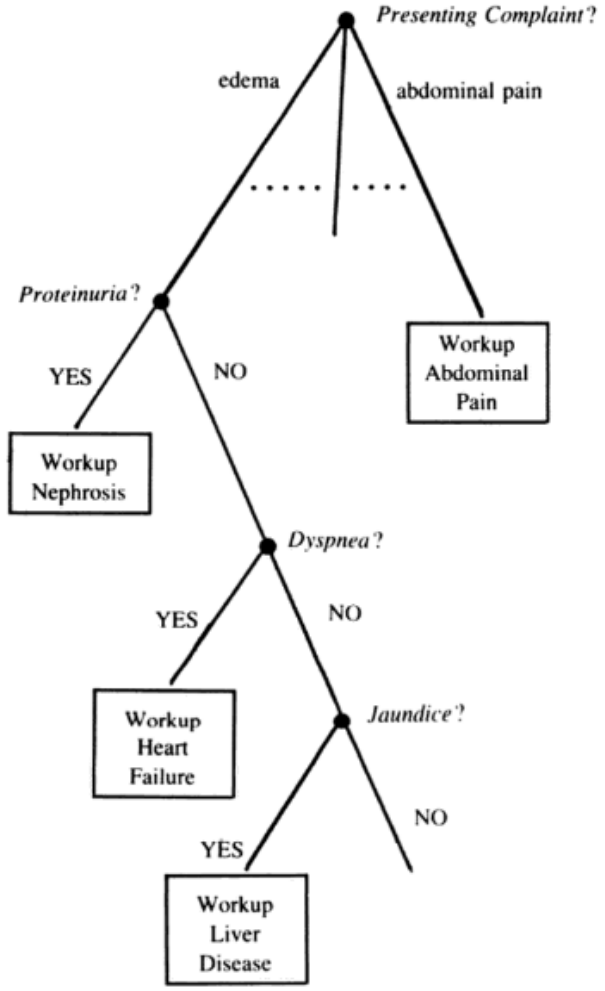
Harry Pople, PhD

Knowledge base consisting of some 500 disease entities, organized into categories by organ system, and their over 3,000 clinical manifestations.





```
PURSUING:  DISSEMINATED INTRAVASCULAR COAGULATION
ACUTE

PLEASE ENTER FINDINGS OF COAGULATION TEST (S)
*GO

ANTITHROMBIN III LESS THAN 50 PERCENT OF NORMAL?
N/A

ETHANOL GEL TEST POSITIVE?
N/A

PROTAMINE PARACOAGULATION TEST POSITIVE?
N/A

BLOOD INCOAGULABLE?
NO
```



While INTERNIST worked - in complex cases it often considered inappropriate possibilities and wasted clinicians' time answering questions with respect to them. To overcome this, INTERNIST-II used a heuristic that recognized that certain manifestations are distinctively characteristic of a disease or category of diseases. Jaundice, which is prominent in this diagram we just saw, is highly suggestive of liver disease so the initial focus in a patient with this symptom should be on this disease category, as it would be if a physician were making the diagnosis.

INTERNIST II

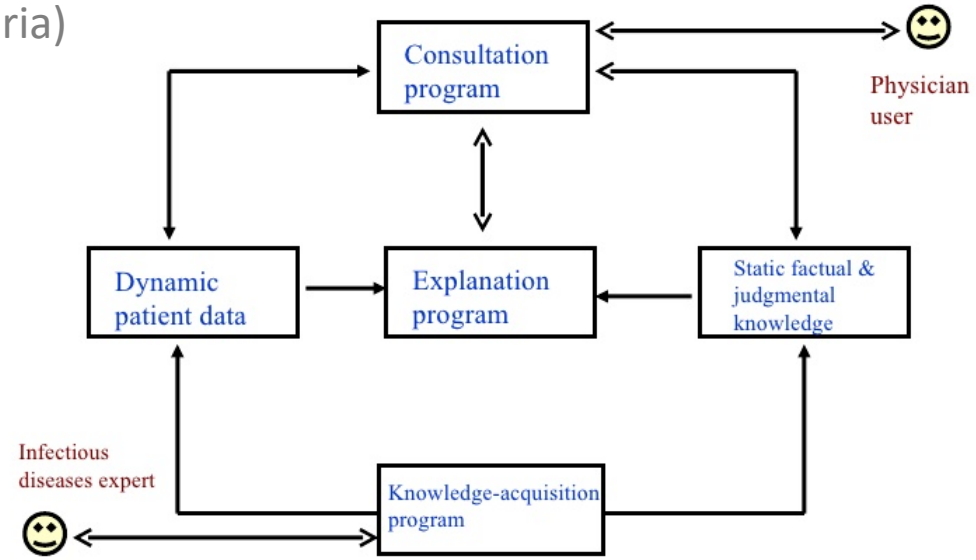
1972: MYCIN
Computer Aided Treatment

Ted Shortliffe, MD, PhD

- Fairly simple inference engine/knowledge base of ~600 rules
- Physician query
- Provided a ranked list of possible bacteria
- Probability of each diagnosis with confidence its confidence in each diagnosis
- Reasoning behind each diagnosis (list of questions and rules which led to its ranking)
- Recommended course of drug treatment.

Never used in practice

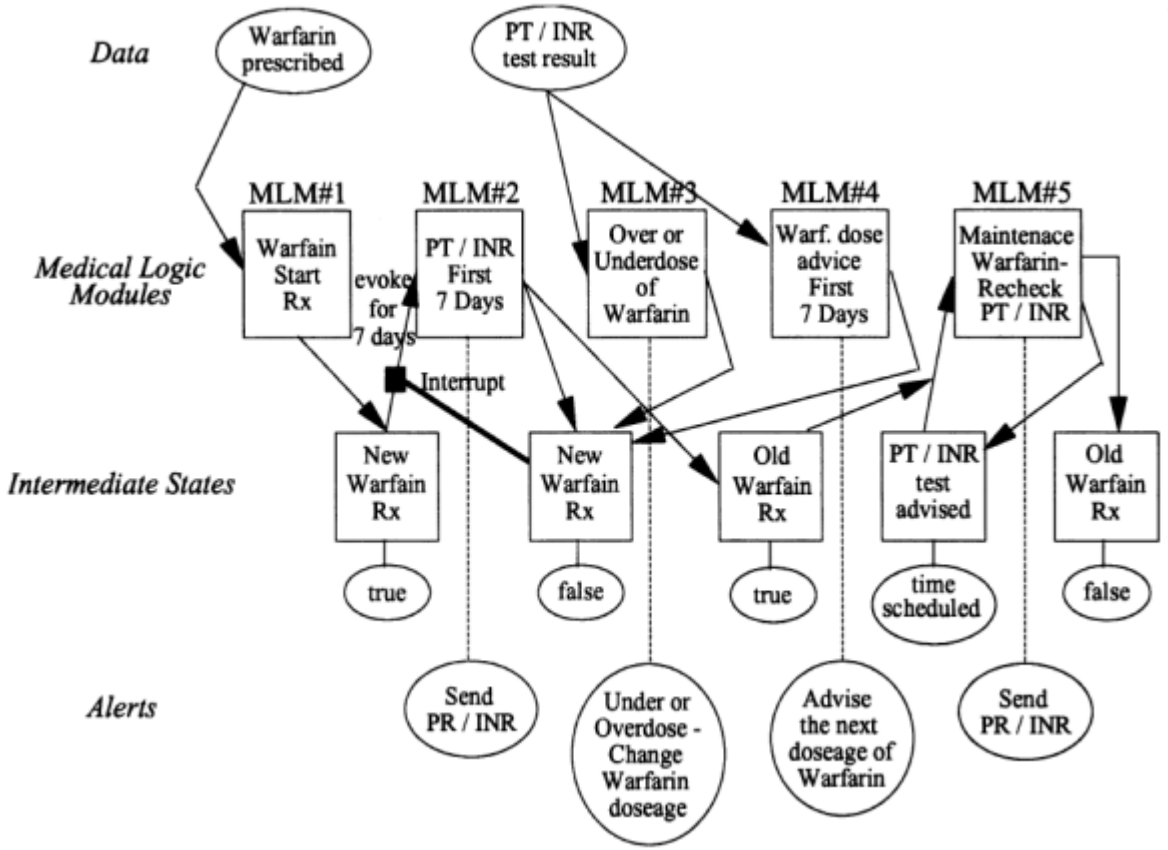
Research indicated that it proposed an acceptable therapy ~ 69% of cases, (better than infectious disease experts using the same criteria)



https://www.youtube.com/watch?v=a65uwr_O7mM
https://www.youtube.com/watch?v=ppkg4mQIgXw

1994: A Standard for Clinical Decision Support

Arden Syntax



George Hripscak

https://www.ncbi.nlm.nih.gov/pubmed/7705066

Arden Example

```
library:
    purpose:
            When a penicillin is prescribed, check for an allergy. (This MLM
            demonstrates checking for contraindications.);;
    explanation:
            This MLM is evoked when a penicillin medication is ordered. An
            alert is generated because the patient has an allergy to penicillin
            recorded.;;
    keywords: penicillin; allergy;;
    citations: ;;
knowledge:
    type: data-driven;;
    data:
            /* an order for a penicillin evokes this MLM */
            penicillin order := event {medication order where
                                    class = penicillin};
            /* find allergies */
            penicillin allergy := read last {allergy where
                                        agent class = penicillin};
            ;;
    evoke:
            penicillin_order;;
    logic:
            if exist(penicillin allergy)then
               conclude true;
            endif;
            ;;
    action:
            write "Caution, the patient has the following allergy to penicillin documented:"
             || penicillin_allergy;;
    urgency: 50;;
end:
```

Curly Braces Problem

```
creatinine := read {‘dam’="PDQRES2"};
last_creat := read last {select "OBSRV_VALUE"
from "LCR" where qualifier in
("CREATININE",
"QUERY_OBSRV_ALL")};
```

→ Interoperability

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US Healthcare

Brief History of Health Informatics: CDS

Early Interoperability Standards

Exciting Times

Today: Integrated Systems

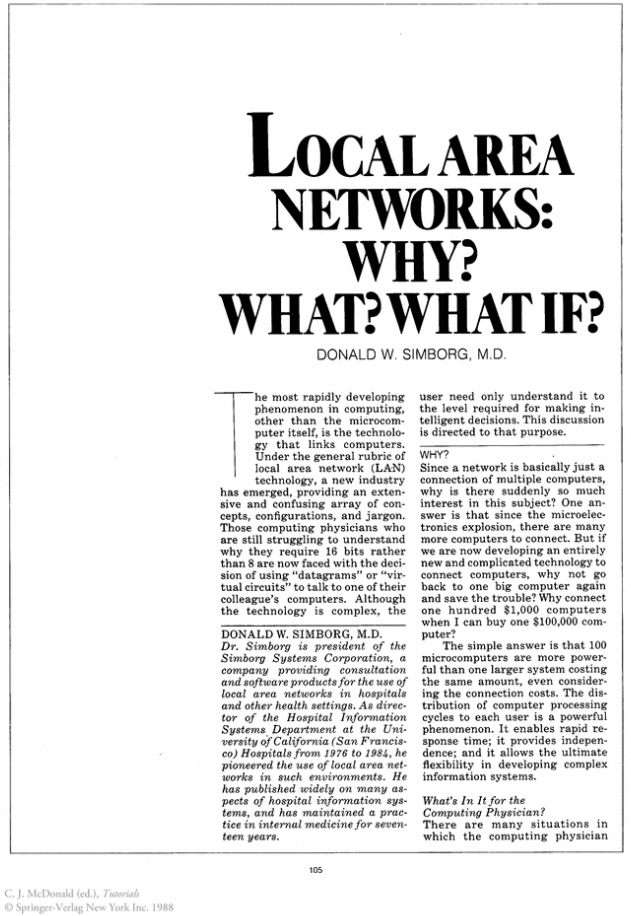
EMR

Lab Systems

MEDITECH

Yesterday: Best of Breed

Dr. Donald W. Simborg, MD, Founder and Chief Executive Officer of Simborg Systems Corporation, which introduced the open architecture patient care system StatLan. **Co-founder of HL7.**



LOCAL AREA NETWORKS: WHY? WHAT? WHAT IF?

