Health Informatics

Lecture 3

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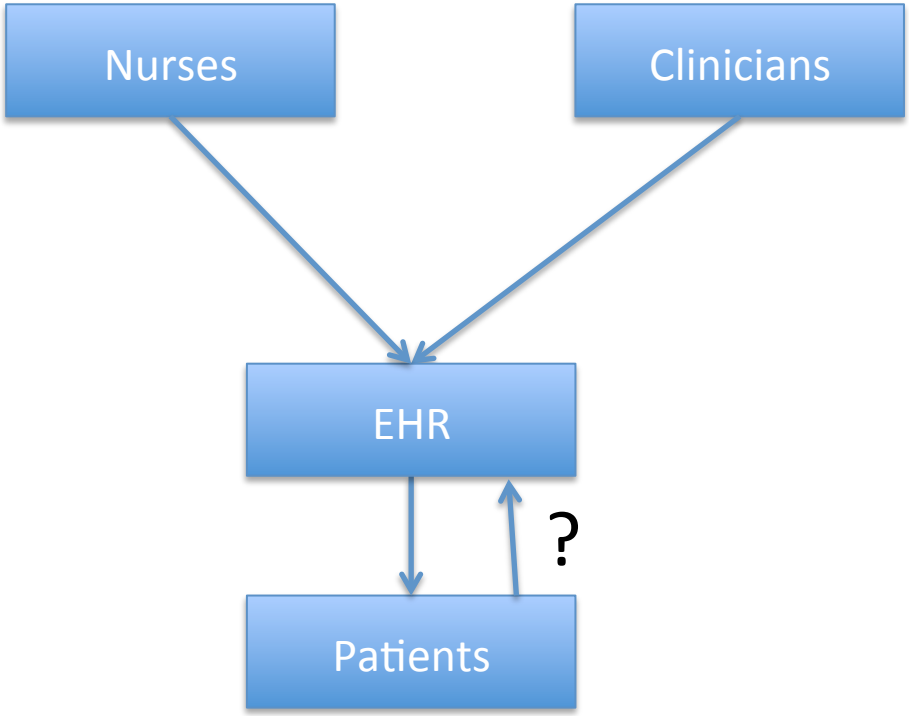
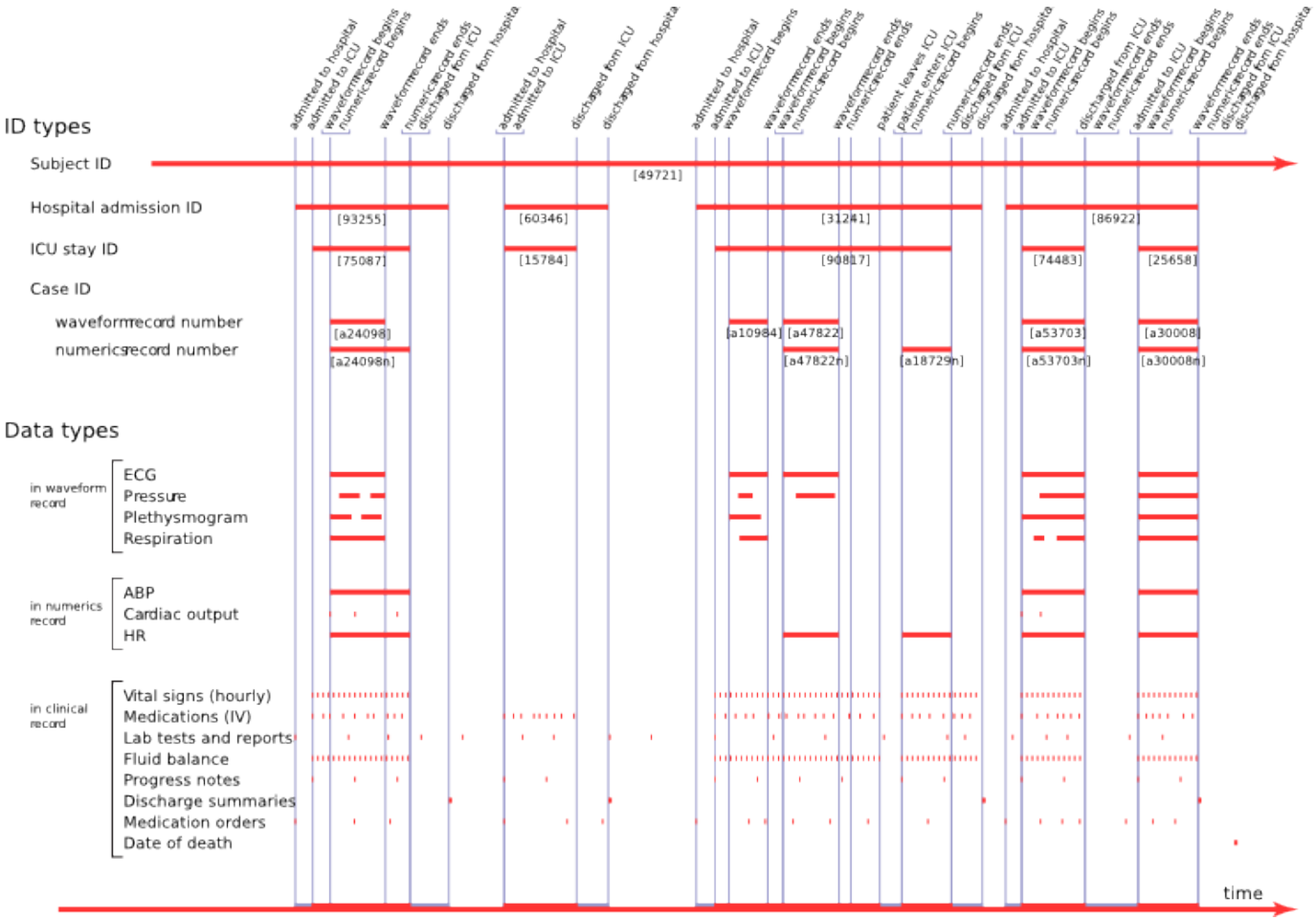
Who accesses/creates data?



