Medical Computing
6.872/HST.950
TuTh 11:00-12:30

Peter Szolovits, PhD (psz@mit.edu)
Isaac S. Kohane, MD, PhD (isaac_kohane@harvard.edu)
Lucila Ohno-Machado, MD, PhD (machado@dsg.bwh.harvard.edu)
Delin Shen *(TA)* (dshen@mit.edu)
Fern DeOliveira (fern@medg.lcs.mit.edu)
Course Secretary; NE43-417, (617) 253-5860

http://medg.lcs.mit.edu/courses/6872/

1

Medical Informatics

- Intersection of medicine and computing
- Plus theory and experience specific to this combination
- =Medical Computing, ~Health Informatics

- Science
- Applied science
- Engineering

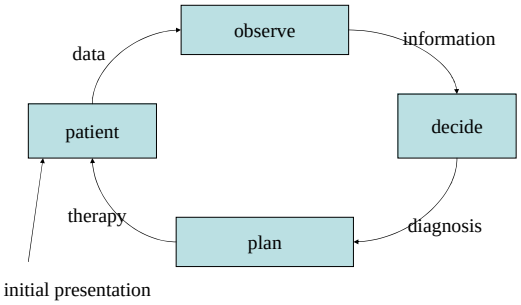
2

Outline

- MI defined by goals and methods of health care
- Medical data: essential
- Expertise (methods)
  - Procedural
  - Inferential
  - Causal
  - Probabilistic

3

The Medical Cycle



4

Care Processes

- Data: instrumentation, monitoring, telemetry
- Information: interpretation, filtering, sampling, smoothing, clustering
- Diagnosis: inference, model-based reasoning, classification
- Prognosis: prediction, natural course, experience
- Therapy: planning, predicting effects, anticipating

5

Meta-level processes

- Acquisition and application of knowledge
- Education
- Quality control and process improvement
- Cost containment
- Reference (library)

6

Time scale in medicine

- Cure—usually acute illness
- Manage—long-term, chronic illness
- Prevent
- Predict (especially based on genetics)

7

WHO Constitution defines "health"

"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"

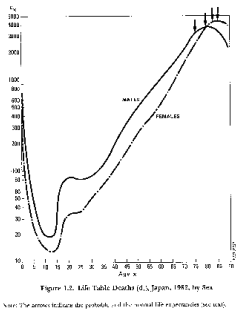
- Physical
- Mental
- Social

—very hard to measure

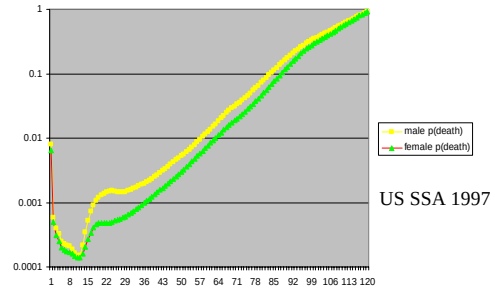
8

Distribution of Ages

- Life table deaths by year (Japan, 1989)



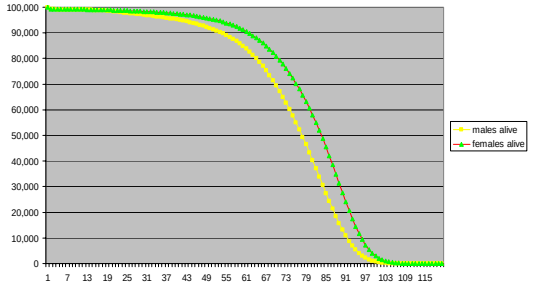
Life table death rates by age



US SSA 1997

10

Life table cohort survival



US SSA 1997

11

Measures of Health

- Longevity at birth (CIA World Fact Book, 2001)

Country	*Male*	*Female*
Rwanda	38.35	39.65
Kenya	46.57	48.44
South Africa	47.64	48.56
Cambodia	54.62	59.12
Brazil	58.96	67.73
Russia	62.12	72.83
Albania	69.01	74.87
USA	74.37	80.05
Japan	77.62	84.15

12

Causes of death
(industrialized countries, 1989)

Circulatory system	48%
Malignant neoplasms	19%
Accidents	7%
Others	26%

13

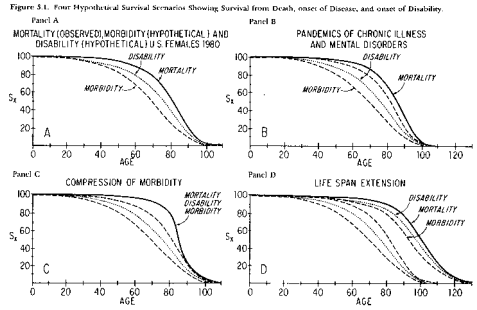
Quality of life

- Value of a total life depends on
  - Length (assume *now* is *N*)
  - Quality (*q*) over time
  - Discounts (γg) for future or past (depends *very* much on what the value is to be used for)

