Health Informatics

Lecture 2

Samantha Kleinberg
samantha.kleinberg@stevens.edu
Overview of today’s class

• Where is health data collected?
• Why is it collected?
  – And why this matters for interpreting it!
What health data are we talking about?

• Hospitals/providers
  – Electronic medical records (more detail next week)
  – ICU data (can be outside EMR)

• Claims data
  – Insurance companies, Medicare

• Patient generated data
  – Personal health records (next week)
  – Self tracking
  – Online forums
Different purposes

• Hospitals/providers
  – Documenting what was done and why
  – Documentation for reimbursement
  – Communication among care team
  – Legal
  – Prevention
  – Research

• Claims data
  – Mainly $

• Patient generated data
  – Personal interest
  – Social support
  – Share with provider
Different availability

• Hospitals/providers
  – Research collaboration
  – MIMIC III

• Claims data
  – Center for Medicare & Medicaid (CMS) datasets

• Patient generated
  – See terms of service for apps/forums
  – Data can be donated by users
Why go digital?

- You can’t grep a dead tree (search)
- Ability to share data
- Prevent data loss
- Store more information than physically possible
- Standardize (more later)
A brief history of medical records

• 1960’s Larry Weed introduces Problem Oriented Medical Record (POMR)
  – Instead of just Dx/Tx, medical history
Pt. received 40 units of regular insulin yest. because of B & 4+ urine sugars. Got 2000 cc Amigen yest. & 500 cc D,W. Was febrile all night up to 40 at 8 PM this gradually came down to 39. 8 PM yest. suctioned & coughed up ½ cup of thick white sputum – cultured also blood cultures. Was in must. tent cmucomist overnight. At 4 PM yest had B-R base. Sputum smear unremarkable – WBC’s but no bacteria.

9/10-12:30

9/11-9 AM
Urine 3+ given 10 U reg. insul. Pt. was hiccuping all night & this AM. Levine tube passed 900-1000 cc bileous fluid removed. Jejunostomy tubes have been draining minimally. Will have Levine tube down.

(THREE PAGES OF SIMILAR NOTES FOLLOW UNTIL 9/26/67)

9/26
Last night 10 PM had seizure like behavior and acting strange. Apparently hallucinating. Blood sugar didn’t register on destroixt. Had been given 10 units reg. insulin at 8 PM after IV glucose returned to nl. This AM vomited up brown black fluid 300 cc + for occult blood. NG tube had been out since 5 PM yest. NG tube replaced & some material small amt. withdrawn. Pt. now NPO NG tube to Gomco.

9/27
Still febrile – Ampicillin 1 g qid – continued; Blood cult. drawn to check if septicemia still present. Chest x-ray today shows infiltrate in (R) lower lobe. No effusion. Sputum grew out pseudomonas but Dr. _______ elected not to treat this.

ON SERVICE NOTE (please read revised problem list and please use #’s shown)

10/2-6 PM
#1 Chronic Relapsing Panc.: b. Diabetes: will continue moment-to-moment Rx of spot urines for now. Today c only 10 U regular insulin pt. spilling mainly 2-3+.
Plan: BLD sugar tomorrow
c. Panc. insuff.: will begin Cotazyn-B
#2 Complications Following Laparotomy:
c. Post op ileus: KUB tomorrow. Pt. now tolerating ice cream and occ. candy. bs. poor; $ gross distention; stool passes regularly ——— fistula

Imp: prob. resolving now
Plan: KUB and continue small feedings
d. Sepsis: afebrile now on Ampicillin. see flow sheet. Reculture tomorrow.
b. RLL Pneumonia: Film of 9/28 shows some ↑ in this process. Will repeat P.A. chest tomorrow & cultures.
e. Colonic-Cutaneous Fistula: Continues to drain semi-formed stool several times per day; the problem is that stool drains onto granulating abd. wound.
Plan: culture stool; Remove some non- func stay sutures; Freq dressings & consider colostomy bag for fistula

10/3
#1 Chronic Relapsing Panc.: c. Panc. insufficiency: Cotazyn-B will be begun (special purchase) and will evaluate effect on absorption and/or stool content by measuring amt of fat
f. Pain: pt. still requires freq narcotics. Neurosurg will eventually perform epidural block and depending upon results will consider cordotomy