EHR components

- Patient data (view/entry)
- Ordering
- Decision support
- Communication

MIMIC – patient overview



https://physionet.org/mimic2/UserGuide/node12.html

Arial 12 **B** *I* U

SOAP

Vital Signs:

Vitals as of: 11/9/2012: Systolic 110: Diastolic 84: Heart Rate 65: Temp 98.3F: Respiratory Rate 16: O2 Saturation 98

Surgery Service, Dr. Jones

S: No further Chest Pain or Shortness of Breath. "Feeling better today." Patient reports headache.

O: Afebrile, P 84, R 16, BP 130/82. No acute distress.

Neck no JVD, Lungs clear

Cor RRR

Abd Bowel sounds present, mild RLQ tenderness, less than yesterday. Wounds look clean.

Ext without edema

A: Patient is a 37 year old man on post-operative day 2 for laparoscopic appendectomy.

P: Recovering well. Advance diet. Continue to monitor labs. Follow-up with Cardiology within three days of discharge for stress testing as an out-patient. Prepare for discharge home tomorrow morning.

Associated signs and symptoms: «˜»

Review of Symptoms:

Constitutional: negative ROSNEGGEN«ROSGener...»

Eyes: negative ROSNEGEYES «ROSEyes...»

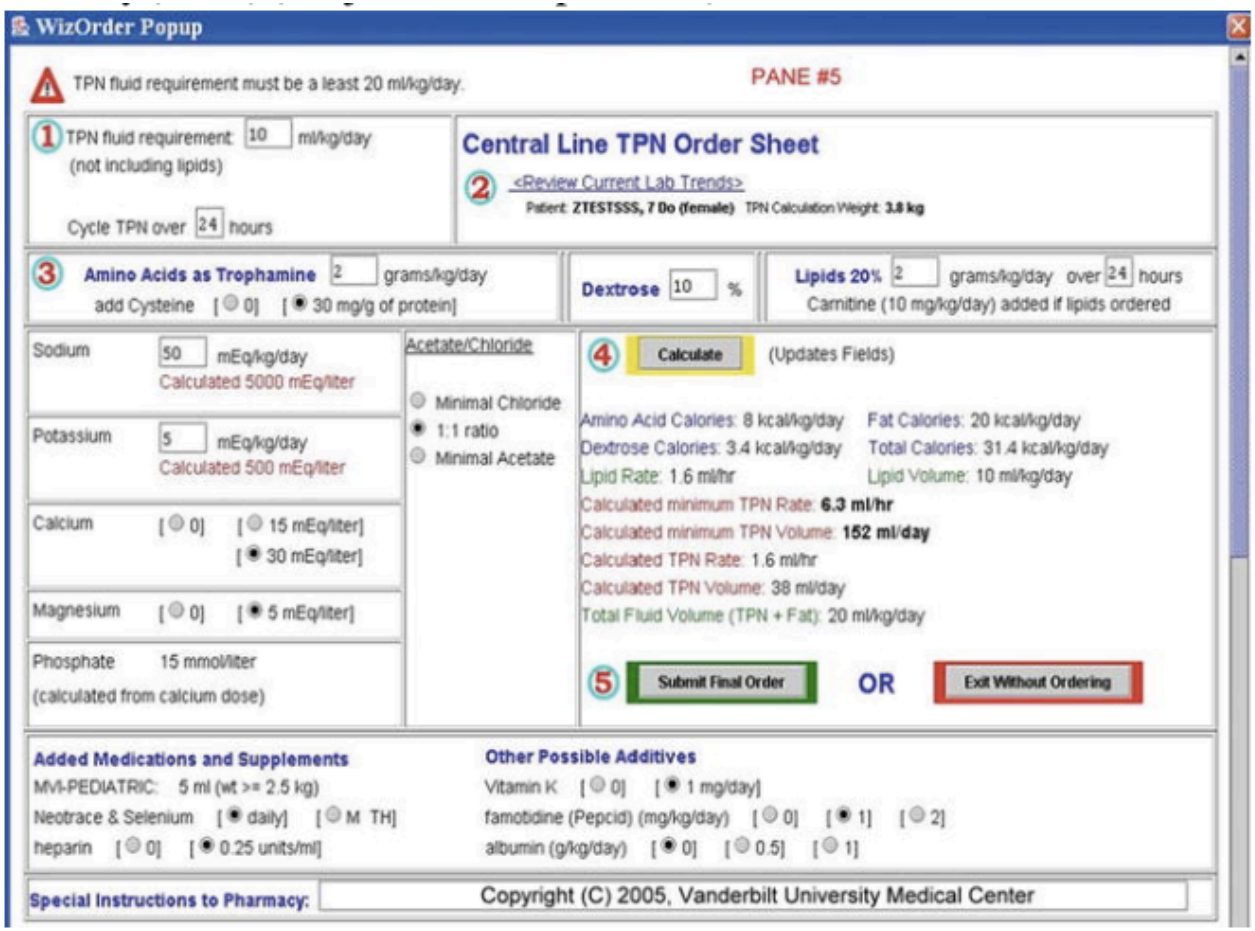
Ears: negative ROSNEGEARS

Nose/Mouth/Throat: negative ROSNEGNMT «ROSENMT...»

Cardiovascular: negative ROSNEGCARDIO«ROSCVS...»

Respiratory: negative ROSNEGRESP«ROSResp...»

Order entry



Shortliffe EH, Cimino JJ (2013) Biomedical Informatics: Computer Applications in Health Care and Biomedicine. Springer Verlag

Types of data

- Narrative text
  - Medical history, description of current illness, family history
  - Format may be semi-structured template or free text
- Numerical values
  - Laboratory tests, vital signs, some aggregate measures
- Image
  - X-ray, ultrasound
- Other
  - Genomic
  - Medications

Structuring data

- Controlled vocabularies
  - Term list: set of concepts, no overlap
  - Ontologies: concepts and structure

- Why do we need controlled vocabularies?

