Medical Data

Why Keep Records?

- Basis for historical record
- Communication among providers
- Anticipate future health problems
- Record standard preventive measures
- Identify deviations from the expected
- Legal record
- Basis for clinical research

Who Keeps Records?

- Doctor
- Nurse
- Office staff, admissions
- Administrator
- Physical therapist
- Lab personnel
- Radiologist
- Pharmacist
- Patient

Forms of Clinical Data

- Numerical Measurements
  - Lab data
  - Bedside measurements
  - Home instrumentation
- Recorded signals (e.g., ECG, EEG, EMG)
- Images (X-ray, MRI, CAT, Ultrasound, Pathology, ...)
- Genes (SNPs, expression arrays, pedigrees, ...)

- Coded (?) discrete data
  - Family history
  - Patient’s medical history
    - Current complaint
      - Symptoms (patient)
      - Signs (doc)
  - Physical examination
  - Medications
- Narrative text
  - Doctor’s, nurse’s notes
  - Discharge summaries
  - Referring letters
Organization of Data

- Doctor's journal (traditional)
- Time order of collection, per patient (Mayo)
- Source of data
- Problem-Oriented Medical Record (POMR) (L. Weed, 1969)
  - Notes organized by problems
  - SOAP: subjective, objective, assessment, plans

The Data Base

- Identifying information (name, age, sex, race, religion, insurance info, etc.)
- Patient profile (occupation, education, marital status, children, hobbies, worries, moods, sleep patterns, habits, etc.)
- Medical history
  - Chief complaints
  - History of present illness
  - Past medical history
  - Review of systems
  - Family history
  - Medications
- Physical examination
- Laboratory data and physiologic tests (complete blood count, electrocardiogram, chest x-ray, creatinine, urinalysis, vital capacity, tonometry, etc.)

POMR

Data Base

Problem List

Progress Notes (by problem)

diagnostic, therapeutic, patient education

Plans (by problem)

The Problem List

- “those features in the patient’s psychobiological makeup that require continuing attention”
- Social history
- Risk factors
- Symptoms
- Physical findings
- Lab tests
- Causally organized; e.g., GI bleeding caused by duodenal ulcer appears under the ulcer
Example Problem List

<table>
<thead>
<tr>
<th>No</th>
<th>Active</th>
<th>Date</th>
<th>Inactive</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hypertension</td>
<td>1953</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Recurrent bronchitis</td>
<td>1958</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Penicillin allergy</td>
<td>1958</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>S/P pyelonephritis</td>
<td></td>
<td>1960</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Gallstones</td>
<td>Oct 1972</td>
<td>Cholecystectomy</td>
<td>Mar 1973</td>
</tr>
<tr>
<td>6</td>
<td>Arthralgias</td>
<td>Mar 1973</td>
<td>#9</td>
<td>June 1973</td>
</tr>
<tr>
<td>7</td>
<td>Pleurisy</td>
<td>Mar 1973</td>
<td>#9</td>
<td>June 1973</td>
</tr>
<tr>
<td>8</td>
<td>Proteinuria</td>
<td>Apr 1973</td>
<td>#9</td>
<td>June 1973</td>
</tr>
<tr>
<td>9</td>
<td>SLE</td>
<td>June 1973</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Unemployment</td>
<td>Nov 1973</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Problem-Related Plans

- Diagnostic: lab tests, radiology studies, consultations, continued observations, …
- Therapeutic: medications, diet, psychotherapy, surgery, …
- Patient education: instruction in self-care, about goals of therapy, prognosis, …

Plans per problem

1. Diarrhea
   
   Dx:
   - stool for occult blood, culture, ova, and parasites, microscopic fat; and muscle fibers
   - Sigmoidoscopy
   - Barium enema if persistent
   
   Rx: Avoid foods that exacerbate

   Ed: Informed that more info is needed to make a diagnosis, will aim for symptomatic therapy for now.

2. Pyuria
   
   Dx:
   - BUN
   - Repeat urinalysis
   - Urine culture

3. Obesity
   
   Rx: 1500 kcal diet, Weight Watchers
   
Progress Notes

- Subjective: interval history, adherence to program
- Objective: physical findings, reports of lab, x-ray, other tests
- Assessment: Appraisal of progress, interpretation of new findings, etc.
- Plan: Dx, Rx, Ed.