#2 Complications Following Laparotomy:
b. RLL Pneumonia: Chest x-ray today shows marked resolution of previously described infiltrates; pt. has been afebrile – sputum recultured (see #2d).
c. Post op ileus: KUB today shows little improvement from film of 9/29. Ba in same position in colon which is distal to fistula. Despite this x-ray findings will continue to feed (see #2f). Bowel sounds poor and abd. seems slightly more distended. Will give oil retention enema to try to clear distal colon.
d. Sepsis: Pt. has been afebrile, cultures repeated today; δ (M) heard today; has been on Ampicillin x 9 days. Although potential still present this problem is under relatively good control.
e. Colonic-Cutaneous Fistula: all stay sutures removed today and wound is well granulated but constantly bathed c stool. Colostomy bag applied to try to control this drainage. Etiology of fistula? but may be serving decompressive function.
f. Malnutrition: Total protein = 6.1 c 2.1/4.0 = A/G in 1965. Wt. has ↓ from 141# ——— 113# since adm.
Imp: little resolution of ileus, in fact, most of food stays in stomach probably; this remains the main problem; other as above fairly well controlled except malnutrition.
Plan: as above plus give gastro-graffin per NG tube and watch progress; avoid surgery.

Figure 1. Sequence of Notes Extracted from a Complicated Record.

MEDICAL RECORDS THAT GUIDE AND TEACH

LAWRENCE L. WEED, M.D.*
PROBLEM LIST

6/17 #1 Rheumatic Heart Disease
   a. Mitral insufficiency
   b. Atrial fibrillation
   c. Compensated congestive failure TTB
   d. Cardiac catheterization
   e. Successful cardioversion

#2 Presumed SBE
#3 Mild Diabetes Mellitus – adult onset
#4 Repeated pulmonary embolism
#5 Post Inferior Vena Cava Ligation
#6 Allergic dermatitis

9/3 #7 Arthralgia

9/8 #8 Family problems

8/5 – CARDIOLOGY
TEMP – 36.5 WEIGHT 73.6 kg

#1 RHD:
   Sx – excellent exercise tolerance – does housework, taking walks, etc. no SOB
   Obj – wt. ↑ again 4 lbs P 100 reg. c rare P/C BP 150/90 chest – few rales @ (L) base that do not clear c cough; cor. – unchanged
   Rx – unchanged – see flow sheet
   Plan – in view of excellent clinical response and exercise tolerance I am not concerned about rales but will continue to watch
   a. Quinidine 0/200 q2h #300
   continue other meds

#5 Post IVC Ligation:
   Sx – ∅
   Obj – leg swelling continues to be a problem esp. during the hot weather
   Rx – unchanged
   Plan – 1. ↑ Naqua to 0/002 QD
   2. Coumadin 0/005 QD
   3. protime today
   RTC 3 mos.

9/8
#1 Arthralgia – see EW note 9-3-66
   Sx – continues @ about same intensity but more concentrated in (R) arm (cath. done in that arm).

Obj – ASO reg. RH factor – not significantly ↑. Repeat sed rate – films of shoulders, elbows, wrists
Rx – symptoms exacerbated by ASA – some relief by heat
Plan – a. uric acid, serum glob. I.E. prep
   b. observe

#8 Family Problems:
   pt. has been upset lately by husband’s constant admonitions not to
over-do herself and his general over protective attitude. Today was
very upset, depressed and crying – it is now obvious that more
fundamental conflicts exist in this marriage. Husband drinks, is
jealous of attention she gives the children, etc.
Plan – have asked her to have husband call me and will get a greater
feeling for the situation starting with the part of the conflict
revolving around her medical condition

9/23
Was pelvic (& pap) done during adm? if not, suggest having these
done.

#1 RHD:
   Sx – continued excellent exercise tolerance
   Obj – wt ↑ 2 Kg B 160/70 P 100 reg: chest – clear; cor – as above
   Rx – Digitalis 0/100 QD. Quinidine 0/200 qid

#5 Post IVC Ligation:
   (R) leg now back to normal s edema but (L) leg now swells even
more and often does not go down @ night – becomes heavy and
cumbersome
   Rx – Naqua seems to help but not taking QD
   Plan – a. Naqua QD
   b. refer to peripheral vasc. clinic
   c. D/C Coumadin

#7 Arthralgia:
   Sx – comes and goes but essentially about the same overall.
   A.M. hand stiffness seems to be her biggest complaint.
   Obj – joint films — osteoarthritis changes in elbows and hands
   Rx – ∅ – heat, rest, ASA
   Plan – continue above

#8 Family Problem:
   marked improvement p she mentioned to husband that I wanted to
talk c him. He has not called but has been much improved in his
attitude toward her and the children.

