Doctors and Quantitative Literacy

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1. Why do doctors and other health care personnel need skills in numeracy?
2. What is the evidence that there's a problem?
3. What are some of the potential solutions to the problem?

1. Need for numeracy in health care

Physicians need to order medications

- 9-month-old child is diagnosed with an ear infection
- Pediatrician wants to prescribe amoxicillin
- Weight of child = 14 pounds
- Steps:
    1. Convert pounds to kg
    2. Dosing of amoxicillin is 80 mg/kg/day divided in 2 doses
    3. Make sure dose does not exceed maximum dose recommended
    4. Determine what suspension of amoxicillin to use (200mg/5ml versus 400 mg/5 ml) and determine amount in ml patient should take

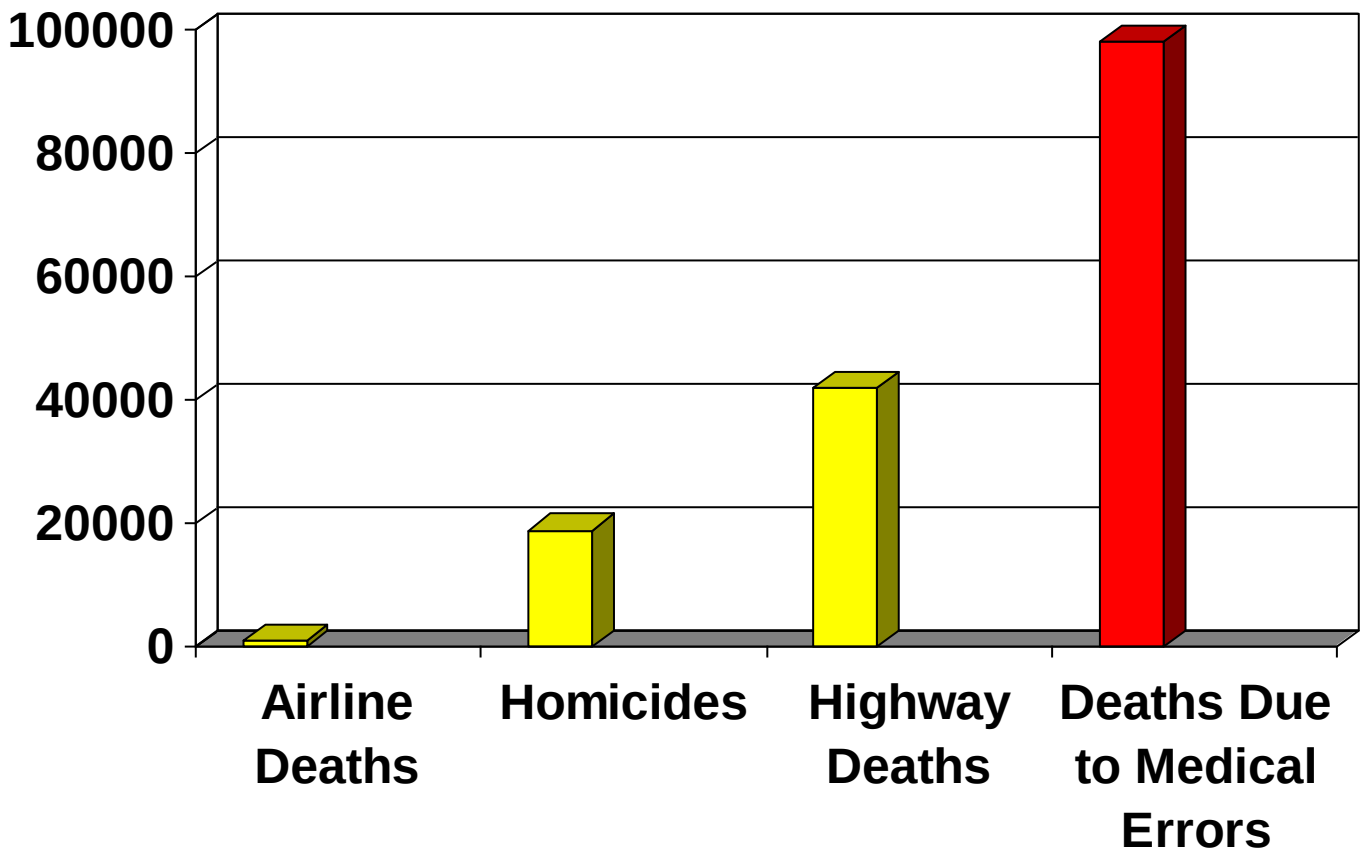
Physicians need to interpret the evidence