Example SOAP Note

#3 RHD with mitral stenosis

S: 2 flight dyspnea, mild fatigue. No orthopnea, hemoptysis, ankle edema. Child has strep throat.

O: BP 120/70. P 78 regular
   Neck veins normal, lungs clear.
   Grade iii diastolic rumble, wide opening snap, P₂ slightly ↑


P: Dx: Cardiac fluoroscopy
   Rx: Continue chlorothiazide and penicillin V 250mg b.i.d.—2 weeks
   Ed: Reinstructed about antibiotic coverage for tooth extractions, sched. for next month. (Will contact oral surgeon.)

POMR characteristics

- Augment with data flow sheets
- Importance of clinical judgment
- Benefits:
  - Communication among team members, explicitness
  - Education and audit
  - Clinical research

POMR evidence

- Difficult adoption
- Some duplication
- Some doctors liked it
- Paper-based POMR slow, computer-based maybe faster
- Demand-oriented MR: by time, by source, by problem, etc. Dynamic arrangement.
Mayo experience

- Paper records, mostly
- Pneumatic tube delivery, therefore limited size
- Formal procedures for reaping and organizing records at discharge
- Comprehensive index

The Computer-based Patient Record

  - Made strong case for CPR
  - Recommended CPRI (Institute), but it never caught on
  - Today’s standards grow more out of communication standards: HL7 (labs) and DICOM (digital images)

Paper record: Strengths

- Familiar; low training time
- Portable to point of care
- No downtime
- Flexibility; easy to record subjective data
- Browsing and scanning
  - Find information by unanticipated characteristics (e.g., Dr. Jones’ handwriting)

Paper record: Weaknesses

- Content: missing, illegible, inaccurate
  - E.g., one hospital study: 11% of tests were repeats to replace lost information
  - Too thick (1.5 lbs avg.)
  - Fail to capture rationale
  - Incomprehensible to patients and families
Sample paper record defects

• 75% of face sheets had no discharge disposition, 48% no principal Dx
• Agreement between encounter (witnessed) and record: 29% med hx, 66% Rx, 71% info re current illness, 72% tests, 73% impression/Dx, 92% chief complaint
• 20.8% of Medicare discharges coded incorrectly (DRG inflation)

More paper record defects

• Unavailable at up to 30% of patient visits
  • Two clinic visits in a day
  • Docs keep records in their office
  • Failure to deliver
  • Misfiled in file room
• Discontinuity across institutions
  • In/outpatient records separate

Ethnographic Design

• Xerox PARC analysis of office work
  • Sociologists, Anthropologists, Engineers
• Much of work is
  • communication,
  • assignment of responsibilities,
  • problem solving

Medicine is an Information Industry

• 35-39% of hospital operating costs due to professional and patient communications
• Physicians spend 38%, nurses 50% of their time charting
• Exponential growth of medical knowledge and literature
Individual Users of Patient Records

- Providers
  - Chaplains
  - Dental hygienists
  - Dentists
  - Dietitians
  - Lab technicians
  - Nurses
  - Occupational therapists
  - Optometrists
  - Pharmacists
  - Physical therapists
  - Physicians
  - Physician assistants
  - Podiatrists
  - Psychologists
  - Radiology technologists
  - Respiratory therapists
  - Social workers

- Management
  - Administrators
  - Financial managers and accountants
  - Quality assurance managers
  - Records professionals
  - Risk managers
  - Unit clerks
  - Utilization review managers

- Reimbursement
  - Benefit managers
  - Insurers (Fed, State, private)

- Other
  - Accreditors
  - Gov’t policymakers, legislators
  - Lawyers
  - Health care researchers, clinical investigators
  - Health Sciences journalists and editors
  - Patients, families

Institutional Users of Patient Record

- Healthcare Delivery
  - Alliances, associations, networks, systems of providers
  - Ambulatory surgery centers
  - Donor banks (blood, tissue, organs)
  - HMO’s
  - Home care agencies
  - Hospices
  - Hospitals
  - Nursing homes
  - PPO’s
  - Physician offices, group practices
  - Psychiatric facilities
  - Public Health Departments
  - Substance abuse programs

- Management and Review
  - Medicare peer review organizations
  - Quality assurance companies
  - Risk management companies
  - Utilization review/management comp.