DONALD W. SIMBORG, M.D.

The most rapidly developing phenomenon in computing, other than the microcomputer itself, is the technology that links computers. Under the general rubric of local area network (LAN) technology, a new industry has emerged, providing an extensive and confusing array of concepts, configurations, and jargon. Those computing physicians who are still struggling to understand why they require 16 bits rather than 8 are now faced with the decision of using "datagrams" or "virtual circuits" to talk to one of their colleague's computers. Although the technology is complex, the user need only understand it to the level required for making intelligent decisions. This discussion is directed to that purpose.

DONALD W. SIMBORG, M.D.
Dr. Simborg is president of the Simborg Systems Corporation, a company providing consultation and software products for the use of local area networks in hospitals and other health settings. As director of the Hospital Information Systems Department at the University of California (San Francisco) Hospitals from 1976 to 1984, he pioneered the use of local area networks in such environments. He has published widely on many aspects of hospital information systems, and has maintained a practice in internal medicine for seventeen years.

WHY?

Since a network is basically just a connection of multiple computers, why is there suddenly so much interest in this subject? One answer is that since the microelectronics explosion, there are many more computers to connect. But if we are now developing an entirely new and complicated technology to connect computers, why not go back to one big computer again and save the trouble? Why connect one hundred $1,000 computers when I can buy one $100,000 computer?

The simple answer is that 100 microcomputers are more powerful than one larger system costing the same amount, even considering the connection costs. The distribution of computer processing cycles to each user is a powerful phenomenon. It enables rapid response time; it provides independence; and it allows the ultimate flexibility in developing complex information systems.

What's In It for the Computing Physician?

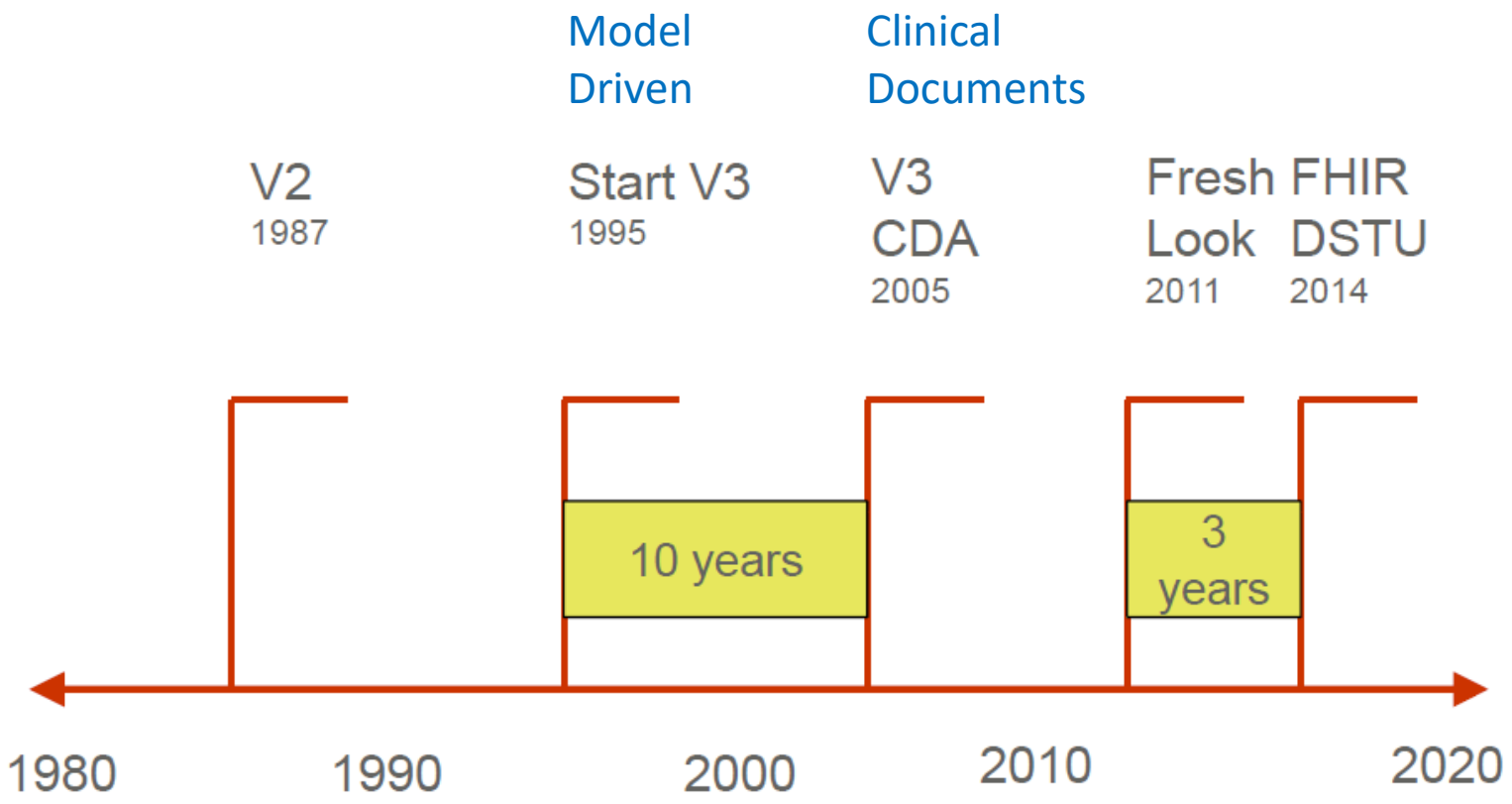
There are many situations in which the computing physician

C. J. McDonald (ed.), *Tutorials*

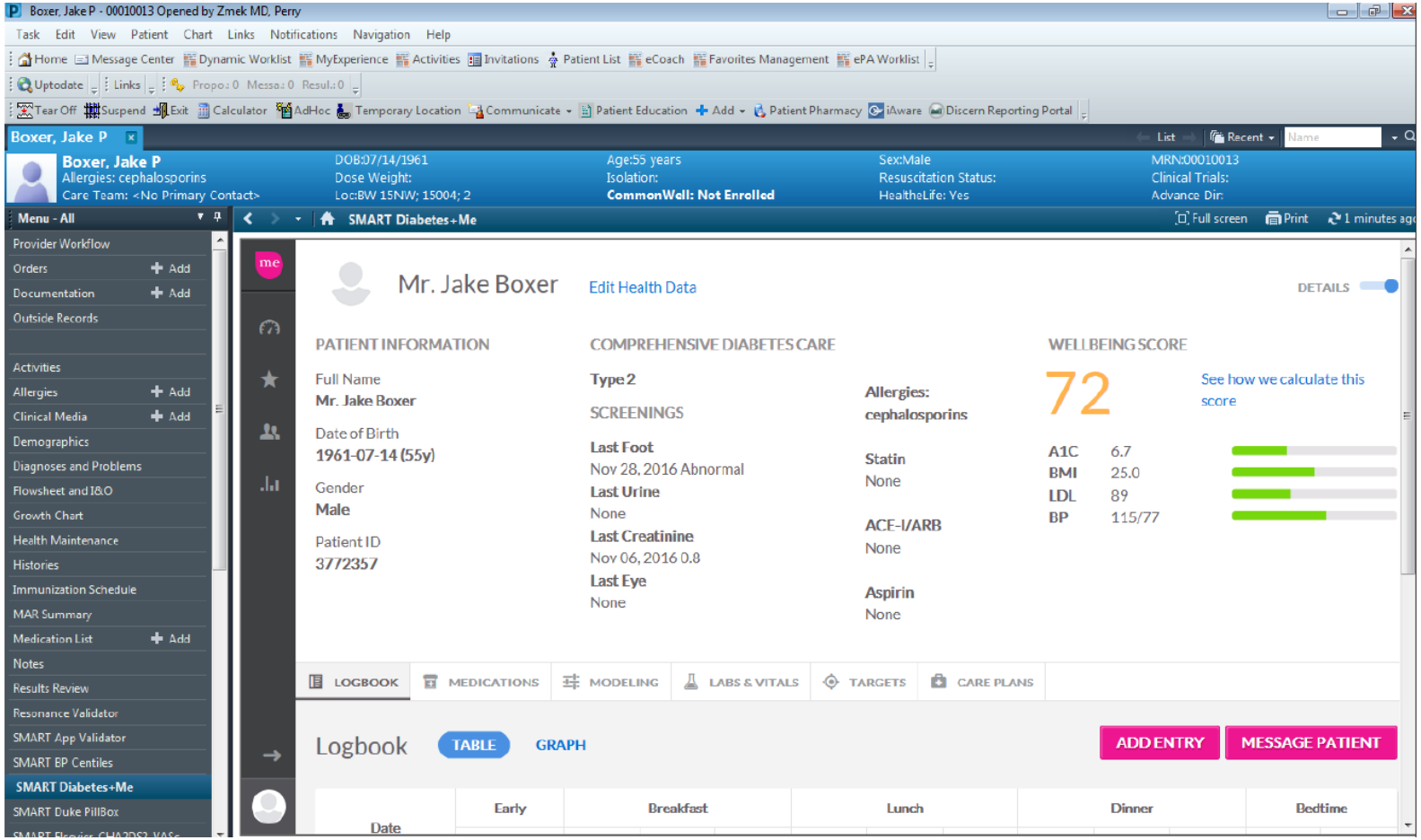
HL7's Mission

"a not-for-profit, ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services"

HL7 Evolution

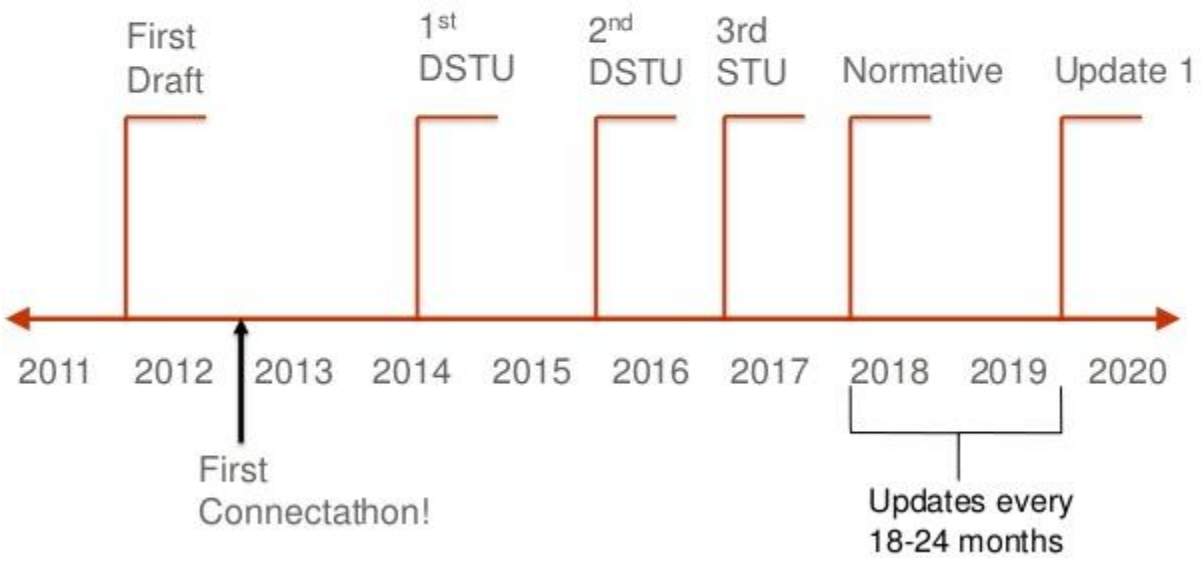


Exciting Times



EMORY UNIVERSITY SCHOOL OF MEDICINE

FHIR Timeline



Standards and Tools of the trade

Why Standards?