Some major vocabularies

- ICD9/10 – diagnosis codes
- SNOMED-CT (Systematized NOmenclature of MEDicine)
- RxNorm – drug names
- MeSH (medical subject heading)
- LOINC (Logical Observation Identifier Names and Codes)
- DSM − mental disorders

ICD9

- 428 Heart failure
  - 428.0 Congestive heart failure, unspecified convert 428.0 to ICD-10-CM
  - 428.1 Left heart failure convert 428.1 to ICD-10-CM
  - 428.2 Systolic heart failure
    - 428.20 Systolic heart failure, unspecified convert 428.20 to ICD-10-CM
    - 428.21 Acute systolic heart failure convert 428.21 to ICD-10-CM
    - 428.22 Chronic systolic heart failure convert 428.22 to ICD-10-CM
    - 428.23 Acute on chronic systolic heart failure convert 428.23 to ICD-10-CM
  - 428.3 Diastolic heart failure
    - 428.30 Diastolic heart failure, unspecified convert 428.30 to ICD-10-CM
    - 428.31 Acute diastolic heart failure convert 428.31 to ICD-10-CM
    - 428.32 Chronic diastolic heart failure convert 428.32 to ICD-10-CM
    - 428.33 Acute on chronic diastolic heart failure convert 428.33 to ICD-10-CM
  - 428.4 Combined systolic and diastolic heart failure
    - 428.40 Combined systolic and diastolic heart failure, unspecified convert 428.40 to ICD-10-CM
    - 428.41 Acute combined systolic and diastolic heart failure convert 428.41 to ICD-10-CM
    - 428.42 Chronic combined systolic and diastolic heart failure convert 428.42 to ICD-10-CM
    - 428.43 Acute on chronic combined systolic and diastolic heart failure convert 428.43 to ICD-10-CM
  - 428.9 Heart failure, unspecified convert 428.9 to ICD-10-CM

http://www.icd9data.com/2013/Volume1/390-459/420-429/428/default.htm

ICD10

Codes

- I50 Heart failure
  - I50.1 Left ventricular failure, unspecified
  - I50.2 Systolic (congestive) heart failure
    - I50.20 Unspecified systolic (congestive) heart failure
    - I50.21 Acute systolic (congestive) heart failure
    - I50.22 Chronic systolic (congestive) heart failure
    - I50.23 Acute on chronic systolic (congestive) heart failure
  - I50.3 Diastolic (congestive) heart failure
    - I50.30 Unspecified diastolic (congestive) heart failure
    - I50.31 Acute diastolic (congestive) heart failure
    - I50.32 Chronic diastolic (congestive) heart failure
    - I50.33 Acute on chronic diastolic (congestive) heart failure
  - I50.4 Combined systolic (congestive) and diastolic (congestive) heart failure
    - I50.40 Unspecified combined systolic (congestive) and diastolic (congestive) heart failure
    - I50.41 Acute combined systolic (congestive) and diastolic (congestive) heart failure
    - I50.42 Chronic combined systolic (congestive) and diastolic (congestive) heart failure
    - I50.43 Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure
  - I50.8 Other heart failure
    - I50.81 Right heart failure
      - I50.810 ..... unspecified
      - I50.811 Acute right heart failure
      - I50.812 Chronic right heart failure
      - I50.813 Acute on chronic right heart failure
      - I50.814 ..... due to left heart failure
    - I50.82 Biventricular heart failure
    - I50.83 High output heart failure
    - I50.84 End stage heart failure
    - I50.89 Other heart failure
  - I50.9 Heart failure, unspecified

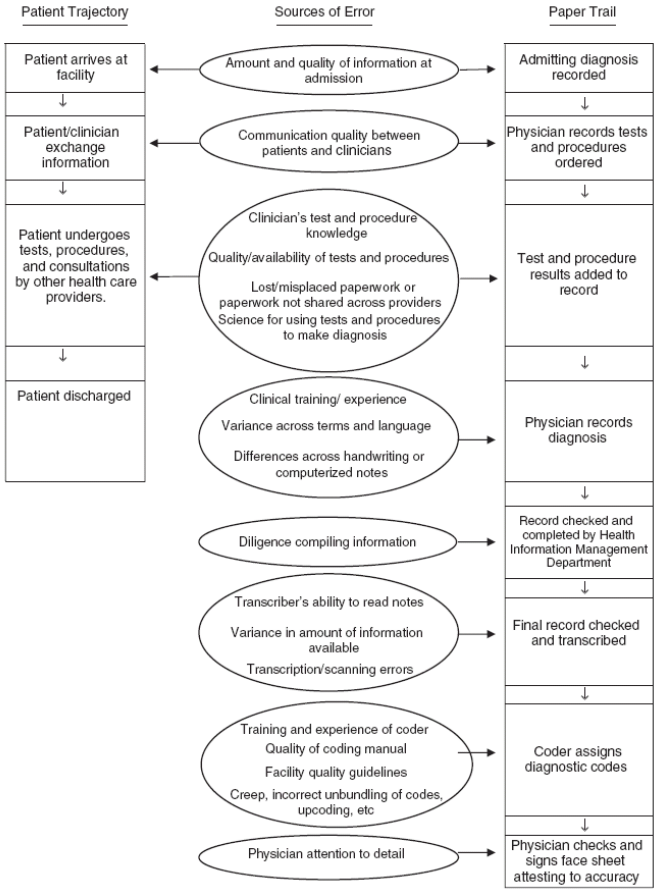
ICD10

http://www.healthcareitnews.com

Claims data

- ICD9/10 codes
- Coder assigns billing codes for visit based on info in EHR
- Many studies use only claims data.
  - What's the problem with that?

Measuring Diagnoses: ICD Code Accuracy



Health Services Research
Volume 40, Issue 5p2, pages 1620-1639, 11 AUG 2005 DOI: 10.1111/j.1475-6773.2005.00444.x
http://onlinelibrary.wiley.com/doi/10.1111/j.1475-6773.2005.00444.x/full#f1

What does it mean for a code to be accurate?

- Compare expert assessments of same record
  - how reliable is code
- Compare EHR coder to physician assessment
  - How well do clinical assessments match billing

Are ICD10 codes more accurate?