FiguRE 3. List of Problems and Associated Clinic Notes on a Patient Being Seen in a Busy Outpatient Department of a Large Urban Hospital.
Key advances

- Problem list
- SOAP
  - Subjective
  - Objective
  - Assessment
  - Plan
• 1960s/70s – First EHRs, but they’re $$$ and not widely adopted. VA adopts EHR
• 1990s – Rise of personal computers + Internet
  – Institute of Medicine sets target for all physicians to use computers by 2000 (reality was <20%)
  – Many hospitals create their own record systems*
• 2000s – HITECH/ARRA and meaningful use
  – Incentives to encourage adoption
Meaningful use

• Incentives for not just adopting EHR, but using them to improve care

• 3 components from ARRA (2009)
  – Using EHR in meaningful way
  – Exchanging health information to improve quality of care
  – Using EHR to submit clinical quality and other measures
Examples of primary uses of EHR

• Order tests, medications
• Billing
• Documentation (admission, discharge, care plan, medical history, etc)
## Stages

### Stage 1: 2011-2012
Data capture and sharing

### Stage 2: 2014
Advance clinical processes

### Stage 3: 2016
Improved outcomes

<table>
<thead>
<tr>
<th>Stage 1: Meaningful use criteria focus on:</th>
<th>Stage 2: Meaningful use criteria focus on:</th>
<th>Stage 3: Meaningful use criteria focus on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronically capturing health information in a standardized format</td>
<td>More rigorous health information exchange (HIE)</td>
<td>Improving quality, safety, and efficiency, leading to improved health outcomes</td>
</tr>
<tr>
<td>Using that information to track key clinical conditions</td>
<td>Increased requirements for e-prescribing and incorporating lab results</td>
<td>Decision support for national high-priority conditions</td>
</tr>
<tr>
<td>Communicating that information for care coordination processes</td>
<td>Electronic transmission of patient care summaries across multiple settings</td>
<td>Patient access to self-management tools</td>
</tr>
<tr>
<td>Initiating the reporting of clinical quality measures and public health information</td>
<td>More patient-controlled data</td>
<td>Access to comprehensive patient data through patient-centered HIE</td>
</tr>
<tr>
<td>Using information to engage patients and their families in their care</td>
<td></td>
<td>Improving population health</td>
</tr>
</tbody>
</table>

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# Stage 2 Objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Previous Measure Name/Reference</th>
<th>Measure Name</th>
<th>Threshold Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect Patient Health Information</td>
<td>Measure</td>
<td>Security Risk Analysis</td>
<td>Yes/No attestation</td>
</tr>
<tr>
<td>Electronic Prescribing</td>
<td>Measure</td>
<td>e-Prescribing</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>Health Information Exchange</td>
<td>Measure</td>
<td>Health Information Exchange</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>Patient Specific Education</td>
<td>Eligible Hospital/CAH Measure</td>
<td>Patient-Specific Education</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>Medication Reconciliation</td>
<td>Measure</td>
<td>Medication Reconciliation</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>Patient Electronic Access</td>
<td>Eligible Hospital/CAH Measure 1</td>
<td>Provide Patient Access</td>
<td>&gt;50%</td>
</tr>
<tr>
<td></td>
<td>Eligible Hospital/CAH Measure 2</td>
<td>View, Download or Transmit (VDT)</td>
<td>At least 1 patient</td>
</tr>
<tr>
<td>Public Health Reporting</td>
<td>Immunization Reporting</td>
<td>Immunization Registry reporting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Syndromic Surveillance Reporting</td>
<td>Syndromic Surveillance Reporting</td>
<td></td>
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<tr>
<td></td>
<td>Specialized Registry Reporting</td>
<td>Specialized Registry Reporting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electronic Reportable Laboratory Result Reporting</td>
<td>Electronic Reportable Laboratory Result Reporting</td>
<td>Public Health Reporting to 3 Registries</td>
</tr>
</tbody>
</table>
• Key updates to patient engagement
  – Instead of 5% of patients for electronic access, now >=1 patient during reporting period
  – Instead of % using secure messaging, now just capability of secure messaging
• Removed some data collection requirements
  – Demographics, smoking status, family history
<table>
<thead>
<tr>
<th>Online Patient Engagement Functionality</th>
<th>Percent of Hospitals with Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td><strong>Online Capabilities Incentivized by Federal Policy</strong></td>
<td></td>
</tr>
<tr>
<td>View information from health/medical record</td>
<td>24%</td>
</tr>
<tr>
<td>Download information from health/medical record</td>
<td>14.3%</td>
</tr>
<tr>
<td>Transmit care/referral summaries to a third party</td>
<td>N/A¹</td>
</tr>
<tr>
<td>View, download and transmit health information</td>
<td>N/A¹</td>
</tr>
<tr>
<td>Secure messaging with health care provider*</td>
<td>N/A¹</td>
</tr>
<tr>
<td><strong>Online Capabilities Not Incentivized by Federal Policy</strong></td>
<td></td>
</tr>
<tr>
<td>Request to update health/medical record</td>
<td>30.9%</td>
</tr>
<tr>
<td>Pay bills</td>
<td>49.3%</td>
</tr>
<tr>
<td>Schedule appointments</td>
<td>21.6%</td>
</tr>
<tr>
<td>Request prescription refills</td>
<td>19.3%</td>
</tr>
<tr>
<td>Submit patient-generated data</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