HL7 Standards Evolution

Key Data Standards

- International Classification of Disease (ICD)
  - ICD Activity
- Current Procedural Terminology (CPT)
- Logical Observation Identifiers Names and Codes (LOINC)
  - LOINC Activity
- National Drug Codes (NDC)
  - NDC Activity
- RxNorm
  - RxNorm Activity
- The Systemized Nomenclature of Medicine (SNOMED)
  - SNOMED Activity

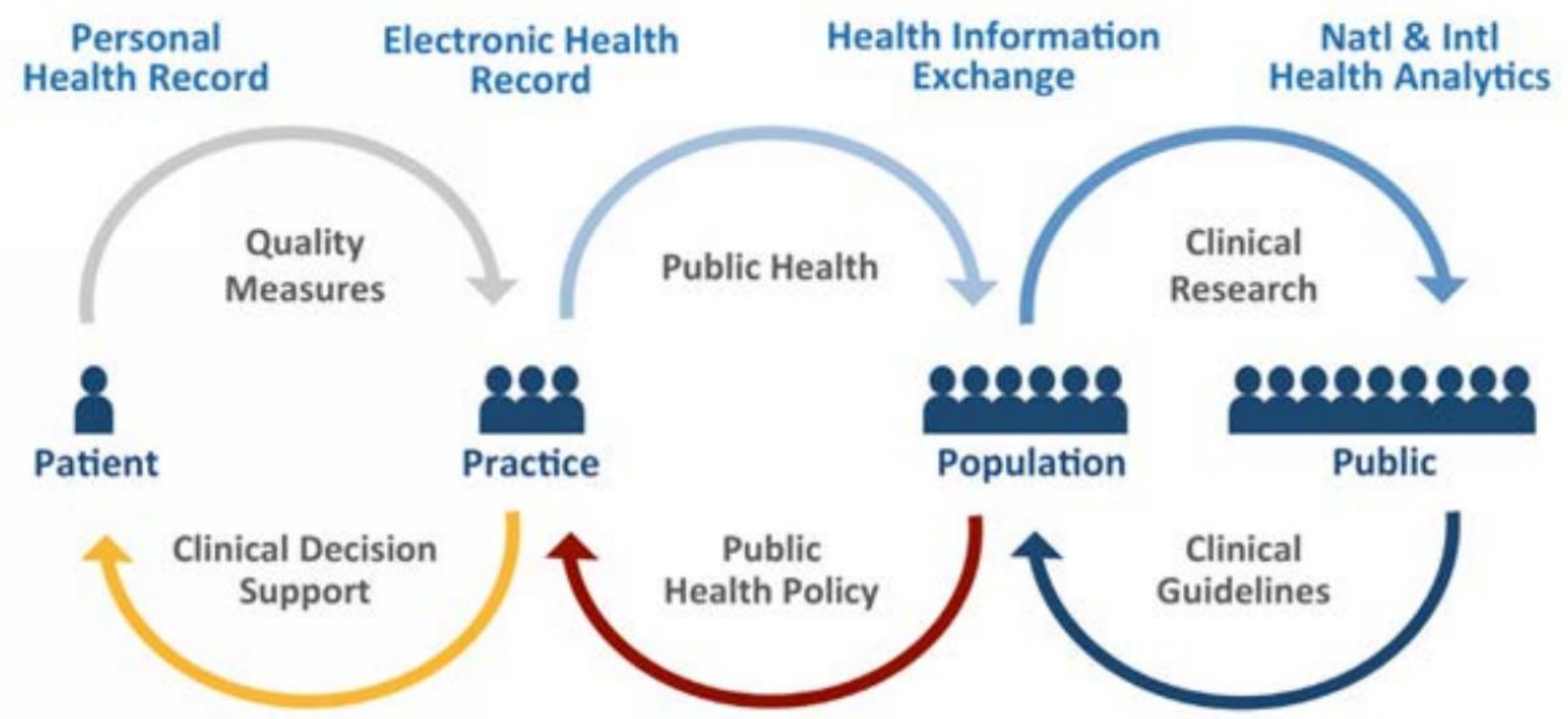
Open mHealth

Why Standards?
Interoperability

Traditional: possessing the technical means to share diverse data among digital systems and tools

Open: ensuring that the data stored in digital health systems is freely available to end users and software developers rather than being restricted only to the vendor companies that created those systems

Contemporary Interoperability Spectrum



https://*www.healthit.gov/sites/default/files/nationwide-interoperability-roadmap-draft-version-1.0.pdf*

Care Coordination
Chronic Disease

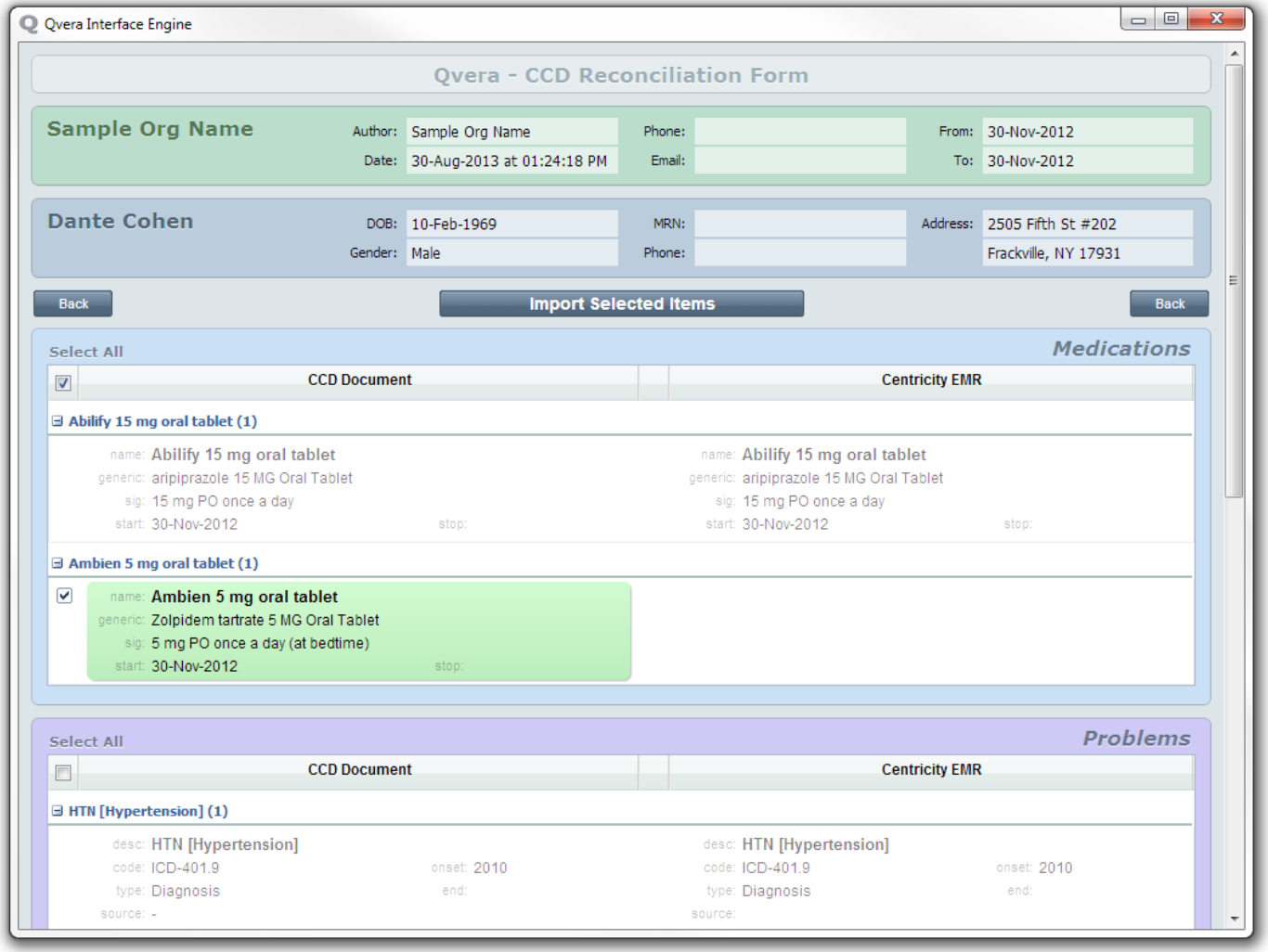
"… while the average Medicare beneficiary sees between six and seven different physicians, **beneficiaries with five or more chronic conditions see almost 14 different physicians in a year** and average 37 physician visits annually. People with five or more chronic conditions fill almost 50 prescriptions in a year."

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1497638/pdf/15158105.pdf

Transitions of Care
Medication Reconciliation

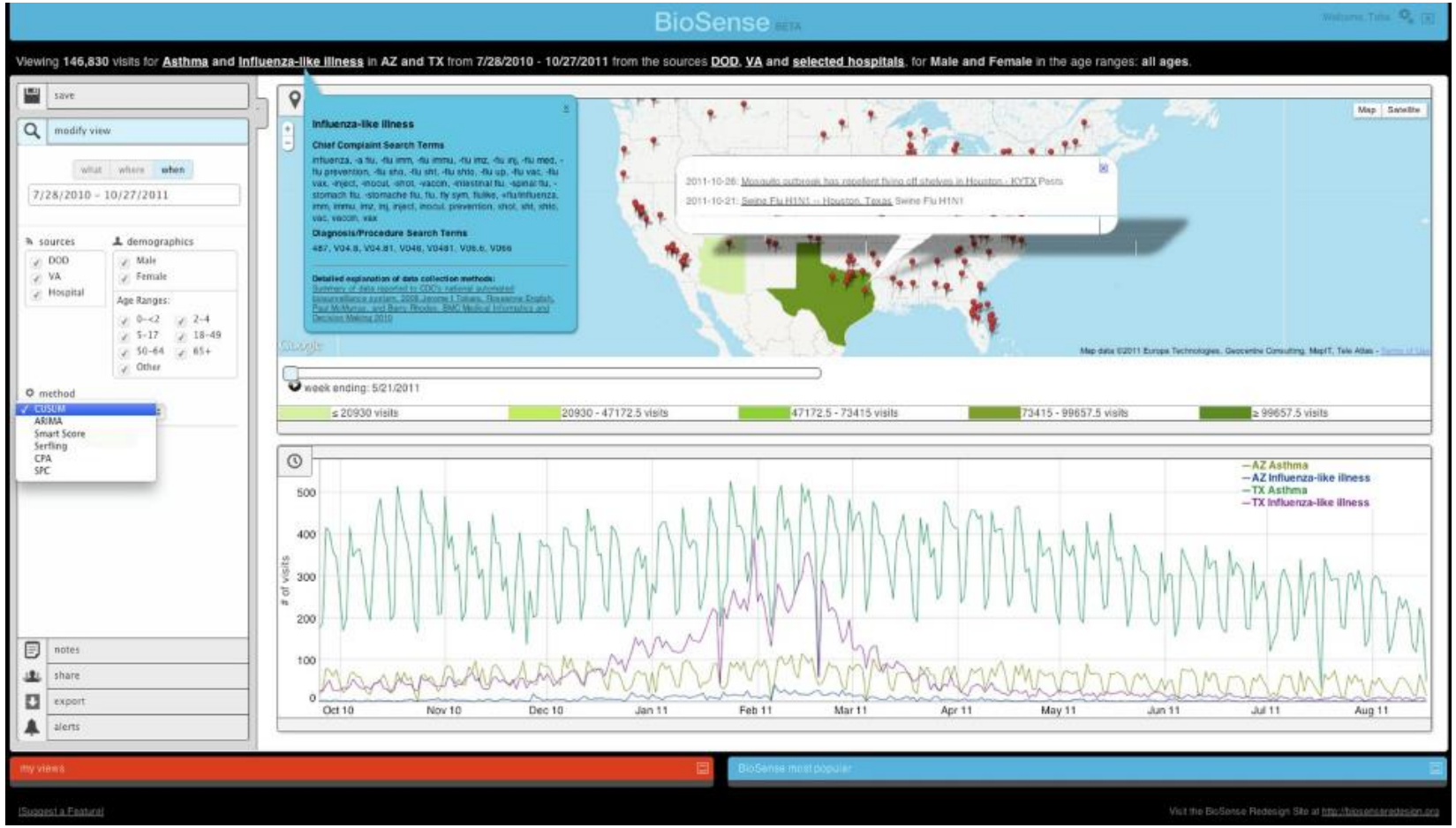
"an estimated 80% of serious medical errors involve miscommunication between caregivers during the transfer of patients."