- Reimbursement
  - Business Health coalitions
  - Employers
  - Insurers

- Research
  - Disease registries
  - Health data organizations
  - Health care technology developers and manufacturers
  - Research Centers

- Education
  - Allied health professional schools, medical, nursing, public health schools

- Accreditation
  - Accreditation organizations
  - Inst. licensure agencies
  - Prof. Licensure agencies

- Policymaking
  - Fed, State, Local gov’t agencies

Primary Uses of Patient Record

- Patient care delivery (Patient)
  - Document services received
  - Constitute proof of identity
  - Self-manage care
  - Verify billing

- Patient care delivery (Provider)
  - Foster continuity of care
  - Describe diseases and causes
  - Support decision making about dx and Rx
  - Assess and manage risk
  - Facilitate care via Clin. Practice Guidelines
  - Document patient risk factors
  - Assess and document patient expectations and satisfaction
  - Generate care plans
  - Determine preventive advice
  - Remind clinicians
  - Support nursing care
  - Document services provided

- Patient care management
  - Document case mix
  - Analyze severity of illness
  - Formulate practice guidelines
  - Manage risk
  - Characterize use of services
  - Basis for utilization review
  - Perform quality assurance

- Patient care support
  - Allocate resources
  - Analyze trends and develop forecasts
  - Assess workload
  - Communicate between departments

- Billing and reimbursement
  - Document services for payment
  - Bill for services
  - Submit insurance claims
  - Adjudicate insurance claims
  - Determine disabilities (workmen’s comp)
  - Manage & report costs
  - Perform actuarial analysis

Secondary Uses of Patient Record

- Education
  - Document health care professional experience
  - Prepare conferences and presentations
  - Teach students

- Regulation
  - Evidence in litigation
  - Foster postmarketing surveillance
  - Assess compliance with standards
  - Accredit professionals and hospitals
  - Compare health care organizations

- Policy
  - Allocate resources
  - Conduct strategic planning
  - Monitor public health

- Research
  - Develop new products
  - Conduct clinical research
  - Assess technology
  - Study patient outcomes
  - Study effectiveness and cost-effectiveness of care
  - Identify populations at risk
  - Develop registries and databases
  - Assess cost-effectiveness of record systems

- Industry
  - Conduct R&D
  - Plan marketing strategy
User Requirements

• Record Content
  • Uniform core data elements
  • Standardized coding systems and formats
  • Common data dictionary
  • Information on outcomes of care and functional status

• Record Format
  • “Front-page” problem list
  • Ability to “flip through” the record
  • Integrated among disciplines and sites of care

• System Performance
  • Rapid retrieval
  • 24/7
  • Available @ convenient places
  • Easy data input

User Requirements (cont.)

• Linkages
  • To other info systems (e.g., radiology, lab)
  • Transferability of information among specialties and sites
  • With relevant literature
  • Other registries and institutional databases
  • To records of other family members
  • E-billing

• Training and Implementation
  • Minimal training required
  • Graduated implementations

• Intelligence
  • Decision support
  • Clinician reminders
  • “Alarm” systems, customized

• Reporting
  • “Derived documents”, e.g., insurance forms
  • Easily customized output, UI
  • Standard clinical reports, e.g., discharge summary
  • Custom and ad hoc reports
  • Trend reports and graphics

• Control and Access
  • Easy patient access
  • Safeguards of confidentiality

MIMIC2 Data Structure (Clinical Data)
is identified. The tables above show the relationship between the major components in the database.

other information such as admission, demographics, procedures or medications can be readily accessed once a particular patient

Figure 2.1: Major MIMIC II clinical database components. The patient table D

### ICD9 codes

<table>
<thead>
<tr>
<th>subject_id</th>
<th>sex</th>
<th>dob</th>
<th>admid</th>
<th>admit_dt</th>
<th>disch_dt</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>P</td>
<td>2876</td>
<td>2876</td>
<td>1984-06-17</td>
<td>1984-06-26</td>
</tr>
<tr>
<td>31</td>
<td>M</td>
<td>2804</td>
<td>2804</td>
<td>1983-05-17</td>
<td>1983-05-17</td>
</tr>
<tr>
<td>61</td>
<td>M</td>
<td>3927</td>
<td>3927</td>
<td>1983-05-17</td>
<td>1983-05-17</td>
</tr>
</tbody>
</table>