¹Measure was not collected in survey year
Percent of physicians that have electronic capabilities to exchange secure messages with patients and for patients to view, download and transmit their online medical record

2015

Stage 3 - interoperability

• Share data
  – % of patients message provider
  – Electronic summaries for other providers

• Other
  – % of electronic prescriptions/orders

• Handle patient-generated data
  – % generated
Available data

• All providers demonstrating meaningful use and receiving payment listed publicly, updated quarterly

• http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/DataAndReports.html
Medicare Merit-based Incentive Payment System

• First year of reporting was 2017, measures submitted March 18, payment changes Jan 1 2019

• Reimbursements -9% to +27%

• Factors
  – Quality (60%)
  – Improvement (15%)
  – Advancing care information (meaningful use replacement) (25%)
Who’s collecting data (hospital)?

- Doctors (attendings, residents, interns)
- Nurses
- Lab
- Radiology
- Pharmacy
- Admin/staff
Primary vs secondary use

• Example primary uses of EHR
  – Delivering care: ensuring continuity, documenting medical history
  – Billing: documenting services provided

• Example secondary uses of EHR
  – Research: find causes of disease, identify drug-drug interactions
  – Public health/policy: identify disease outbreaks
Information exchange

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Information exchange

• Within hospital
  – Between units, people with different roles, etc

• Between multiple organizations
  – Primary care + specialist, etc
Fig. 2  Schematic layout of the CTICU and key activities during which observations were conducted. Patient cubicles surround the Nursing station where most of the clinical information systems lie. The letters on the human representations signify the followi...
Fig. 6 The cognitive workflow model for inpatient care. The workflow flows in an anti-clockwise fashion. Although this being a continuous cycle with no start or finish, the symbol of the sun (morning) can be used as the starting point. Please note the three levels of abstraction (see text for details): (a) the complete workflow model as top level, (b) the grouped CZs shown with different background colors—1 through 3, (c) the individual critical zones—1 through 7. The 4th level is the individual level which was shown in Fig. 5 with the attending as an example.

Visual TASK: A Collaborative Cognitive Aid for Acute Care Resuscitation

Michael J. Gonzales\(^1\), Joshua M. Henry, MD\(^2\), Aaron W. Calhoun, MD\(^2\), and Laurel D. Riek, PhD\(^1\)

\(^1\)Dept. of Computer Science and Engineering
University of Notre Dame
Notre Dame, IN 46556
{mgonza14, lriek}@nd.edu

\(^2\)Dept. of Pediatrics, Division of Critical Care
University of Louisville
Louisville, KY 40202
{joshua.henry, aaron.calhoun}@louisville.edu

Figure 3: Left: Part of a PALS reference guide for the Pulseless Arrest Algorithm. Right: Visual TASK, our redesigned PALS guide. The red/dashed highlighted region shows the current split of information on PALS cards, whereas our redesign pairs this information with its associated task.
Information exchange – over time

Barriers to Effective Care Plan Implementation

Our study exposed the complex nature of teamwork in complex care, revealing five characteristics that, in combination, distinguish it fundamentally from other teamwork settings. In summary, these are,

- **Flat-structure, consensus driven plan development**: goal-setting requires consensus of multiple caregivers, with no single decision-maker “in charge”.