http://www.jointcommission.org/assets/1/6/tst_hoc_persp_08_12.pdf

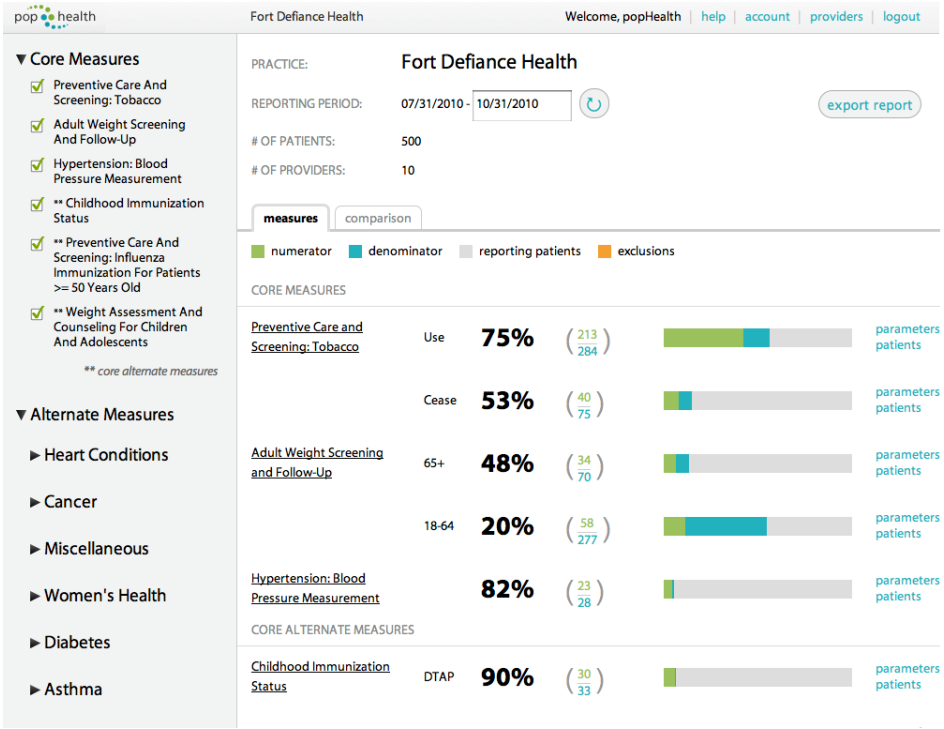


Courtesy: Qvera

Public Health
Surveillance



Population Health
Quality Measures



https://www.osehra.org/popHealth

The Triple Aim (IHI):

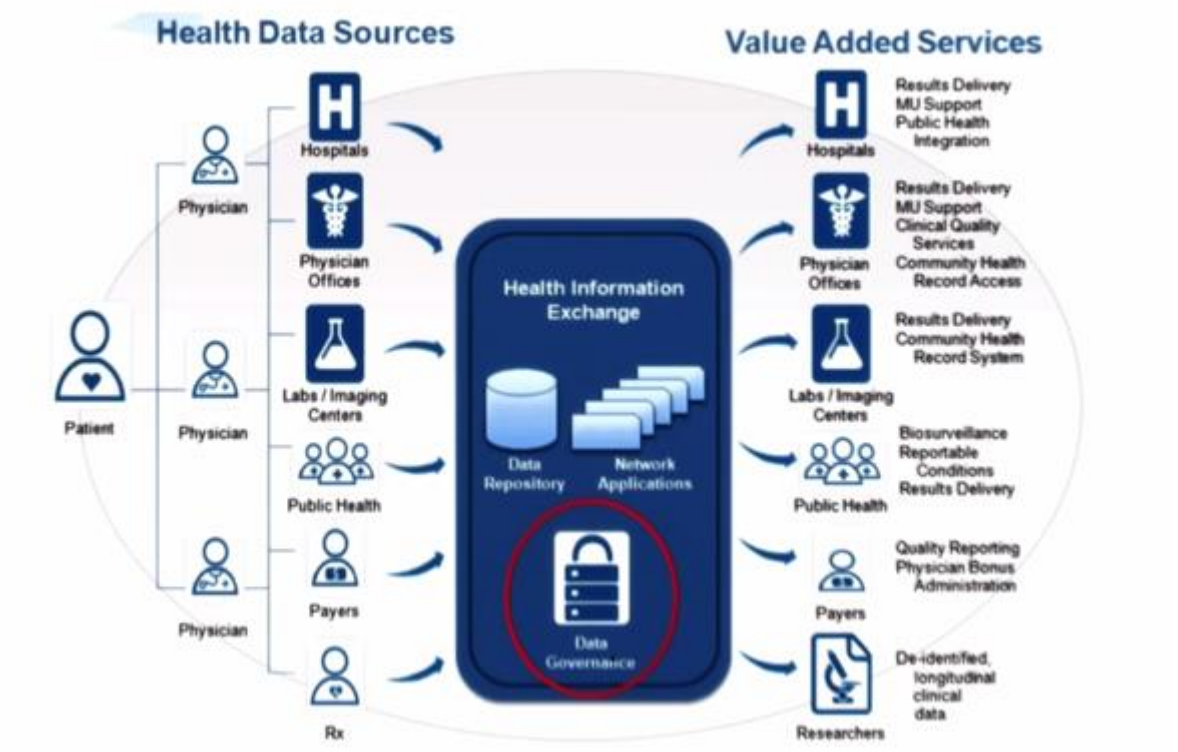
Improving the patient experience of care (including quality and satisfaction)

Improving the health of populations

Reducing the per capita cost of health care

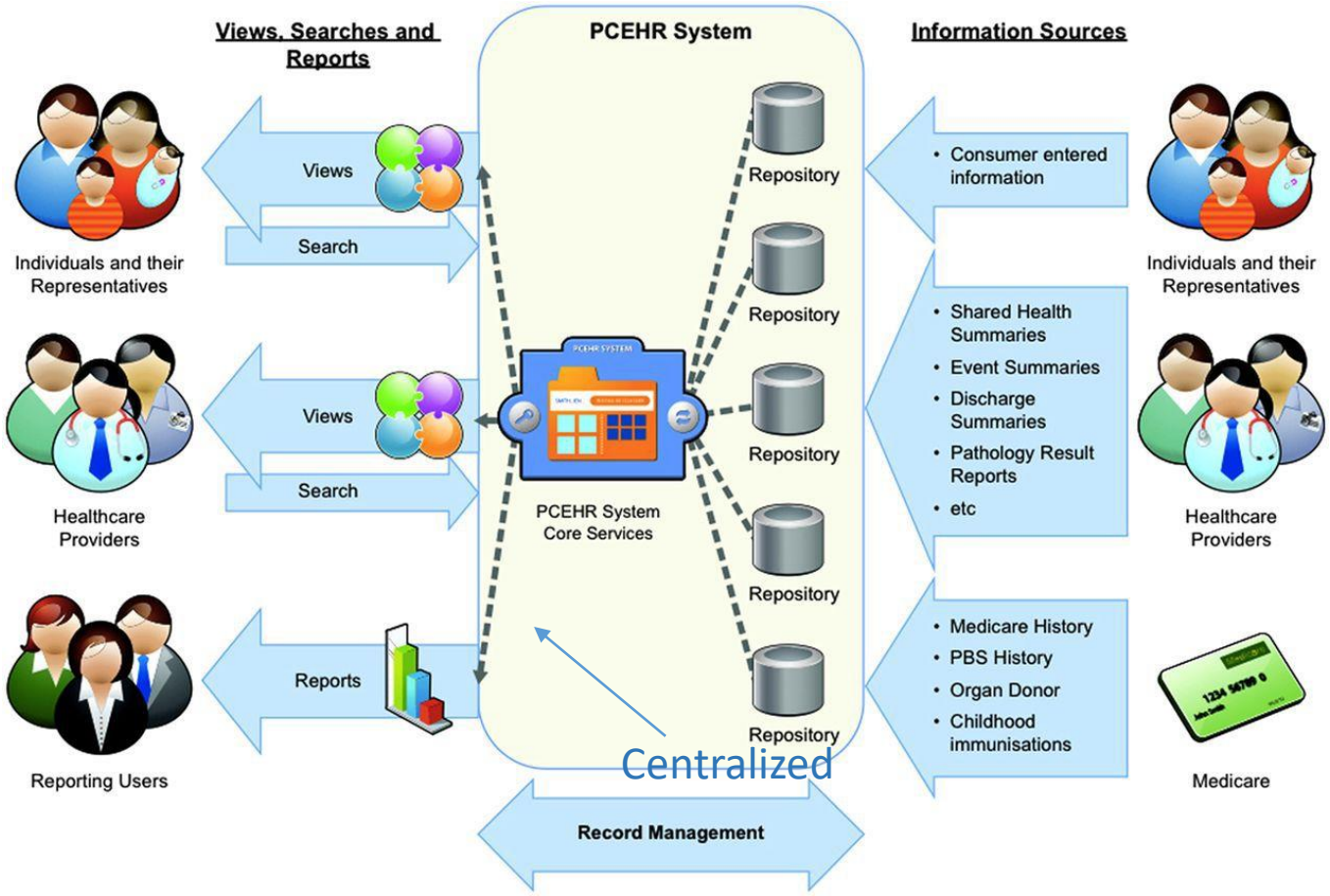
http://www.ihi.org/engage/initiatives/tripleaim/pages/default.aspx

Regional Health Information Exchange
Indiana Health Information Exchange (IHIE)

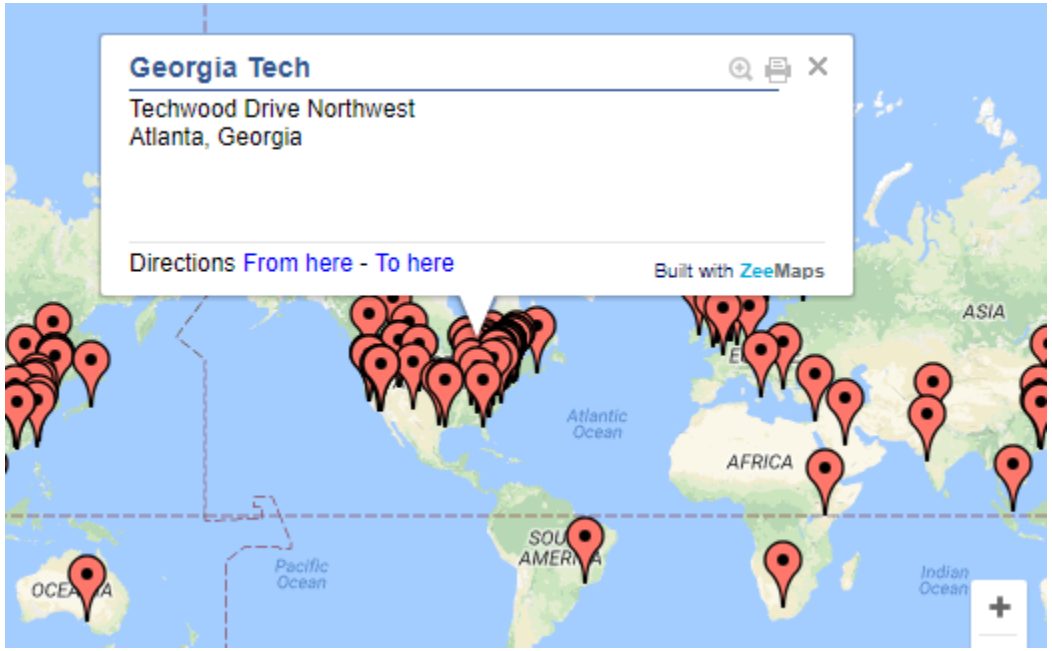


http://www.ihie.org/

National EHR
My Health Record (Australia)



