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

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

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BioMedical Informatics

- Intersection of biomedicine and computing
- Plus theory and experience specific to this combination
- Biology + Medicine; becoming friends
- =BioMedical Computing, ~Informatics, ~Health Informatics

- Science
- Applied science
- Engineering

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Outline

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

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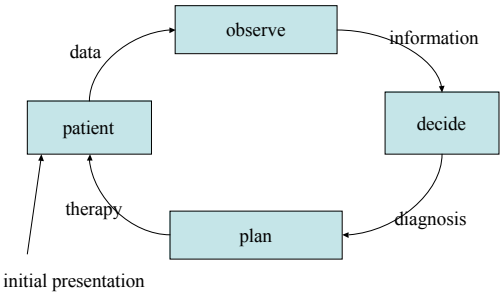
The Medical Cycle



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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

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Meta-level processes

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

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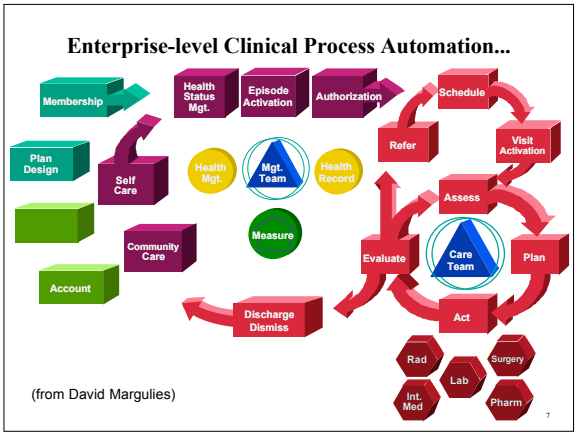

Time scale in medicine

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

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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

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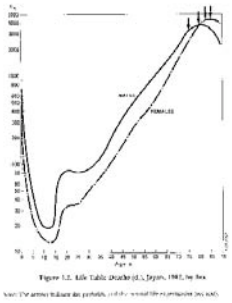
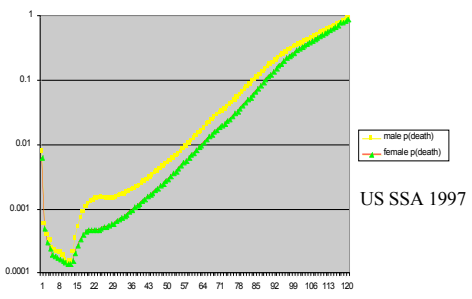
Distribution of Ages

- Life table deaths by year (Japan, 1989)



Life table death rates by age



US SSA 1997

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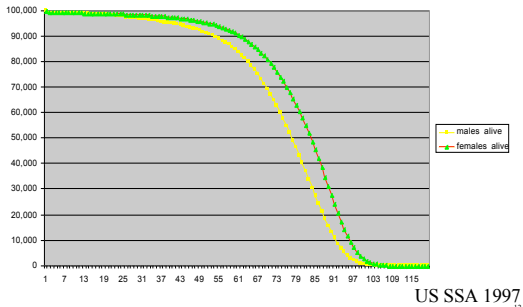
Life table cohort survival



US SSA 1997

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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

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Causes of death

(industrialized countries, 1989)

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

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Quality of life

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

$V_N = \int_{[t=0,T]} q(t)\, \gamma(t-N)\, dt$

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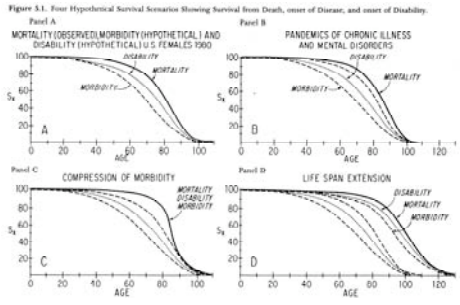
Modeling life quality



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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)

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Next 10 Chronic Conditions Persons aged ≥ 65

Condition	Both	Male	Female
Varicose veins	7.7	3.4	10.8
Hernia	7.6	9.1	6.5
Hemorrhoids	7.6	7.1	8.0
Psoriasis, dermatitis, dry skin	7.4	6.3	8.3
Hardening of arteries	7.4	7.3	7.4
Tinnitus	7.3	7.6	7.1
Corns, calluses & bunions	7.3	4.2	12.7
Constipation	6.5	4.4	8.0
Hay fever	6.4	6.4	6.5
Cerebrovascular	5.7	5.6	5.8

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

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Societal quality of life

- Aggregation of individual qualities

+ Equity (distributions)

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

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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

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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

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Changing Context of Health Care

- Fee-for-service
- CMS (Center for Medicare Services) (was 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

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Determining Factors:

$€£¥…

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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
    - _ of health expenses in last year of life
  - Marginally useful procedures
    - Defensive medicine
  - Bad Medicine

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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

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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"

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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

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What is Insurance?

- Purpose is to reduce variance of (cost) experience over a population
- What population
  - U.S. (275M people), vs.
  - Ten employees of a small company, vs.
  - One individual
- Insurance for small populations is just deferred cost payment
- Power through aggregation. You can't argue with MGH about the cost of your appendectomy, but Blue Cross can about the cost of 1,000.

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Insurance without Risk

- Insurer aggregates many "lives"
- Competition for capitated coverage by HMO's and their ilk
- HMO (e.g., Harvard Pilgrim) further passes risk down:
  - Capitated contract for primary care (e.g., Harvard Vanguard)
  - Capitated contract for cardiology, …
- Risk borne by lowest-level contractor; some group practices lose their shirts (WGBH Frontline, 2000)

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U.S. Alternatives

- Return to fee-for-service; individual health savings accounts; individual responsibility
- Single-payer nationally-aggregated insurance, with managed care
- Clinton health plan: "managed competition"
- … or nothing planned, but development dictated by market forces, laws, discoveries.

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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
- DHHS push for EMR

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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)

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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

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Challenges

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

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- Class Participation
  - Attend (many guest lectures)
  - Read
  - Contribute
- Homework
- Project
  - Individual? Small group? Class-wide?

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