- **Loosely coupled**: the activities of care providers are largely decoupled, but identifying interactions between their activities is crucial for preventing conflicts.

- **Extended duration**: care plans extend over months to years, during which a child’s condition evolves.

- **Continual distributed revision**: care teams must create and frequently update well-coordinated care plans while rarely (if ever) meeting as a whole.

- **Syncopated time scales**: the timescales on which care providers interact with the child vary greatly from several times a week to once or twice a year.

Why is information exchange important?

• Reduce duplicate tests
• Improve diagnosis and treatment
  – E.g. Medication interactions, allergies
  – Results of prior testing/diagnoses ruled out
• Reduce errors/improve efficiency
  – Eg. Asking for family history repeatedly

• Research! Feedback loop, missing data
Why is information exchange hard?

- Patient matching
- Preserving privacy
- Differing data formats
How can CS help?
What’s the practical impact?

- Study took all major emergency departments in Memphis, compared outcomes with HIE and without
- Access: 6.8% of ED visits (12 EDs), associated with decreased hospital admissions
- Cost: estimate HIE reduced overall cost by $1.07 million (primarily due to reduced admissions)
Study design.

Frisse M E et al. J Am Med Inform Assoc doi:10.1136/amiajnl-2011-000394
HIE Models

• Direct exchange between care providers
  – Ex: Doctor refers patient to specialist for follow-up, and sends brief history

• Central organization
  – many-to-many

• Patient mediated
  – EX: PHR, bringing paper records to appointment
Direct exchange

• Pushing info to public health registries, sending orders and results to clinicians

• Challenges?

• Different data formats
• Depends on individuals requesting/matching patients
Patient exchange

(consumer mediated exchange)

• Patients share access with their providers
• In some cases, can correct errors, add information
Note on patient access...

• Patients have the right to see their medical record
  – And to have record sent to a third party
• Demonstrating access is important for meaningful use!
VA Blue Button

• Enable VA patients to download medical data with one click
• Launched in 2010
• Share with MD, other services (e.g. Microsoft HealthVault)
VA blue button – patient exchange example

http://www.youtube.com/watch?v=IGGnda44Yik
<table>
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<tr>
<th>Problem:</th>
<th>Ankylosing spondylitis (SCT 9631008)</th>
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<tbody>
<tr>
<td>Date/Time Entered:</td>
<td>05 May 2017 @ 1200</td>
</tr>
<tr>
<td>Location:</td>
<td>Portland OR VAMC</td>
</tr>
<tr>
<td>Status:</td>
<td>ACTIVE</td>
</tr>
<tr>
<td>Provider:</td>
<td>Provider One</td>
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<tr>
<td>Comments:</td>
<td>--</td>
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<table>
<thead>
<tr>
<th>Problem:</th>
<th>Temporal lobectomy behavior syndrome (SCT 10651001)</th>
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</thead>
<tbody>
<tr>
<td>Date/Time Entered:</td>
<td>05 Jan 2017 @ 1200</td>
</tr>
<tr>
<td>Location:</td>
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<td>Status:</td>
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<td>Provider:</td>
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<tr>
<td>Comments:</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem:</th>
<th>Ehlers-Danlos syndrome, type 8 (SCT 50869007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date/Time Entered:</td>
<td>04 Jan 2017 @ 1200</td>
</tr>
<tr>
<td>Location:</td>
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<tr>
<td>Status:</td>
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</tr>
<tr>
<td>Provider:</td>
<td>Provider One</td>
</tr>
<tr>
<td>Comments:</td>
<td>--</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Problem:</th>
<th>Mild cognitive impairment (SCT 386805003)</th>
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</thead>
<tbody>
<tr>
<td>Date/Time Entered:</td>
<td>20 Jan 2016 @ 1200</td>
</tr>
<tr>
<td>Location:</td>
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</tr>
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<td>Status:</td>
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<tr>
<td>Provider:</td>
<td>Provider One</td>
</tr>
<tr>
<td>Comments:</td>
<td>INDEPENDENT IN ADLs AND IADLs</td>
</tr>
</tbody>
</table>
However...