Global Research
Observational Health Data Sciences and Informatics (OHDSI)



http://www.ohdsi.org/

Standards and Tools of the trade

- Data Standards
  - Why Standards?
  - **HL7 Standards Evolution**
  - Key Data Standards
    - International Classification of Disease (ICD)
      - ICD Activity
    - Current Procedural Terminology (CPT)
    - Logical Observation Identifiers Names and Codes (LOINC)
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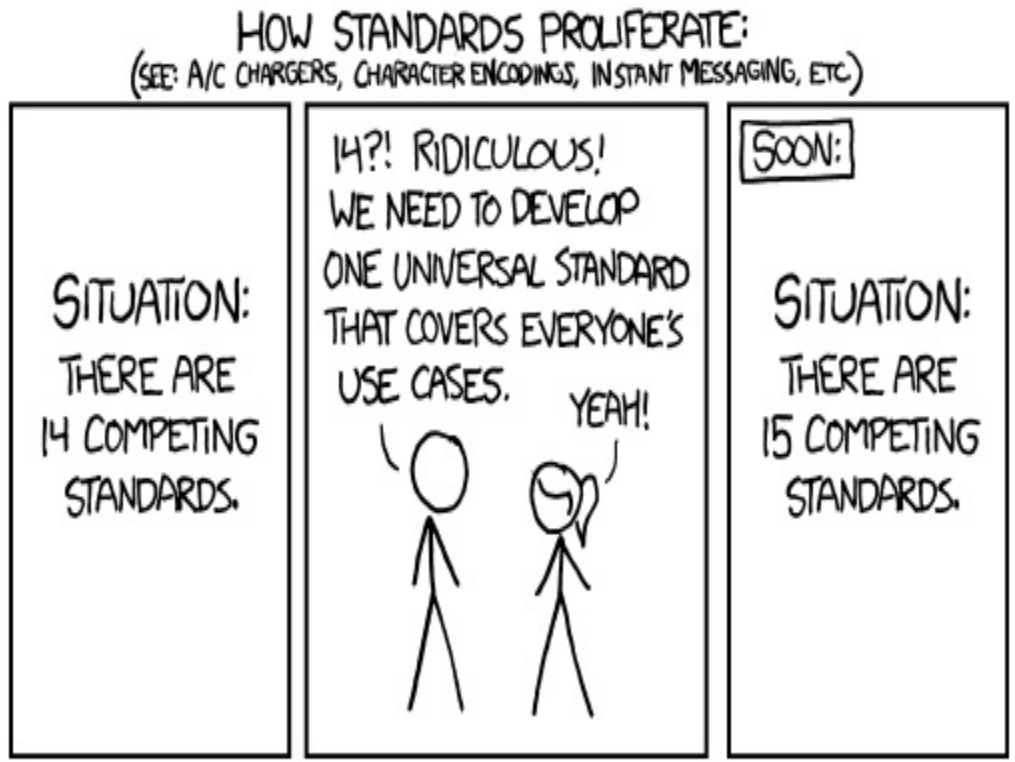
      - NDC Activity
    - RxNorm
      - RxNorm Activity
    - The Systemized Nomenclature of Medicine (SNOMED)
      - SNOMED Activity
  - Open mHealth


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)
SITUATION: THERE ARE 14 COMPETING STANDARDS.
14?! RIDICULOUS! WE NEED TO DEVELOP ONE UNIVERSAL STANDARD THAT COVERS EVERYONE'S USE CASES.
YEAH!
SOON:
SITUATION: THERE ARE 15 COMPETING STANDARDS.

HL7 V2 Message

An implementation-driven standard that works well enough in a wide variety of use cases.

95% of US healthcare organizations use HL7 V2.x

LOINC **1554-5** Glucose [Mass/volume] in Serum or Plasma --12 hours fasting

```
MSH|^~\&|GHH LAB|ELAB-3|GHH OE|BLDG4|200202150930||ORU^R01|CNTRL-3456|P|2.4<cr>
PID|||555-44-4444||EVERYWOMAN^EVE^E^^^^L|JONES|19620320|F|||153 FERNWOOD DR.^^STATESVILLE^OH^35292||(206)3345232|(206)752-121||||AC555444444||67-A4335^OH^20030520<cr>
OBR|1|845439^GHH OE|1045813^GHH LAB|15545^GLUCOSE|||200202150730|||||||| 555-55-5555^PRIMARY^PATRICIA P^^^^MD^^|||||||||F||||||444-44-4444^HIPPOCRATES^HOWARD H^^^^MD<cr>
OBX|1|SN|1554-5^GLUCOSE^POST 12H CFST:MCNC:PT:SER/PLAS:QN||^182|mg/dl|70_105|H|||F<cr>
```

Glucose level (normal ranges)

Segments:

MSH – Header
PID – Patient Identifier
OBR – Observation Request
OBX – Observation Result

http://wiki.hl7.org/index.php?title=Examples_section_of_the_v3Guide#The_V2.4_Message

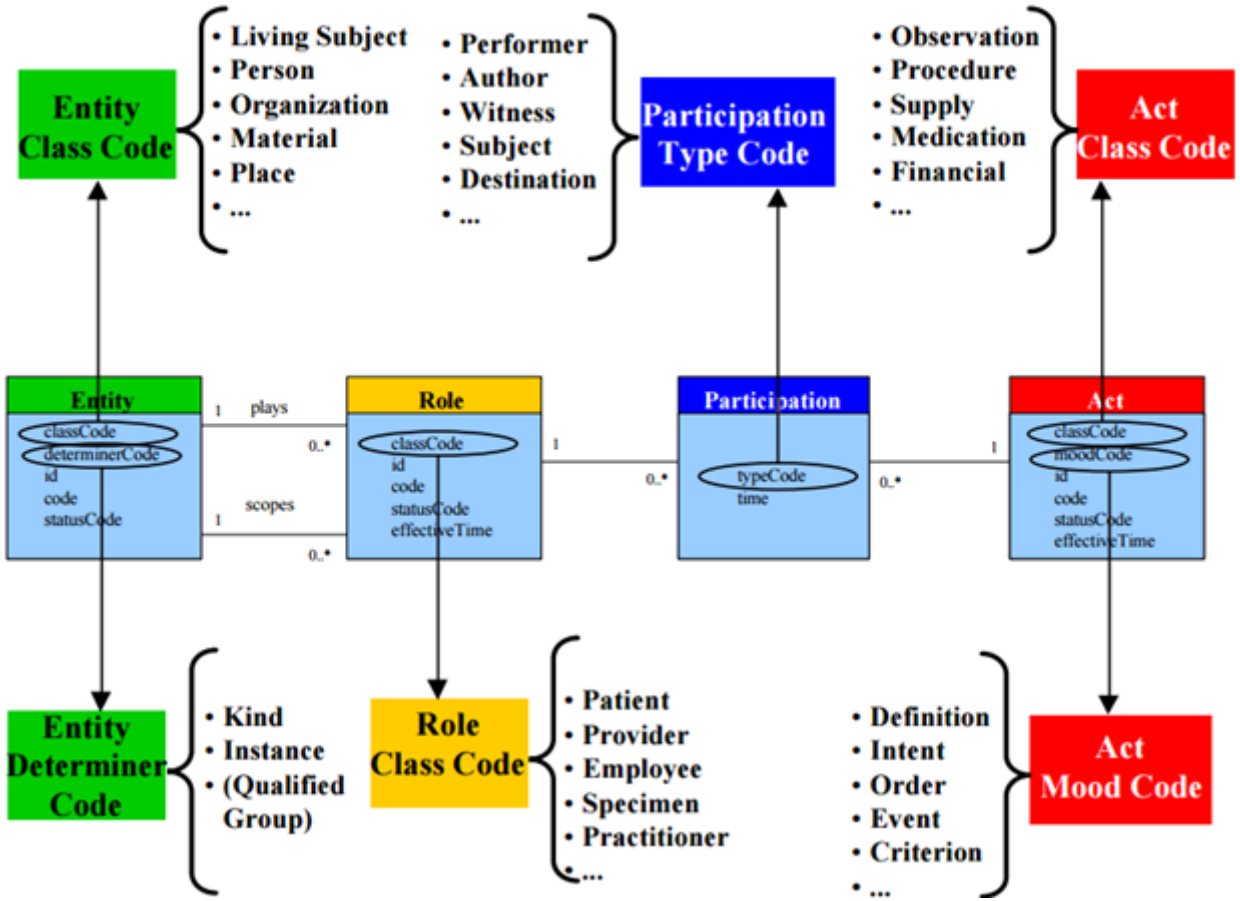
V2 Message Types/Segments

ACK – General acknowledgement
ADT – Admit/discharge/transfer
BAR – Add/change billing account
DFT – Detailed financial transaction
MDM – Medical document management
MFN – Master files notification
ORM – Order (Pharmacy/treatment)
ORU – Observation result (unsolicited)
QRY – Query, original mode
RAS – Pharmacy/treatment administration
RDE – Pharmacy/treatment encoded order
RGV – Pharmacy/treatment give
SIU – Scheduling information unsolicited

DG1 – Diagnosis
EVN – Event type
GT1 – Guarantor
IN1 – Insurance
MSH – Message header
NK1 – Next of kin/associated parties
NTE – Notes and comments
OBR – Observation request
OBX – Observation result
ORC – Common order
PID – Patient identification
FT1 (for DFT messages) – Financial transaction

RIM Core Structural Attributes

"a static model of health and healthcare information as viewed within the scope of HL7 standards development activities"



HL7 V3 Model Driven

Transmission Wrapper
Trigger Event Control Act wrapper
Domain Content

```
<observationEvent>
 <id root="2.16.840.1.113883.19.1122.4" extension="1045813"
    assigningAuthorityName="GHH LAB Filler Orders"/>
 <code code="1554-5" codeSystemName="LN"
     codeSystem="2.16.840.1.113883.6.1"
     displayName="GLUCOSE^POST 12H CFST:MCNC:PT:SER/PLAS:QN"/>
 <statusCode code="completed"/>
 <effectiveTime value="200202150730"/>
 <priorityCode code="R"/>
 <confidentialityCode code="N"
   codeSystem="2.16.840.1.113883.5.25"/>
 <value xsi:type="PQ" value="182" unit="mg/dL"/>
 <interpretationCode code="H"/>
 <referenceRange>
   <interpretationRange>
     <value xsi:type="IVL_PQ">
     <low value="70" unit="mg/dL"/>
     <high value="105" unit="mg/dL"/>
    </value>
    <interpretationCode code="N"/>
   </interpretationRange>
 </referenceRange>
```

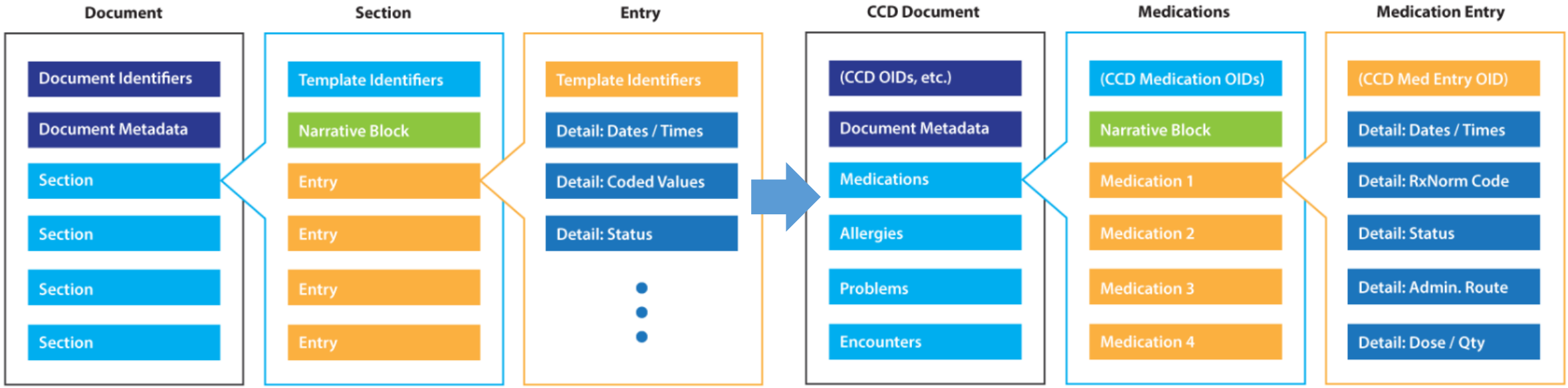
LOINC **1554-5** Glucose [Mass/volume] in Serum or Plasma --12 hours fasting

Glucose level (normal ranges)

Level	Code	Display
1	_Confidentiality	Confidentiality
2	L	low
2	M	moderate
2	N	normal
2	R	restricted
2	U	unrestricted
2	V	very restricted

http://wiki.hl7.org/index.php?title=Examples_section_of_the_v3Guide#The_v3_Message_-_Domain_Content

HL7 Clinical Document Architecture (CDA)



Complex XML schema
Renderable
Not composeable

1. Open Alma Deleon CCD with Text Viewer Program
2. Copy and paste into XML Input Box
3. Click Tree View

https://www.linkedin.com/pulse/connecting-ios-your-emr-using-healthkit-cda-part-three-eric-whitley

Document Template

Section Template

Entry Level Template
Family History

templateid
@root: 2.16.840.1.113883.10.20.22.4.46
id
@root: 9FBDA803-4612-4A37-880F-B1E1B373F0B0
code
@code: 64572001
@codeSystem: 2.16.840.1.113883.6.96
@codeSystemName: SNOMED-CT
@displayName: Condition

SNOMED Disease

statuscode
@code: completed
value ..
@xsi:type: CD
@code: 346.90
@codeSystem: 2.16.840.1.113883.6.104
@codeSystemName: ICD9
@displayName: Migraine Headaches

ICD9 Migraine

originaltext Migraine Headaches
@representation: TXT
@mediaType: text/plain
@language: en-US
entryrelationship ..
@typeCode: SUBJ
@inversionInd: true
@contextConductionInd: true
observation ..
@classCode: OBS
@moodCode: EVN

From RIM

EntryRelationship: One of several elements used to connect clinical act statements to each other.