Health Serv Res

Table 1

Frequency of Clinical Condition by Data Source (%)

Conditions	Chart Data	ICD-9- CM Data	ICD-10 Data	Difference Chart— ICD-9-CM	Difference Chart—ICD-10	p-Value ICD-9-CM versus ICD-10
In Charlson Index						
Myocardial infarction	12.8	9.6	8.4	3.2	4.4	<.001
Cerebrovascular disease	8.1	4.6	4.5	3.5	3.6	.642
Rheumatic disease	2.6	1.5	1.4	1.1	1.2	.683
Dementia	3.3	1.1	2.4	2.2	0.9	<.001
In Elixhauser Index						
Cardiac arrhythmias	21.8	9.4	9.1	12.4	12.7	.241
Pulmonary circulation disorders	2.7	1.6	1.6	1.1	1.1	.578
Valvular disease	7.0	3.2	3.5	3.8	3.5	.134
Hypertension	30.2	25.2	22.2	5.0	8.0	<.001
Hypothyroidism	8.8	6.2	3.7	2.6	5.1	<.001
Lymphoma	1.0	0.9	0.8	0.1	0.2	.157
Solid tumor without metastasis	9.5	7.4	7.4	2.1	2.1	.736
Renal failure	4.0	4.6	4.9	−0.6	−0.9	.180
Blood loss anemia	1.1	0.7	0.6	0.4	0.5	.858
Deficiency anemia	1.9	1.9	1.4	0	0.5	.011
Coagulopathy	7.7	1.8	1.8	5.9	5.9	1.000
Fluid and electrolyte disorders	11.1	6.1	5.6	5.0	5.5	.089

Health Serv Res

Quan, H., Li, B., Duncan Saunders, L., Parsons, G. A., Nilsson, C. I., Alibhai, A., Ghali, W. A. and for the IMECCHI Investigators (2008), Assessing Validity of ICD-9-CM and ICD-10 Administrative Data in Recording Clinical Conditions in a Unique Dually Coded Database. Health Services Research, 43: 1424–1441. doi:10.1111/j.1475-6773.2007.00822.x

IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, VOL. 17, NO. 2, MARCH 2013

Temporal Properties of Diagnosis Code Time Series in Aggregate

Adler Perotte and George Hripcsak

-Calculate how often code mentioned given opportunities (dates with some ICD9 codes recorded)

-Use distribution of proportion to calculate differential entropy

-Entropy captures variability/uncertainty

-Had physicians create gold standard (categorizing as chronic/acute), used majority

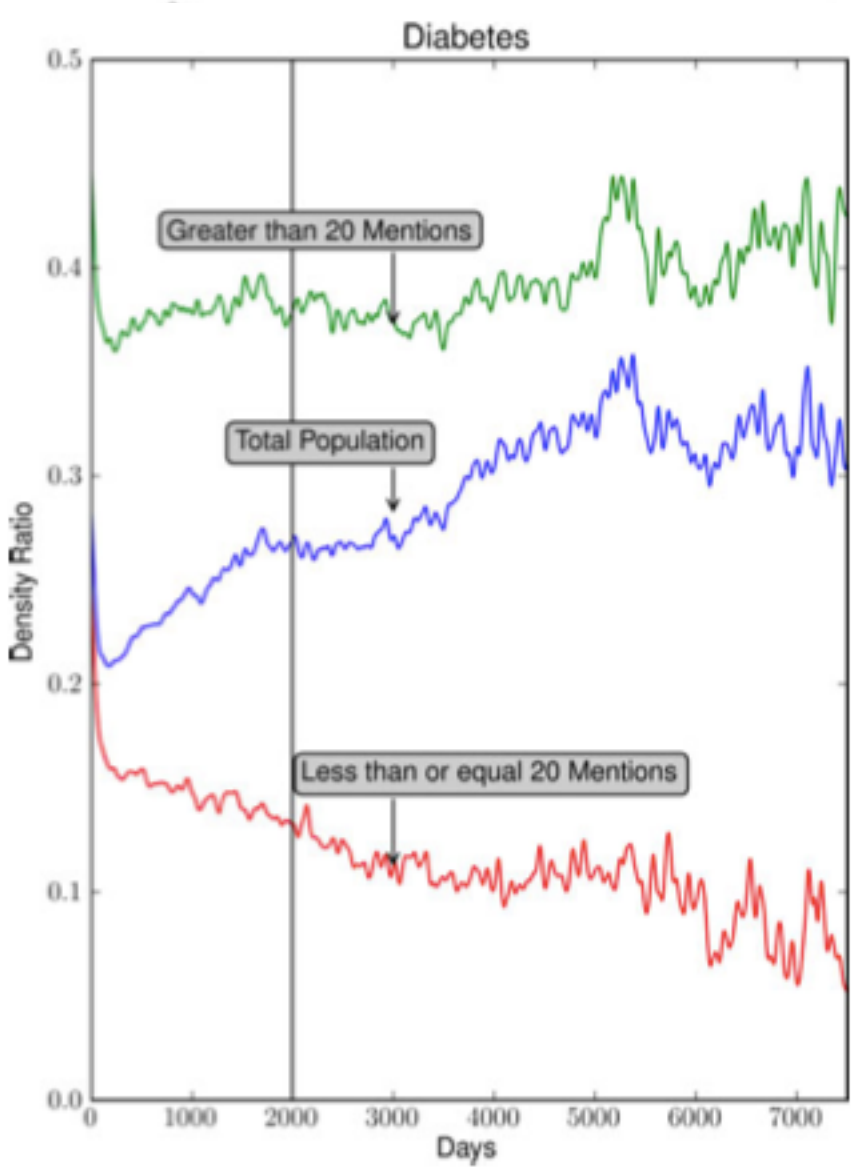


Fig. 5. Documentation probability over time for all diabetes patients, those with greater than 20 positive mentions, and those with less than or equal to 20 positive mentions.