People hide information
  – Lab tests under assumed name
  – Seeking an out of state provider rather than primary care
  – Giving false information
  – Simply not giving information when requested

13-17% of consumers in recent surveys say they’ve engaged in information hiding in their record
Data from outside hospital?

http://vimeo.com/81272562
Today’s paper

• What’s the problem? Why is the approach novel?
• What challenges come with non-randomized non-blinded trials?
• What results should we be skeptical about?
• What did they find and how?
• Can non-randomized trial results ever be stronger than RCT results?
• Questions/criticisms?
Back to HIE Models

• Direct exchange between care providers
  – Ex: Doctor refers patient to specialist for follow-up, and sends brief history

• Central organization
  – many-to-many

• Patient mediated
  – EX: PHR, bringing paper records to appointment
Query model

- Alice comes to emergency room, physician wants to get all of Alice’s records from all of her providers
HIOs

• Health Information organizations
• Regional HIO
  – Serves a specific geographic area
• HII (health information infrastructure)
• NHII = national HII, e.g. connected RHIOs
Why NHII?

• Biosurveillance
• Full sharing of records
• Integration with public health
• Clinical trials
Patient matching

• Basic problem: How do we know Joe Smith at Hospital A is the same Joe Smith at Hospital B?

• Effects of incorrect match
  – Medical errors: e.g. missing allergy/incorrect allergy
  – Loss of privacy: disclosing another patient’s info

• Challenges
  – Missing data, highly scattered records, common characteristics
UPI

• Everyone gets a “unique patient identifier” (UPI)
• SSN often used, this would replace that

• What’s are pros/cons? Is it a bigger security risk?
• Note: congress has banned funding HHS to investigate UPIs
Other approaches

Figure 5-1. Illustration of the Intermediate Score Range Where Both True Matches and Non-Matches Are Present

NOTE: To disambiguate these linkages, human review is often necessary.
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of unique patients in HIO</td>
<td>225,000 to 9.4 million</td>
</tr>
<tr>
<td>Software type</td>
<td>Use commercial product: 5 HIOs</td>
</tr>
<tr>
<td></td>
<td>HIOs using commercial software that make some adjustments to the system: 3 HIOs</td>
</tr>
<tr>
<td></td>
<td>Use own matching solution: 2 HIO</td>
</tr>
<tr>
<td>Type of matching</td>
<td>Probabilistic: 4 HIO</td>
</tr>
<tr>
<td></td>
<td>Deterministic: 1 HIO</td>
</tr>
<tr>
<td></td>
<td>Combination of probabilistic and deterministic: 1 HIO</td>
</tr>
<tr>
<td></td>
<td>Fuzzy match based on heuristics: 1 HIO</td>
</tr>
<tr>
<td>Manual review component</td>
<td>0 FTEs (full-time equivalents): 2 HIO</td>
</tr>
<tr>
<td></td>
<td>0.5 to 1.0 FTEs: 3 HIO</td>
</tr>
<tr>
<td></td>
<td>Will use manual review, but number of FTEs TBD: 2 HIO</td>
</tr>
<tr>
<td>Summary of all variables used by the HIOs for matching</td>
<td>Medical record number</td>
</tr>
<tr>
<td>(note: not all HIOs use all of these methods)</td>
<td>First name</td>
</tr>
<tr>
<td></td>
<td>Middle name</td>
</tr>
<tr>
<td></td>
<td>Last name</td>
</tr>
<tr>
<td></td>
<td>Maiden or alias names</td>
</tr>
<tr>
<td></td>
<td>Gender</td>
</tr>
<tr>
<td></td>
<td>Date of birth (as single value or separate fields for month, day, and year)</td>
</tr>
<tr>
<td></td>
<td>Social security number (whole number or last four digits)</td>
</tr>
<tr>
<td></td>
<td>Phone numbers</td>
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<tr>
<td></td>
<td>Street address</td>
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<td>City</td>
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<td>Zip code</td>
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<td>Driver's license number</td>
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<td></td>
<td>Race</td>
</tr>
<tr>
<td></td>
<td>Marital status</td>
</tr>
<tr>
<td></td>
<td>Date of encounter</td>
</tr>
</tbody>
</table>
Challenges

• Data may be...
  – Missing
  – Incorrect
  – Outdated
For next week

Read:

S. Abhyankar, D. Demner-Fushman, F. M. Callaghan, and C. J. McDonald. Combining structured and unstructured data to identify a cohort of ICU patients who received dialysis. Journal of the American Medical Informatics Association