Observation: An act that is intended to result in new information about a subject.

Standards and Tools of the trade

- Data Standards
  - Why Standards?
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  - **Key Data Standards**
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      - ICD Activity
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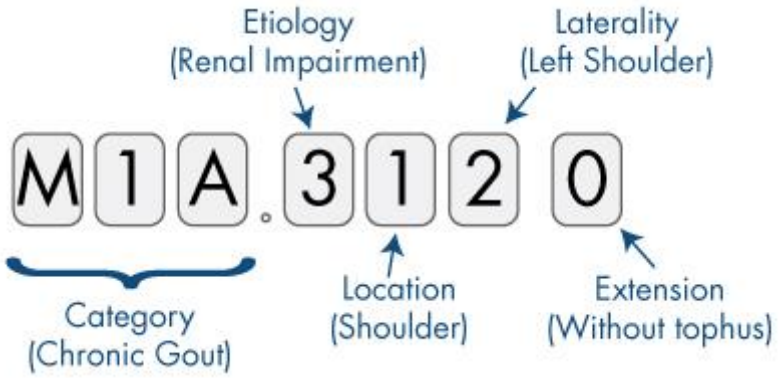
      - NDC Activity
    - RxNorm
      - RxNorm Activity
    - The Systemized Nomenclature of Medicine (SNOMED)
      - SNOMED Activity
    - Open mHealth

WHO: ICD-10
Complexity



ICD-10 Versus ICD-9

ICD-9	ICD-10
3 to 5 characters in length	3 to 7 characters in length
Approximately 13,000 codes	Approximately 68,000 available codes
First character may be alpha (E or V) or numeric; characters 2–5 are numeric	Character 1 is alpha; characters 2 and 3 are numeric; characters 4–7 are alpha or numeric
Limited space for adding new codes	Flexible for adding new codes
Lacks detail	Very specific
Lacks laterality	Has laterality (i.e., codes identifying right vs. left)

Breast Cancer

174.5:	Malignant neoplasm of female breast, lower-outer quadrant	Three possible codes based on laterality: • C50.511- Malignant neoplasm of lower-outer quadrant of **right** female breast • C50.512- Malignant neoplasm of lower-outer quadrant of **left** female breast • C50.519- Malignant neoplasm of lower-outer quadrant of **unspecified** female breast

ICD Activity

http://apps.who.int/classifications/icd10/browse/2015/en

or

https://icd.who.int/dev11/l-m/en

How many ICD-10 top level classifications are there?

In what ICD-10 top level classification is *idiopathic gout* found?

What joint is affected in *gonarthrosis*?

What is the proper ICD-10 code for *Type 2 diabetes mellitus with multiple complications*?

According to the ICD-11 Foundation information, which of the these is *not* a symptom of *essential hypertension*?
Headache, Tinnitus, Nosebleeds, Lethargy

ICD Activity

How many ICD-10 top level classifications are there?
22

In what ICD-10 top level classification is *idiopathic gout* found?
Diseases of the musculoskeletal system and connective tissue

What joint is affected in *gonarthrosis*?
Knee

What is the proper ICD-10 code for *Type 2 diabetes mellitus with multiple complications*?
E11.7

According to the ICD-11 Foundation information, which of the these is *not* a symptom of *essential hypertension*?
Headache, Tinnitus, Nosebleeds, Lethargy

AMA: Current Procedural Terminology (CPT)

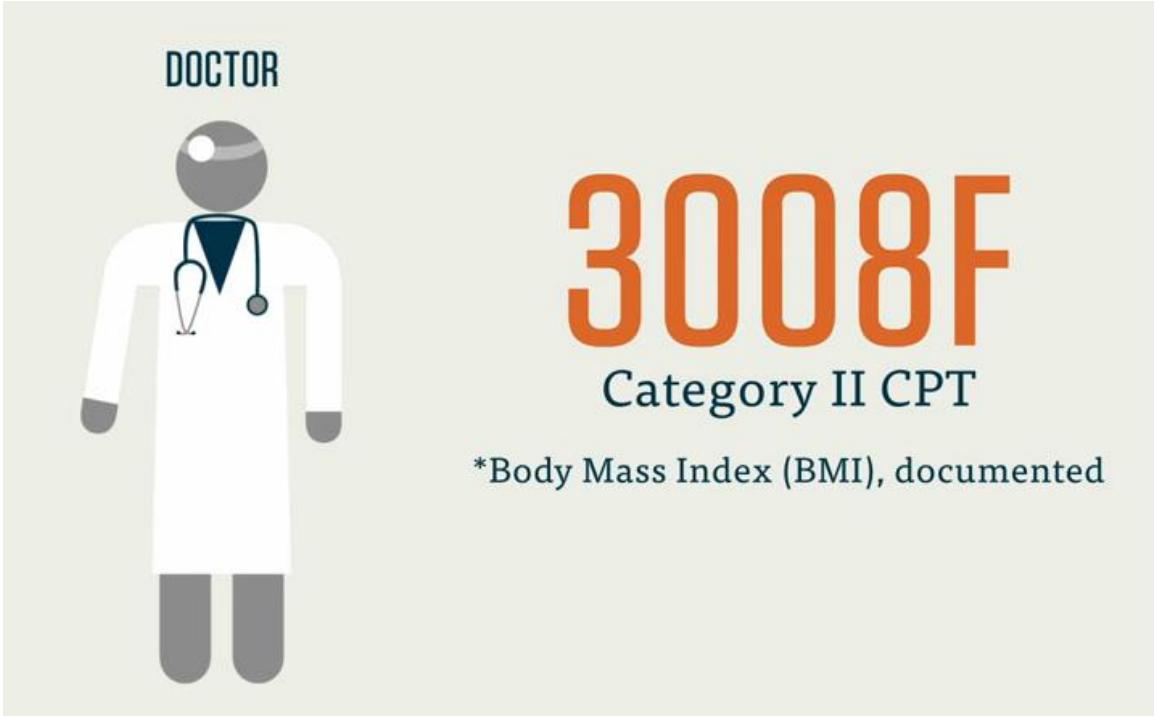
Names

Description	
Full	Influenza virus vaccine, trivalent, derived from recombinant DNA (RIV3), hemagglutinin (HA) protein only, preservative and antibiotic free, for intramuscular use
Medium	Influenza Virus Vaccine Trivalen RIV3 PRSR FR IM
Short	Flu Vacc RIV3 No Preserv

CPT
Categories

Category III Emerging/Experimental

Procedures that are consistent with contemporary **medical** practice and are **widely** performed



Supplementary **tracking codes** that can be used for **performance measures**

CPT
Medical Complexity

Office Visit CPT Coding Guidelines - New Patient

Office Visit Code	Type of History	Type of Exam	Type of Decision Making
99201	Problem focused	Problem focused	Straightforward
99202	Expanded - problem focused	Expanded - problem focused	Straightforward
99203	Detailed	Detailed	Low complexity
99204	Comprehensive	Comprehensive	Moderate complexity
99205	Comprehensive	Comprehensive	High complexity

CPT
Workload

CPT psychotherapy code	Session time	Minimum face-to-face time
90833	30	16
90836	45	38
90838	60	53

CPT Activity

Navigate here: https://www.ama-assn.org/practice-management/find-coding-resources
Click and register for free search

Set region to Mississippi

Search on keyword 'psychotherapy'.

Which code represents clinical action that relates to *quality and performance metrics*?

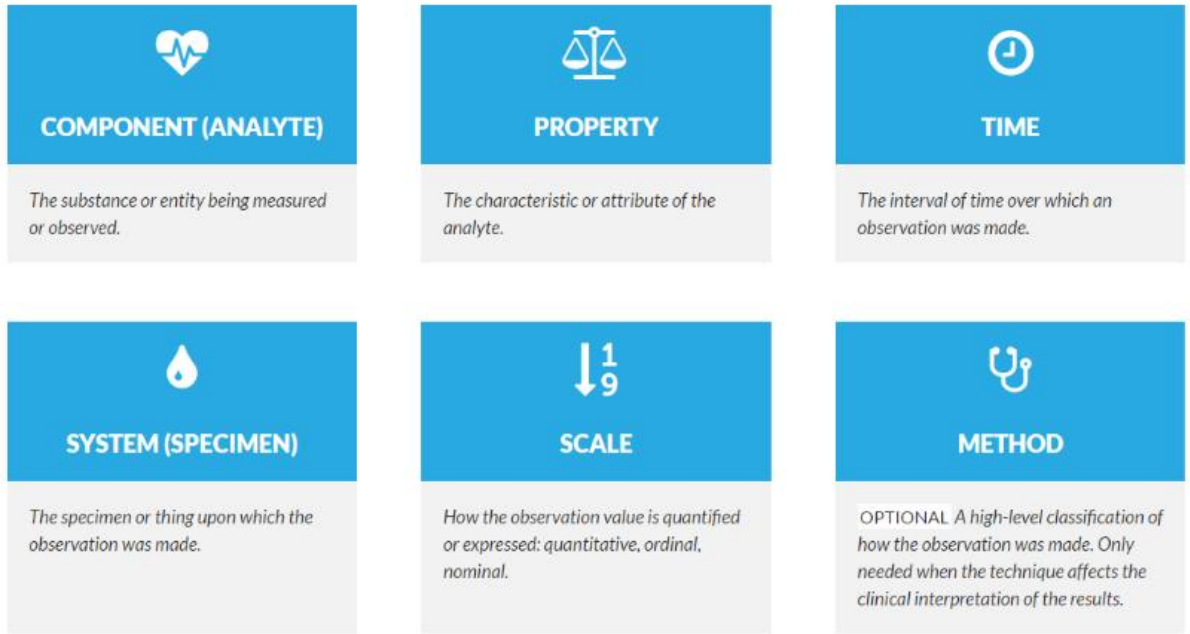
What are the CPT codes for a *multiple family group psychotherapy* and the Medicare payment for doing it in a facility?