$V_N = \text{Integral}_{[t=0,T]}\ q(t)\ g(t\text{-}N)\ dt$

14

Modeling life quality



15

Top 10 Chronic Conditions
Persons aged ≥ 65

Condition	Both	Male	Female
Arthritis	49.6	40.7	55.7
Hypertension	39.0	33.0	43.2
Hearing impairment	30.0	35.2	26.3
Heart disease	25.7	26.9	24.9
Orthostatic impairment	16.8	15.7	17.8
Cataracts	15.5	11.3	18.4
Chronic sinusitis	15.2	13.7	16.2
Visual impairment	10.1	12.0	8.8
Genitourinary	9.9	11.3	8.9
Diabetes	8.9	7.8	9.7

U.S. Nat'l Ctr Health Stat, *Vital and Health Statistics*, 1985 (1982 data)

16

Societal quality of life

- Aggregation of individual qualities

+ Equity (distributions)

- Is more better? (Population control.)
- Is less better?
- How much to spend?

18

Who makes decisions?

"In those days there was no bureaucratic regimentation, there were few forms to fill out, malpractice premiums were affordable, and the overhead costs of running a practice were reasonable. Our bills were simple, spelled out so anybody could understand them without the use of codes. Patients usually paid their own bills, promptly too, for which an ordinary receipt was given. Hospital charges were set by the day, not by the aspirin. Medical care was affordable to the average person with rates set by the laws of the marketplace, and care was made available to all who requested it regardless of ability to pay. Doctors were well respected; rarely were we denigrated by a hostile press for political reasons. Yes, in the days before government intervention into the practice of medicine, doctor's fees were low, but the rewards were rich; those were truly the 'golden years' for medicine."

Edward Annis, past President of AMA
Code Blue, 1993

3

Aggregation

- Trend: social aggregation leads to decisions at a larger scale
  - Multi-specialty providers
  - Government guarantees and mandates
  - Risk sharing
  - Oregon-wide spending “optimization”;
  - British NHS

20

Changing Context of Health Care

- Fee-for-service
- CMS (Center for Medicare & Medicaid Services)—formerly HCFA (Health Care Financing Agency)—pays for Medicare
- Capitation
  - HMO’s (Health Maintenance Organizations) take overall responsibility to care for patient for fixed fee
  - Pushing risk down to the physician or group

21

Determining Factors:

$£€¥R

22

Exponentially growing expense of health care

- More healthcare than steel in GM cars
- Increased demand
  - Much more possible
  - Better tests, therapies
  - High human motivation
- No pushback
- Waste
  - Unnecessary procedures
    - ½ of health expenses in last year of life
  - Marginally useful procedures
    - Defensive medicine
  - Bad Medicine

23

Managed Care

“Decisions that were once the exclusive province of the doctor and patient now may be examined in advance by an external reviewer—someone accountable to an employer, insurer, health maintenance organization (HMO), or other entity responsible for all or most of the cost of care. Depending upon the circumstances, this outside party may be involved in discussions about where care will occur, how treatment will be provided, and even whether some treatments are appropriate at all.”

Controlling Costs and Changing Patient Care IOM, 1989

24

How is care managed?

- Active case management:
  - Preadmission review
  - Continued-stay review
  - Second surgical opinion
- Selective case management—high-cost cohorts
- Institutional
  - Capitation
  - Institutional arrangements (referrals, hospitals, pharmacies, …)
  - Control “leakage”

25

Managed Care Scorecard

- "U.M. has helped to reduce inpatient hospital use and to limit inpatient costs…"
- "The impact of U.M. on net benefit costs is less clear. Savings on inpatient care have been partially offset by increased spending for outpatient care and program administration."
- "U.M. … does not appear to have altered the long-term rate of increase in health care costs."

IOM, 1989

26

Quality Improvement

- IOM Study: 96,000 US deaths/year from medical error (perhaps half preventable?)
- Information intervention *at the point of decision making* can improve decisions
- DPOE: Direct Physician Order Entry allows such intervention
- Leapfrog Group: Large employers ($$$) require DPOE from providers

30

Outline

- MI defined by goals and methods of health care
- Medical data: essential
  - History of medical record keeping
  - Organization of medical records
  - Computerized medical records
    - Why
    - Key issues
    - Failures and successes
  - Current approaches
- Expertise (methods)

31

Implications of Health Care Organization for Informatics

- Money determines much
  - Medicine spends 1-2% on IT, vs. 6-7% for business overall, vs. 10-12% for banking
  - "Bottom line" rules, therefore emphasis on
    - Billing
    - Cost control
    - Quality control, especially if demonstrable cost savings
    - Retention and satisfaction (maybe)
  - Management by accountants

32

Challenges

- Computerized Medical Records (EMR/CPR/…)
- Usability of systems in the workflow of health care
- Large-scale "Engineering Systems" problem
- Genomic Medicine

33