1600

SNOMED

Search Results

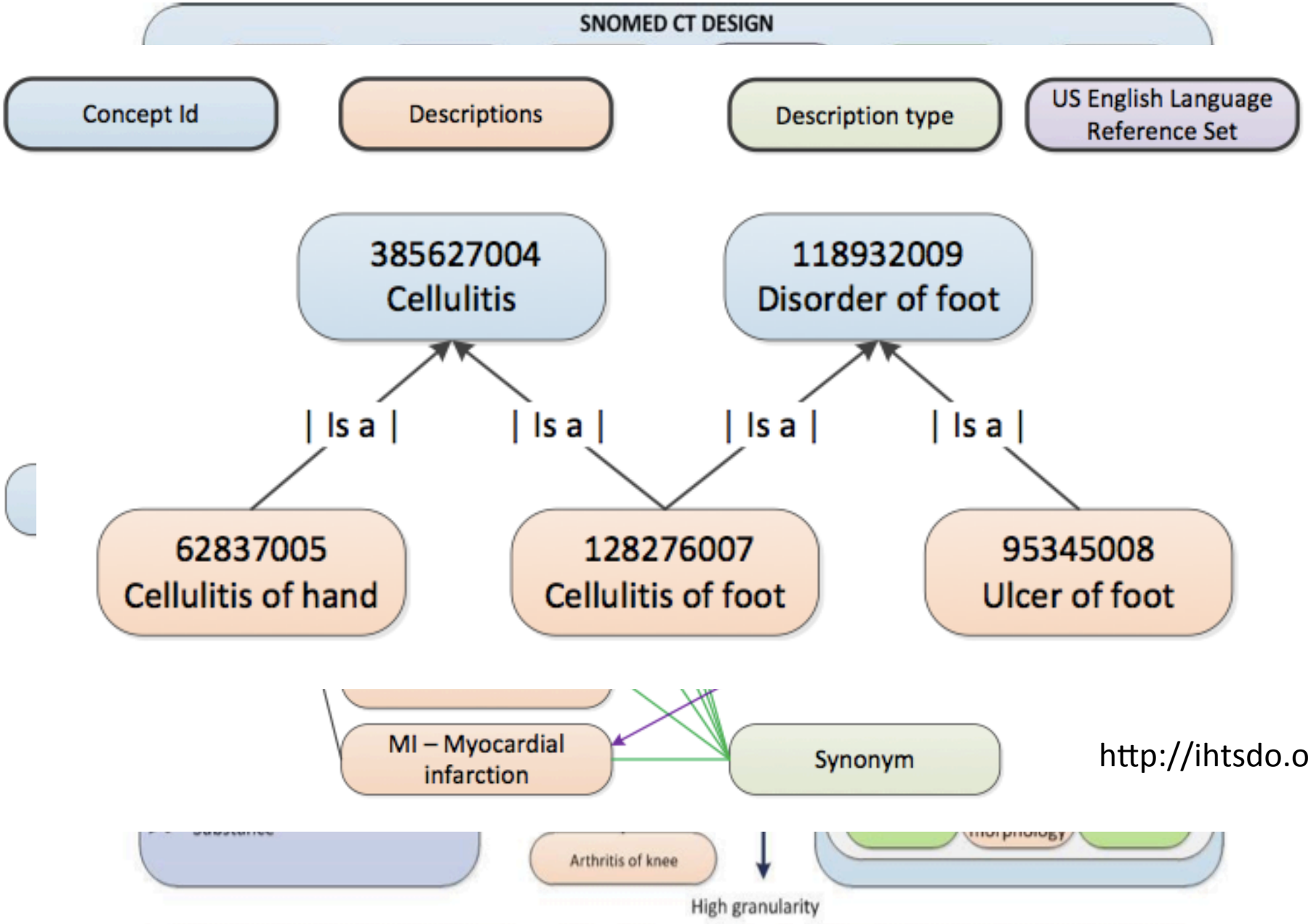
- Arterial bypass graft (procedure)
- Operative procedure on coronary artery (procedure)
- Repair of heart (procedure)
- Thoracic artery repair (procedure)

Name: Coronary artery bypass grafting (procedure)
Concept ID: 232717009

- Allograft bypass of coronary artery (procedure)
- Aortocoronary artery bypass graft with saphenous vein graft (procedure)
- Aortocoronary bypass grafting (procedure)
- Connection of mammary artery to coronary artery (procedure)
- Coronary artery bypass graft x 1 (procedure)
- Coronary artery bypass graft, anastomosis of artery of thorax to coronary artery (procedure)
- Coronary artery bypass grafts greater than 5 (procedure)
- Coronary artery bypass grafts x 2 (procedure)
- Coronary artery bypass grafts x 3 (procedure)
- Coronary artery bypass grafts x 4 (procedure)
- Coronary artery bypass grafts x 5 (procedure)
- Emergency coronary artery bypass graft (procedure)
- Prosthetic bypass of coronary artery (procedure)