Set Region to Atlanta, GA

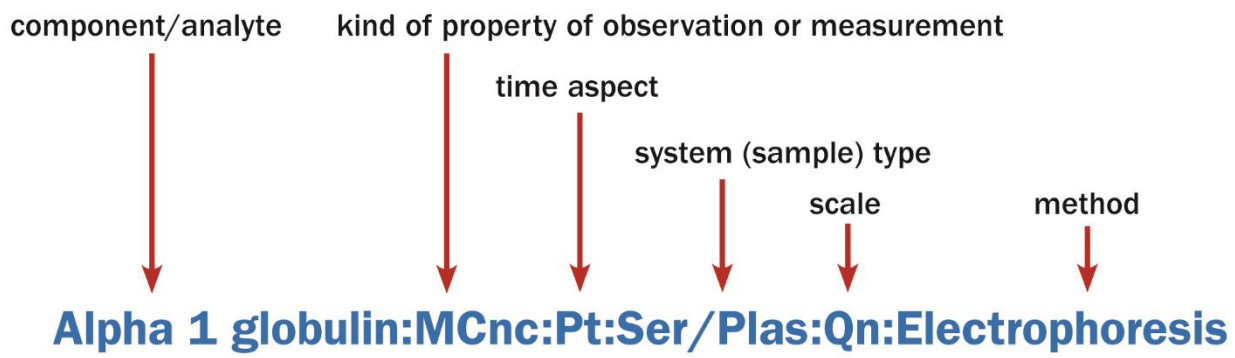
Search for *cesarean*. What is the Medicare payment for *standby service, requiring prolonged attendance, each 30 minutes*?

Search for *diabetes*. Find the CPT code for *Preventive behavior change ...* and type it in here.

Regenstrief: LOINC
Clinical Observations and Lab Tests



Name Details



LOINC Activity

Go to https://loinc.org/
Sign up for a free account to enable searching.
Locate the search page: https://search.loinc.org/searchLOINC/search.zul

Search for LOINC code 1514-9. What does *Qn* in the fifth (scale) subpart of its *Fully-Specified Name* indicate?

How many LOINC codes are there for the determination of Warfarin (Coumadin) level in *Urine*?

How many LOINC codes are there for a glucose determination using a glucometer?

True/False: The Point in Time aspect is used for these tests?

True/False: The Qualitative scale is used for the result set?

FDA: National Drug Codes (NDC)

NDC Activity

Go to https://www.accessdata.fda.gov/scripts/cder/ndc/

Search for ‘insulin’ with the non-proprietary name search. How many entries are returned?

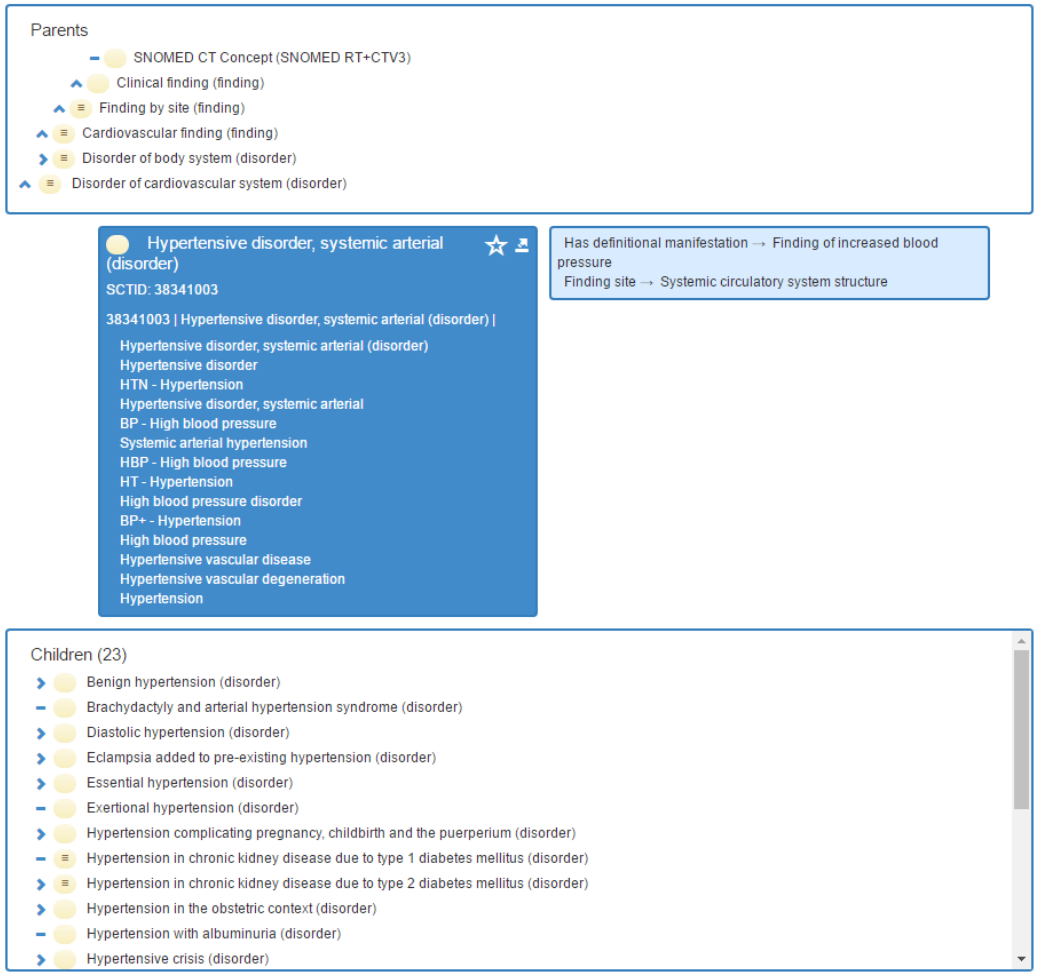
How many insulins have a route of administration of *oral*?

How many of these liquid, orally administered insulins are approved by the FDA?

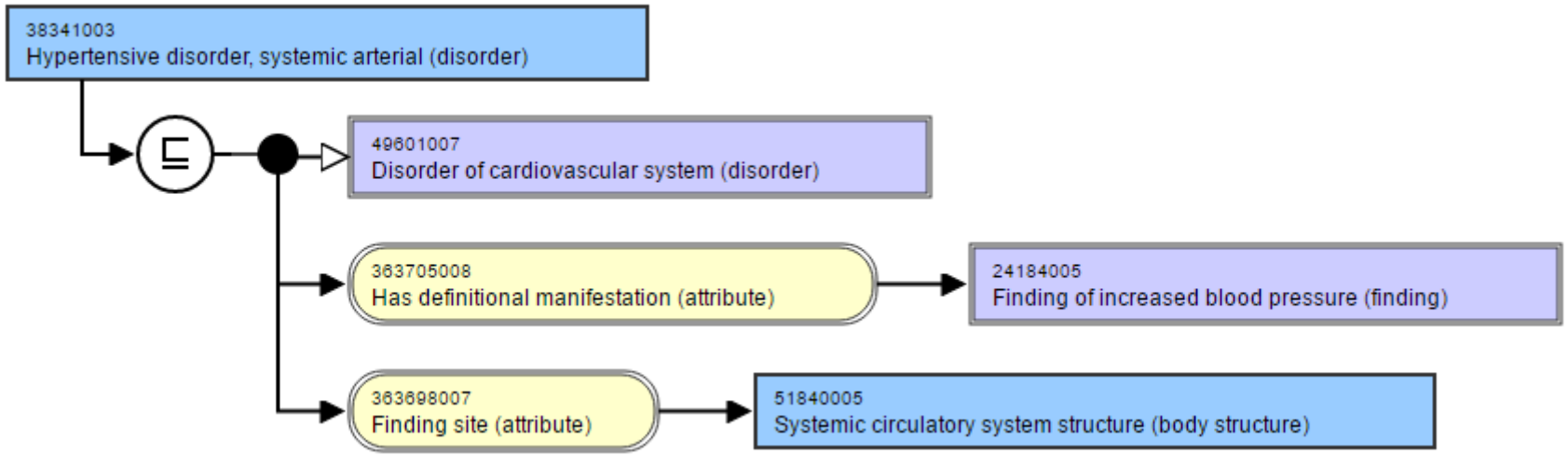
What is the labeler code for *Novo Nordisk*?

Are the package codes consistent across all drug products with NDC codes?

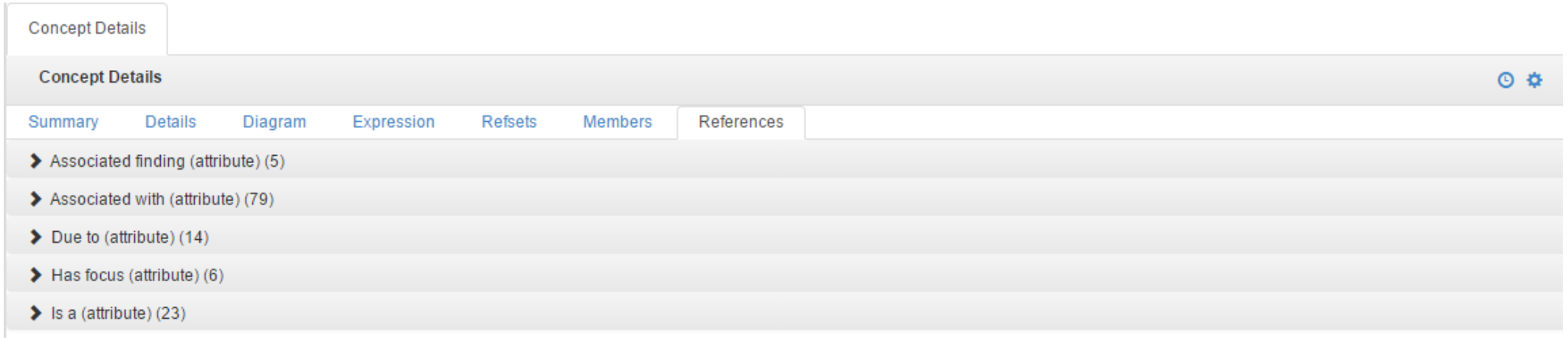
IHTSDO: SNOMED
Hierarchical View of Medicine



SNOMED
Graphical View



SNOMED
Concept Details



SNOMED
Associated With (Attribute)

Associated with (attribute) (79)

Term	ConceptId
Arteriolar nephritis (disorder)	16147005
Autosomal dominant progressive nephropathy with hypertension (disorder)	703310005
Benign arteriolar nephrosclerosis (disorder)	62240004
Benign hypertensive heart AND renal disease (disorder)	66052004
Benign hypertensive heart disease (disorder)	36221001

SNOMED Activity

http://browser.ihtsdotools.org/ Use the US Release

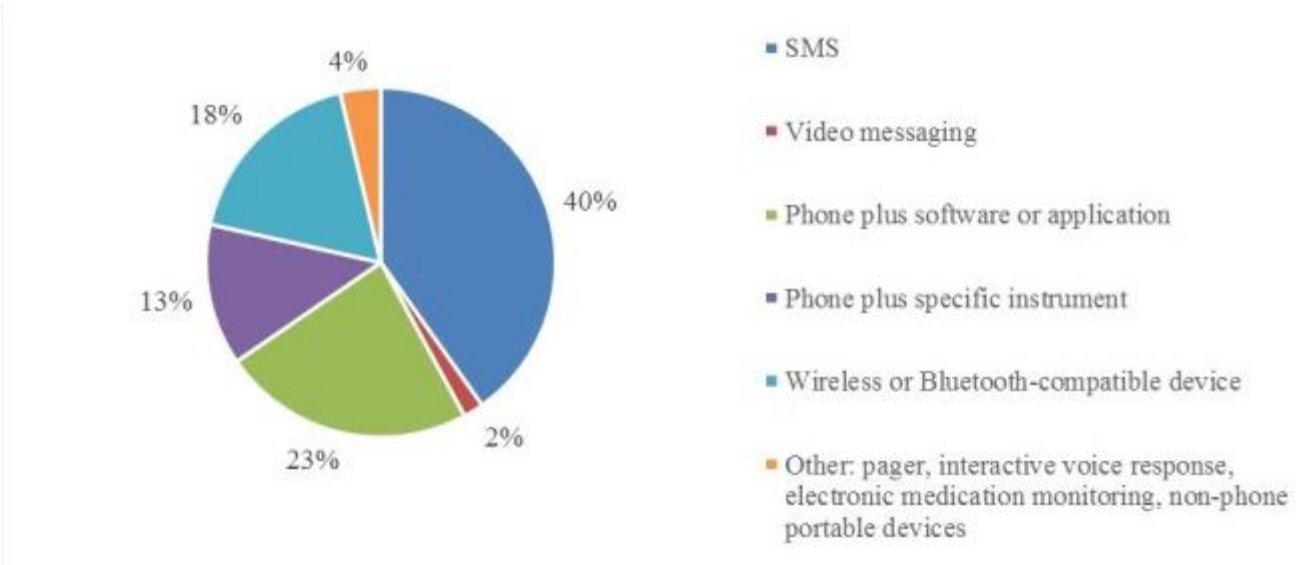
Search for term *Diabetes Type 2* and select the response with SCTID 44054006
What is the parent of this term?