10 rows in set (0.00 sec)

```r
mysql> select subject_id, sex, dob from d_patients limit 10;
```

### Admissions

<table>
<thead>
<tr>
<th>hadm_id</th>
<th>subject_id</th>
<th>admit_dt</th>
<th>disch_dt</th>
</tr>
</thead>
<tbody>
<tr>
<td>2876</td>
<td>56</td>
<td>1984-06-17</td>
<td>1984-06-26</td>
</tr>
<tr>
<td>2075</td>
<td>31</td>
<td>1983-05-02</td>
<td>1983-05-14</td>
</tr>
<tr>
<td>15047</td>
<td>31</td>
<td>1981-04-03</td>
<td>1981-07-28</td>
</tr>
<tr>
<td>15321</td>
<td>31</td>
<td>1982-05-21</td>
<td>1982-06-23</td>
</tr>
<tr>
<td>7149</td>
<td>61</td>
<td>1981-05-23</td>
<td>1981-06-03</td>
</tr>
</tbody>
</table>

2 rows in set (0.00 sec)

```r
mysql> select * from admissions limit 10;
```
```r
> hct = dbGetQuery(conn, "select charttime, value1 from chartevents where itemid='813' and subject_id='21280'")
> hct$t = as.POSIXct(hct$charttime)
> plot(hct[,"t"], hct[,"value1"], main="HCT for patient 21280", xlab="time", ylab="HCT")
```

### NoteEvents

```sql
mysql> select category, count(*) c from noteevents group by category order by c desc;
+-------------------+--------+
<table>
<thead>
<tr>
<th>category</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursing/Other</td>
<td>101934</td>
</tr>
<tr>
<td>RADIOLOGY_REPORT</td>
<td>65884</td>
</tr>
<tr>
<td>DISCHARGE_SUMMARY</td>
<td>3930</td>
</tr>
<tr>
<td>MD Notes</td>
<td>179</td>
</tr>
</tbody>
</table>
+-------------------+--------+
```

**DATE: **2644-1-19 12:09 PM  
**CHEST (PORTABLE AP)**  
**Clip #** [**Clip Number (Radiology) 12570**]  
**Reason:** aspiration pna?  
**Admitting Diagnosis:** HEAD BLEED  
**UNDERLYING MEDICAL CONDITION:**  
**[**Age over 90**]** year old woman with ICH and sone with increased secretions  
**REASON FOR THIS EXAMINATION:** aspiration pna?  
**FINAL REPORT**  
This is a portable semirect chest that is dated [**2644-1-19**] compared to [**2644-1-17**].  
**CLINICAL INDICATION:** Question aspiration pneumonia.  
Nasogastric tube terminates below the diaphragm. The cardiac silhouette appears enlarged, but stable. There is a large mass-like opacity overlying the left side, which has slightly lobulated margins. This measures about 6 cm in greatest diameter. Bilateral pleural effusions are noted, moderate on the left and small on the right. No pneumothorax is identified.  
As compared to the previous study, alveolar opacities adjacent to the pleural mass have resolved.  
**IMPRESSION:**  
Marked improvement in left perihilar alveolar process with residual well-marginated mass-like opacity, concerning for neoplasm. This could be initially confirmed with PA and lateral chest radiographs, but CT may be considered for more complete characterization. Findings communicated to clinical service caring for the patient.

---

```r
> hct1 = hct[hct$t<as.POSIXct("2504-06-01 00:00:00"),]
> plot(hct1[,"t"], hct1[,"value1"], main="HCT for patient 21280", xlab="time", ylab="HCT")
```