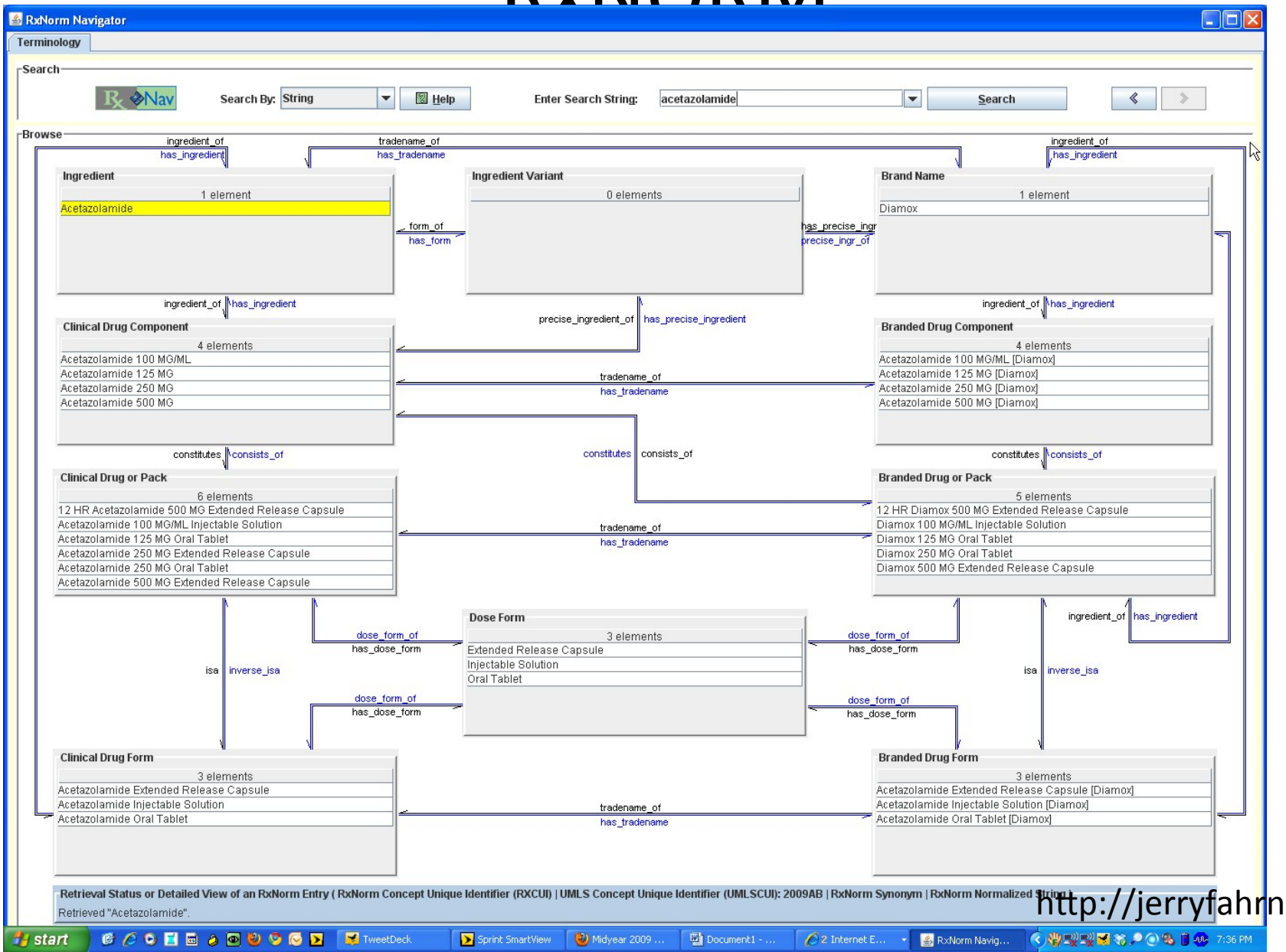
Staging Scale
Substance

SNOMED CT Components, Hierarchies and Outputs



http://ihtsdo.org/

RxNORM



http://jerryfahrni.com/

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DISCHARGE SUMMARY

Name: [**Known patient lastname**], [**Known patient firstname**]

[**Unit Number 626**]

Admission Date: [**2016-11-07**]

Discharge Date: [**2016-11-22**]

Date of Birth: [**1972-09-20**]

Sex: F

HISTORY OF PRESENT ILLNESS: Patient is a 44-year-old lady status post living related kidney transplant on [**2016-10-19**], who presented at [**Hospital 36**] for end-stage renal disease secondary to type 1 diabetes mellitus.

She presented to [**Hospital1 **] on [**2016-11-07**] with increased drainage from her surgical wound and JP, increased abdominal pain, and anuria x4 days. The patient reported constipation for a week. She denies flatus. She was complaining of nausea and vomiting. Her abdominal pain had become progressively worse left lower quadrant most notable. There is no radiation to the back or elsewhere. She denied any fevers, chills. She noted decreased p.o. intake recently. Her drainage from her wound incision and JP was notable for yellowish clear urine smelling fluid.

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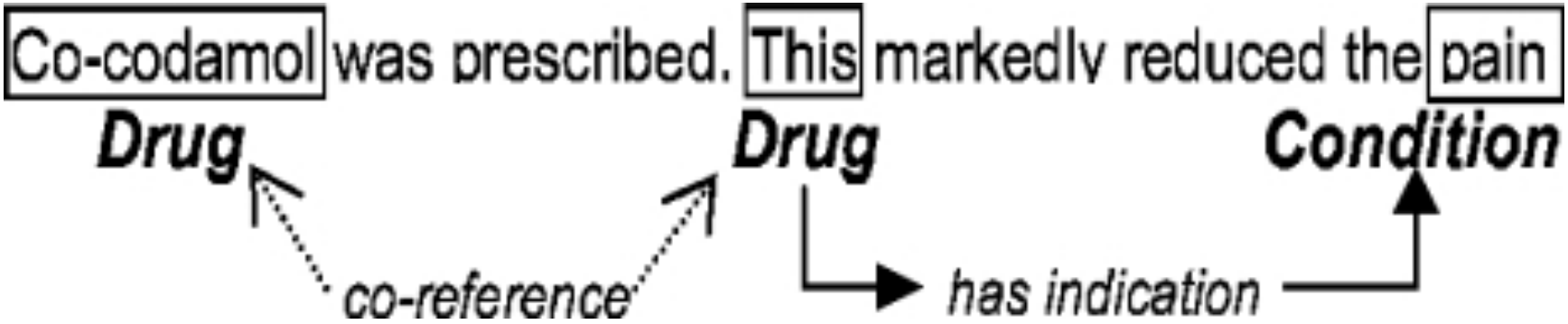
http://mimic.physionet.org