How many children are found for the record in the previous question?

What is the finding site? (Note: If none is shown, toggle to the *Inferred* tab.)

From the refsets tab click *Open maps for this concept*. What is the mapping for Diabetic oculopathy associated with type 2 diabetes mellitus to ICD-9? Type or copy and paste the relevant ICD-9 code below with no leading or trailing spaces.

mHealth Data Spectrum



mHealth Data Challenges

Volume

Accuracy

Syntax/Semantics

- Interoperability
- Integration

Meaning

Open mHealth

```
{
    "blood_glucose": {
        "unit": "mg/dL",
        "value": 128
    },
    "effective_time_frame": {
        "time_interval": {
            "start_date_time": "2015-02-05T07:25:00Z",
            "end_date_time": "2015-06-05T07:25:00Z"
        }
    },
    "temporal_relationship_to_meal": "fasting",
    "temporal_relationship_to_sleep": "on waking",
    "descriptive_statistic": "average"
}
```

Challenges

Semantic Interoperability

EHR/PHR Usability and Efficiency

Privacy/Security/Trust

Levels of Interoperability

Simple Transport: The exchange of data from one HIT system to another *without the ability of the recipient system to interpret that data*. A basic example is a primary care physician's office printing/faxing a clinical summary report from their EHR and giving it to a patient to take to a specialist physician they have referred that patient to.

Structured Transport: *Based on its location in that structure* the receiving system knows that a particular data element is the patient's birthdate or gender or that a particular number is the result of a test to measure their kidney function. V2 messaging is an example and most clinical labs use it for the purposes we described earlier.

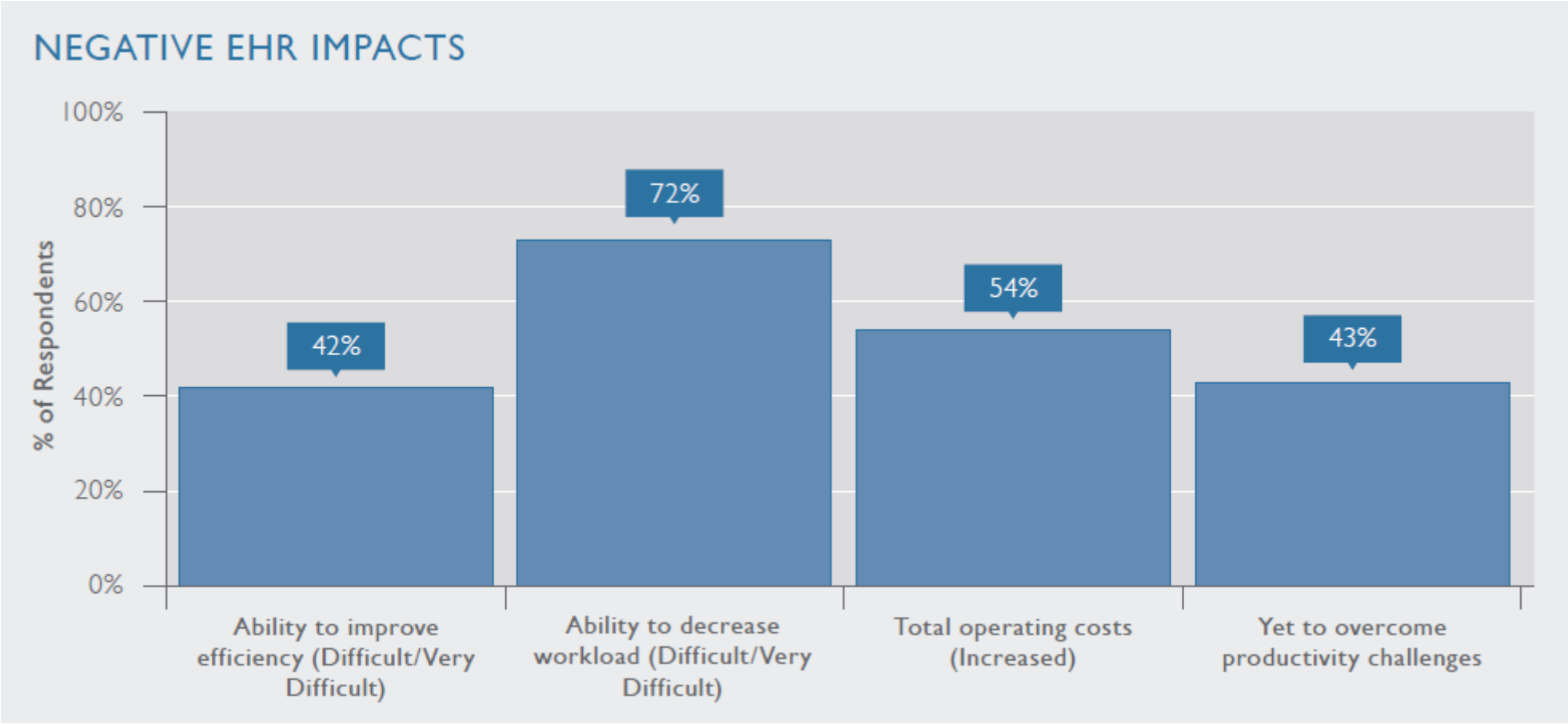
Semantic Transport: Using data exchange and coding standards in an agreed upon manner so that, for example, a recipient system can accurately interpret the data it receives. Given this level of interoperability, the recipient system should be able to *appropriately* trigger clinical decision support suggestions using data gathered from various other systems.

EHR/PHR Usability

Responding "Agree" or "Strongly agree" to the following:	
Our electronic health record improves my job satisfaction	35
In our practice, our electronic health record improves the quality of care	61
Our electronic health record requires me to perform tasks that other staff could perform	61
Using an electronic health record enhances patient-doctor communication that is not face-to-face	54
When I am providing clinical care, our electronic health record slows me down	43
Our electronic health record improves my job satisfaction	38
Using an electronic health record interferes with patient-doctor communication during face-to-face clinical care	36
I receive an overwhelming number of electronic messages in this practice	31
Based on my experience to date, I prefer using paper medical records instead of electronic records	18

RAND/AMA Survey

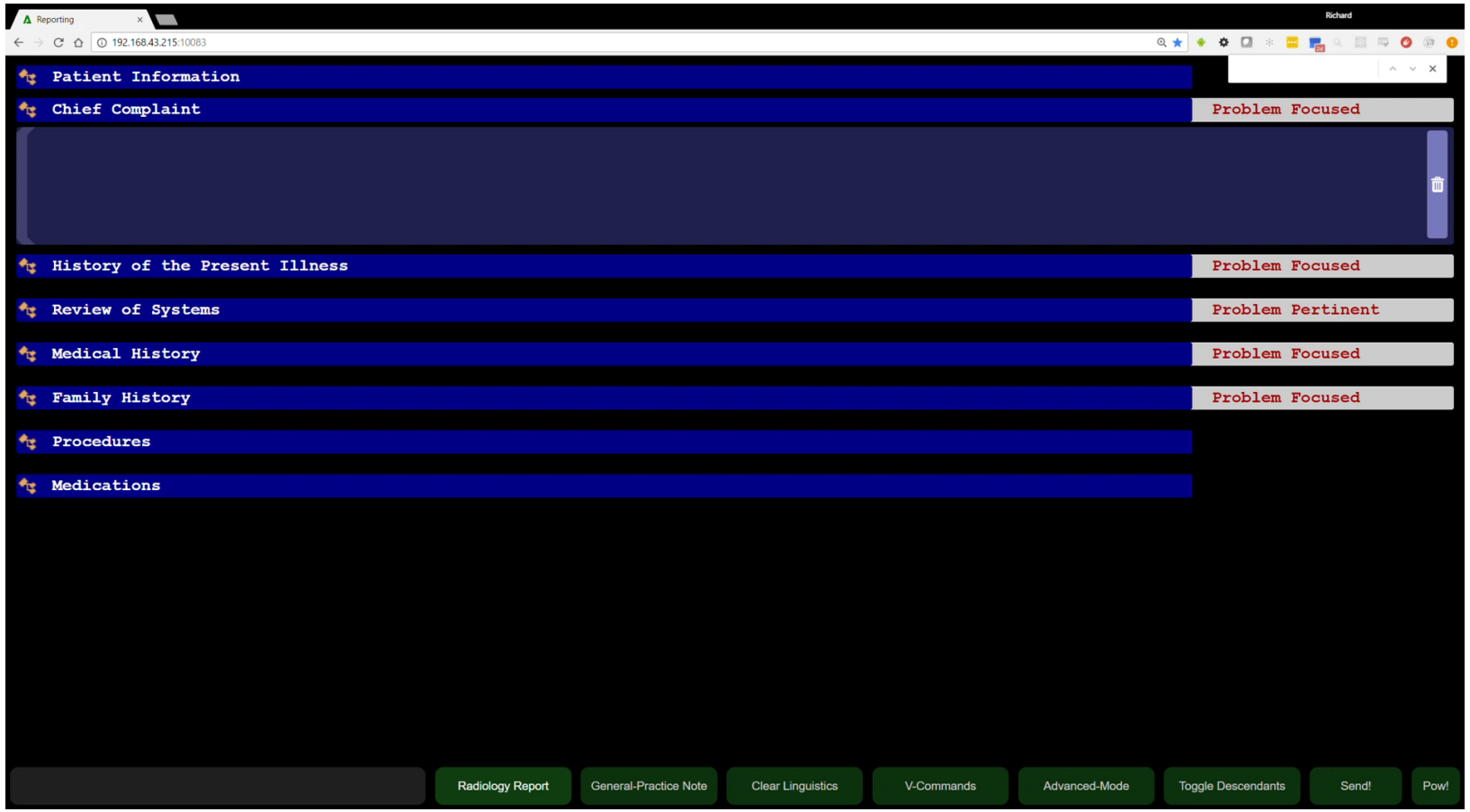
American EHR Survey



Praxis


Evolution
225%
Clipboard
Spell check
Bracket Checker
Include Title
Reduce PraxCoder Datum
Save
Save with Knowledge
Cancel
Hypercholesterolemia - c
«Mary» is a «32 y.o.» y.o. «female» who is using the diary provided. She has not used the diary that as I recommended. She reports no problems with the medication given. She is not taking her medication. She states is no longer eating eggs, diary, or red meat products. She is taking the [Pravachol] medication as indicated. Patient claims to exercise []x a week. Her Body mass index is «21.9». Her last weight taken on «09/29/2014» was «140» lbs. Patient latest LDL was «300» mg/dl taken on «09/28/2014». Previously, her LDL had been «180» drawn on «07/17/2011»
«labs.ldl.date(1)»
tial Hypertension - retinopathy
She continues to be asymptomatic. She continues to be almost asymptomatic. She is taking

Semantic Interoperability
Standards or ML?



Courtesy: Applicadia

PHR Usability

Getting data into the PHR

- Multiple Providers
- Data Blocking

Understanding the data

Sharing the data according to individual choices

PHR Usability Activity (Optional)

Create your own Health Vault account

Upload data from the CCD I'll provide you

Go through the data sharing sequence and check "Share only the types of information selected below"

Could your parents do that?

Privacy/Security/Trust

In a 2008 Markle Foundation survey of 1,580 adults, 77% reported privacy concerns related to misuse of personal data by marketers, 56% expressed concerns about misuse by employers and 53% had similar concerns about insurers.

Privacy: Data is only used for patient authorized purposes
Security: Data is only accessed by persons with authorization
Trust: Assuring that data is shared only with persons who are actually who they say they are

No purely technical solutions.

http://www.connectingforhealth.org/resources/ResearchBrief-200806.pdf

Get Ready for the FHIR Lecture

Harvard Business Review

The Untapped Potential of Health Care APIs

https://hbr.org/2015/12/the-untapped-potential-of-health-care-apis