### A Nursing Note

**NSG Admit noteB:** Please refer to careview and remarks for details.  
Pt arrived from the ED at 0400 with Nipride gtt off and Dilatin IV infusing.  
Pt arousable to voice and able to answer last name "[**Known patient lastname 243**]", but unable to determine if oriented to place or date. Speech slurred/garbled. Impaired gag, strong cough. Initially, moving RUE and RLE spontaneously, withdrawing LLE to nailbed, nothing from LUE. Next exam pt moved all extremities, LUE to nailbed. OU PERL 2mm/2mm. Pt does not appear to be in discomfort.  
Temp on arrival 95.7. Heated blankets applied. Unable to place aline at this time. Following cuff to keep SBP 90-140. NS 250cc bolus admin x1 for SBP 85 with good effect, ↑103. Palp bilat pedal pulses. RESP Pox wave form dampened at times. LS dimly CTA. MC 3L on.  
BS hypoactive. Abd S/N/T/ND. Dr. [**Last Name (NamePattern4) 244**] placed NGT in (R) nare. Placement verified by auscultation. CXR to be done. Foley insitu, draing small amounts of clear yellow urine. Bilat wrist restraints applied to prevent pt from pulling NGT out.  
**PLAN:** Admin K-excelate. 3% NS with q2h Na levels. Neuro exam qih. Monitor I/O, resp status. MRI today after questionnaire completed. Call H.O. with changes.
Can we formalize the medical record?

- It’s hard:
  - “Sometime before his 5th birthday, Johnny had scarlet fever, which caused changes in his heart sounds.”
- QMR: LEG <S> WEAKNESS PROXIMAL ONLY
- PIP: (EDEMA with LOCATION = FACIAL or PERI-ORBITAL, PAINFULNESS = not PAINFUL, SYMMETRY = not ASYMMETRAL, ERYTHEMA = not ERYTHEMATOUS)
- Uncertainty is ubiquitous
  - Explicit: “... may be consistent with ...”
  - Implicit: “... a week before hospitalization ...”
- next lecture

Minimum Clinical Dataset

- Demographics
  - Name, address, phone number
  - Family contacts
  - Insurance details
  - Employer
- Problem list
  - Current problems
  - Significant past problems
- Current and recent medications
- Recent past visit history
- Allergies
- Lab data
- Clinical measurements (e.g., vitals)
- Radiology, pathology, ... studies

Data for Lotte Ingriddotter

- Name, Address, and Phone
  - Lotte Ingriddotter
  - 34 Oak St
  - Elmhurst, NY 11109
  - Tel. 944-0902
- General Information
  - Date of birth: June 16-1980
  - Sex: F; Race: Y
- Problems for Lotte Ingriddotter
  - HIV/AIDS (CDC Category A, T4 CD4 200/0; from 5/3/84-02 [copy CMR database copy MEDLINE])
  - HEPATITIS B (From 5/3/84-02 [copy CMR database copy MEDLINE])
  - HEPATITIS B (From 5/3/84-02 [copy CMR database copy MEDLINE])
  - TSH (From 5/3/84-02 [copy CMR database copy MEDLINE])

Web Design: E. Lewis (with component CMR and MEDLINE groups)
Labs Summary

Lab Studies for Lotte Inggridottt, Unlimited

Laboratory Tests for Lotte Inggridottt

<table>
<thead>
<tr>
<th>Test Date</th>
<th>Test Type</th>
<th>Result</th>
<th>Units</th>
<th>Normal Low</th>
<th>Normal High</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/06/95 11:38</td>
<td>T4</td>
<td>13.2</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
<tr>
<td>04/02/94 16:39</td>
<td>T4</td>
<td>14.7</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
<tr>
<td>04/06/94 16:48</td>
<td>T4</td>
<td>19.0</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
<tr>
<td>01/06/95 15:23</td>
<td>T4</td>
<td>14.0</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
<tr>
<td>01/01/94 14:11</td>
<td>T4</td>
<td>14.9</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
<tr>
<td>04/05/94 16:47</td>
<td>T4</td>
<td>11.0</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
<tr>
<td>02/11/93 15:55</td>
<td>T4</td>
<td>12.9</td>
<td>mg/dL</td>
<td>6.4-13.3</td>
<td></td>
</tr>
</tbody>
</table>

Plot of T4/HbA1c for Lotte Inggridottt

Growth Charts for Lotte Inggridottt

<table>
<thead>
<tr>
<th>Test Date</th>
<th>Test Type</th>
<th>Result</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/06/95 09:07</td>
<td>100</td>
<td>10</td>
<td>mg/dL</td>
</tr>
<tr>
<td>04/02/94 16:39</td>
<td>96</td>
<td>27</td>
<td>mg/dL</td>
</tr>
<tr>
<td>01/06/95 09:07</td>
<td>100</td>
<td>10</td>
<td>mg/dL</td>
</tr>
</tbody>
</table>