2013-10-18 22:41:00
NPN 7AM-11PM:
S/O: Pt has had a very eventful day. At~6:45 AM he was noted to have SBP 40's by NBP, with HR 60's. Initially responsive, but rapidly decreasing responsiveness followed by respiratory arrest. Pt was ambued with 100% FiO2, then [**Month/Day **]. An A-line was placed; we have consistently been able to easily draw blood from the line, but it appears dampened and reads quite a bit lower than the NBP, so we have been using the NBP all day. He soon required pressors for SBP 70's. He was started initially on Neo, which was titrated up to a max of 120 mcg/min with little if any effect. he was then started on Levo. Over several hours, with some difficulty, the Neo was weaned to off with the Levo as high as 40 mcg/min. He was transiently on Dopa, as high as 10 mcg/kg/min, but it was soon D/C'd d/t HR into the 140's. Around 1PM his BP again began to fall, into the 50's. His extremities were cold, and HR dropped into the 60's again. He was given 250cc fluid bolus, and Dopa was again attempted, at a lower dose. This time, however, he began to have lots of ventricular ectopy, including short runs of VT. Dopa was again D/C'd, Levo increased more, and he again stabilized for a few hours. About 7:45 he suddenly went into sustained VT. A-line tracing was flat (though is has never been reliable). In the interest of saving time, a cuff pressure was not checked. He was unresponsive, and was defibrillated once with 200J. He converted initially to ST with lots of ectopy, then settled down into NSR after a few minutes. He has remained in NSR since. BP is borderline on high-dose Levo. EKG shows ST depressions, but not much changed from yesterday. CK's, Troponin added to earlier labs.
F/E: Pt is dialysis-dependant. He has had >2.5L fluid since MN, and will be dialyzed tomorrow. Lytes have been followed closely; Mg repleted after episode of VT, and he has been given 15gm Kaexolate for borderline hyperkalemia.
NEURO: Pt initially unresponsive this AM. Over the day he has been agitated with ANY intervention. Initially well-sedated on [**Month/Day 15**], but he was changed to Fentanyl gtt with prn Ativan to try to avoid hypotension from the [**Month/Day 15**]. Fentanyl has been increased a couple of times. He is OK when left alone, but easily agitated.
[**Month/Day **]: Hct 30-32, stable. Coags greatly elevated with INR 5.1 this AM. He was given 2mg Vit K SQ, but coags worse afterwards. No further intervention at present.
GI: Vomitted brown OB+ material both before and after intubation. Belly soft, obese, obviously tender. Too unstable to go to CT. Plan was for U/S, but he was hypotensive to 50's when they came, so it was deferred. Medium loose brown, foul-smelling stool this AM (sent for C-diff). On Protonix.
ID: Temp rising to max of 101.7 this evening. He has been fully cultured and is on multiple abx. Ampho dose which was up when he arrested this AM was stopped with ~half of it infused. He did not recieve the rest.....HO aware. WBC 30-40K, Lactate has risen to 7.9. He has a worsening metabolic acidosis, with bicarb now down to 12.
RESP: Intubated, vented. Current settings A/C .5/750/24/PEEP 5. ABG's show adequate oxygenation, compensated metabolic acidosis. LS diminished. He has minimal secretions, but he was found to have green beans in the back of his throat on intubation, and we have suctioned a few pieces out...none since this AM.
SKIN: He has 2 small decubs on buttocks, covered with Duoderm. Also has open area in left groin.
ACCESS: A-line as described above. He has a right femoral tunneled [**Male First Name (un) 139**] catheter. A clotted left EJ line was removed this AM. Multiple attempts at other access have been made by many people without success.
SOCIAL: pt has a sister [**Last Name (un) 140**] who was in. He also has a very involved home care nurse named [**First Name8 141**] [**Last Name 142**] who was extremely upset about his condition. She was in to visit this evening, and was here for the VT episode. The pt's lawyer also came in briefly. He does not have a proxy; SW notified by case manager of his admission, serious condition, and need for proxy determination.
A: septic shock with multiple potential sources.
P: continue abx, follow cx results. Support BP and resp as needed. Follow labs closely. Anticipate possible need for CVVHD is does not tolerate HD. SW consult for proxy.

https://physionet.org/mimic2/UserGuide/node14.html

NLP example



CLEF Corpus: Semantic Annotation of Clinical Text

NLP task examples

- Which patients met Framingham CHF criteria?
- What drugs and symptoms are often mentioned together?

- Question Answering
- Summarization

NLP approaches

- Bag of words
- Linguistic rules
- Data driven

Available data

- MIMIC II deidentified EHR data + notes
  - ShARe/CLEF
  - https://sites.google.com/site/shareclefehealth/data
  - http://clefehealth2014.dcu.ie
- i2b2 challenges
  - Relations, coreference, temporal statements
  - https://www.i2b2.org/NLP/DataSets/Main.php

Redundancy

RESEARCH ARTICLE Open Access

Redundancy in electronic health record corpora: analysis, impact on text mining performance and mitigation strategies

Raphael Cohen[1*], Michael Elhadad[1] and Noémie Elhadad[2]

Abstract

Background: The increasing availability of Electronic Health Record (EHR) data and specifically free-text patient notes presents opportunities for phenotype extraction. Text-mining methods in particular can help disease modeling by mapping named-entities mentions to terminologies and clustering semantically related terms. EHR corpora, however, exhibit specific statistical and linguistic characteristics when compared with corpora in the biomedical literature domain. We focus on copy-and-paste redundancy: clinicians typically copy and paste information from previous notes when documenting a current patient encounter. Thus, within a longitudinal patient record, one expects to observe heavy redundancy. In this paper, we ask three research questions: (i) How can redundancy be quantified in large-scale text corpora? (ii) Conventional wisdom is that larger corpora yield better results in text mining. But how does the observed EHR redundancy affect text mining? Does such redundancy introduce a bias that distorts learned models? Or does the redundancy introduce benefits by highlighting stable and important subsets of the corpus? (iii) How can one mitigate the impact of redundancy on text mining?

NLP challenges

- Time
- Negations, Uncertainty
- Context
  - Obese vs. morbidly obese
  - Distinguishing semantics (MI = myocardial infarction, mitral insufficiency)
- Resolving references

Levels of granularity

Journal of Biomedical Informatics 45 (2012) 471–481

Contents lists available at SciVerse ScienceDirect

Journal of Biomedical Informatics

journal homepage: www.elsevier.com/locate/yjbin

A hybrid knowledge-based and data-driven approach to identifying semantically similar concepts

Rimma Pivovarov, Noémie Elhadad *

Department of Biomedical Informatics, Columbia University, 622 W. 168th Street, VC-5, New York, NY 10032, USA

Today's paper

Research and applications

Combining structured and unstructured data to identify a cohort of ICU patients who received dialysis

Swapna Abhyankar, Dina Demner-Fushman, Fiona M Callaghan, Clement J McDonald

+ Author Affiliations

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Personal health record

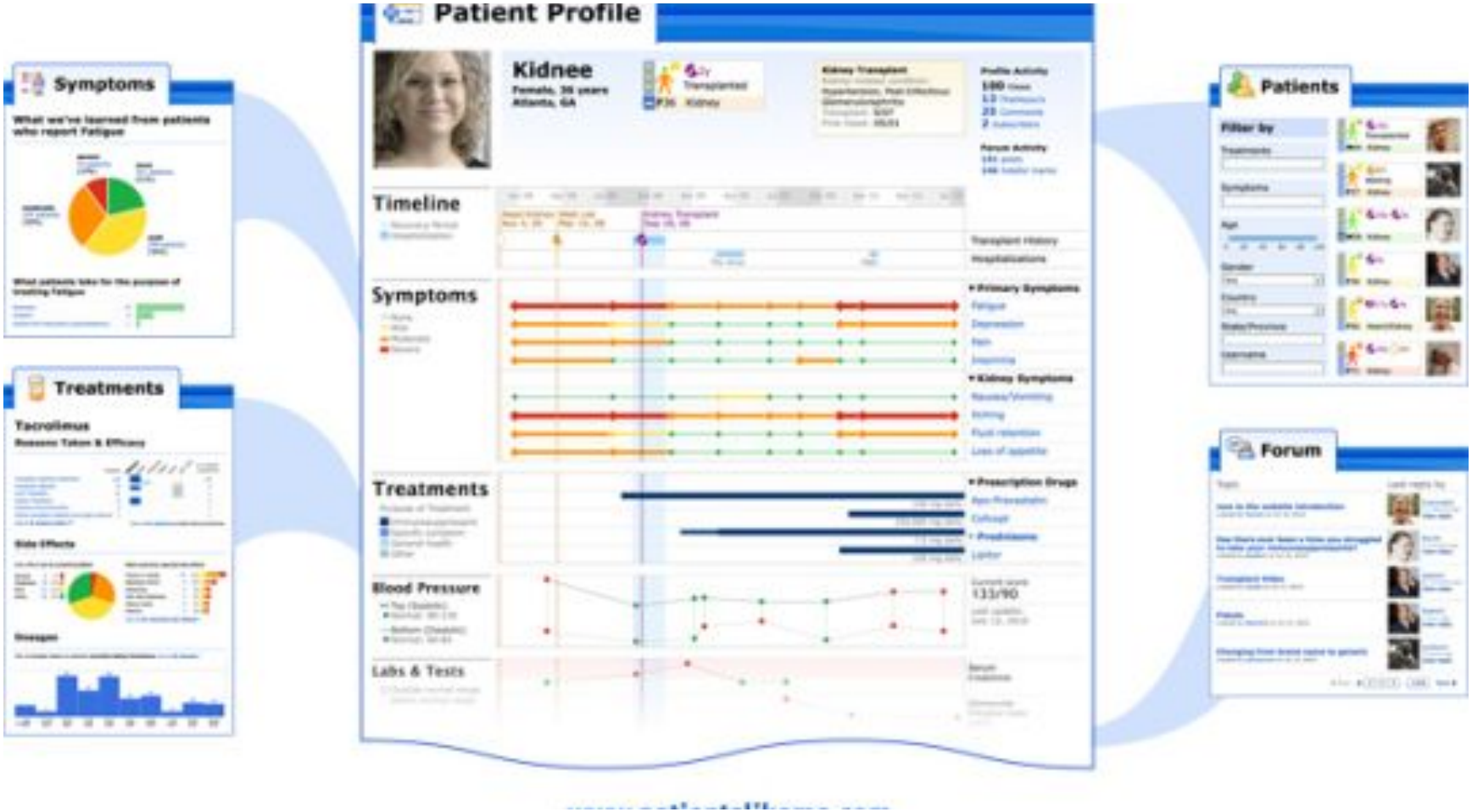
Basic idea: patient managed, can be shared with others

Types:

- Patient access to part of EHR (institution-based)
- Self-maintained (patient creates their history/ updates all info)
- Export EHR to 3rd party site, adds data (e.g. Microsoft Health Vault)

Now, with a few years of experience, we've observed that Google Health is not having the broad impact that we hoped it would. There has been adoption among certain groups of users like tech-savvy patients and their caregivers, and more recently fitness and wellness enthusiasts. But we haven't found a way to translate that limited usage into widespread adoption in the daily health routines of millions of people. That's why we've made the difficult decision to discontinue the Google Health service. We'll continue to operate the Google Health site as usual through January 1, 2012, and we'll provide an ongoing way for people to download their health data for an additional year beyond that, through January 1, 2013. Any data that remains in Google Health after that point will be permanently deleted.

Online communities



patientslikeme.com

PHRs and privacy

- Because they're not medical providers, external/linked PHR not subject to HIPAA
- Provider PHRs ARE covered by HIPAA

Who's using PHRs?

ORIGINAL INVESTIGATION

HEALTH CARE REFORM

The Digital Divide in Adoption and Use of a Personal Health Record

Cyrus K. Yamin, BS; Srinivas Emani, PhD; Deborah H. Williams, MHA; Stuart R. Lipsitz, ScD; Andrew S. Karson, MD, MPH; Jonathan S. Wald, MD, MPH; David W. Bates, MD, MSc

Intensity of use

- 51% low use (0-1 log ins over 2 years)
- 27% high use (10+ log ins)
  - 41% of these were age 51-65

- Common message types
  - Question about care, medication refills, referrals/ appointments
- More comorbidities = more messages

PHR pros/cons

- Maintain and reuse information (HIE)
- Patients can correct errors, fill in gaps
  - Centralized, can deal with multiple providers
- Better understanding of health
- Barriers to use/access
- Data quality
  - Patients introducing errors, removing information
- Security
- Patient concern/ not understanding data

For next week

- For this Friday, reading as usual
- For Monday, complete human subjects training, submit to MIMIC to gain access to data
  - See Canvas, follow MIMIC instructions EXACTLY. If you take the wrong course, you won't be able to access the data.