- Disease affects 4 in 1000 individuals
- Scientific literature shows:
  - Drug A reduces risk by 25%
  - Drug B reduces risk by 10%
- In one study, 10% of medical students could not identify the drug with the biggest benefit
  - 39% were not able to calculate the size of the benefit

Sheridan et al, *Effective Clinical Practice* 2002

2. Evidence of a problem

An unsafe system



To Err Is Human, Institute of Medicine,1999

Medication ordering: A critical source of errors

- Medication errors are the most common type of medical error
  - At least 25% of all medication-related injuries are preventable
- Majority of errors occur at the prescribing stage
- In any given week, more than four of five U.S. adults take at least one medication
  - Almost a third take at least five different medications
- Frequency and cost of errors is enormous

Preventing Medication Errors: Quality Chasm Series. IOM. 2006

Basic numeracy skills

- Basic numeracy survey
  1. Flip coin 1000 times; how many heads?
  2. Chance of winning lottery 1%; how many prizewinners in 1000 tickets?
  3. Chance of winning car in sweepstakes is 1 in 1000; what percentage win a car?
- Cross-sectional survey of medical students
  - 77% answered 3 questions correctly
  - 18% answered 2 correctly

Sheridan et al, *Effective Clinical Practice* 2002

Calculation errors

Drug calculation test given to staff in a NICU

- Pharmacist score = 96%
- Physician score = 89%
  - 39% 10-fold errors
- Nurse score = 76%
  - 56% 10-fold errors

- Those who perform poorly on written exams even more likely to perform worse in stressful situations

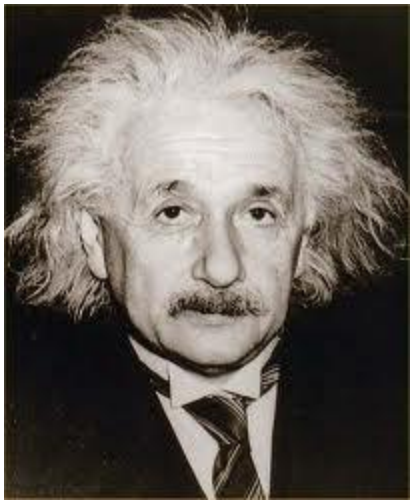
Perlstein, *Am J Dis Child* 1979; Rowe, *Arch Dis Child* 1998

More evidence of physician struggles

- Study of 34 residents testing their skills on:
  - unit conversion
  - fluid and rehydration management
  - drug-dosing
- Mean score was only 42%
- Residents had significant difficulty with unit conversion, some trouble with drug calculation
- Only 5 of 34 wrote acceptable fluid orders
    - Potts and Phelan, Arch Pediatric Adolesc Medicine, 1996

“*Do not worry about your difficulties in mathematics. I can assure you mine are still greater.*”

Albert Einstein (1879 - 1955)



3. Some approaches to address the issue

Better training

- Potential for serious clinical errors is high
- Few physicians are ever tested in the skill of drug dose calculation
- Medical schools and residency programs should consider assessing competencies in mathematics
- Remedial skills training may be necessary for those with deficits; advanced skills training is probably necessary for all trainees
- Ongoing training and regular assessment of numeracy skills may improve patient safety, critical interpretation of the evidence, and medical decision-making

Medical student training exercises

Traditional probabilities

- Probability of colorectal cancer = 0.3% [base rate]
- Among those with cancer, probability of positive FOBT = 50% [sensitivity]
- Among those without cancer, probability of positive test is 3% [false-positive rate]
- What is the probability that a person who tests positive actually has colorectal cancer?

Bayes' Theorem

$$P(Ca|Test_{pos}) = \frac{P(Test_{pos}|Ca)P(Ca)}{P(Test_{pos})} = \frac{(50\%)(0.3\%)}{((3\%)(99.7\%)+(50\%)(0.3\%))} = 5\%$$

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Natural frequencies

- Out of every 10,000 people, 30 have colorectal cancer
  - Of these, 15 will have a positive hemoccult test
- Out of the remaining 9970 people without colorectal cancer, 300 will still test positive
- How many of those who test positive actually have colorectal cancer?
- 15 cases/300+15 positive tests = 5%

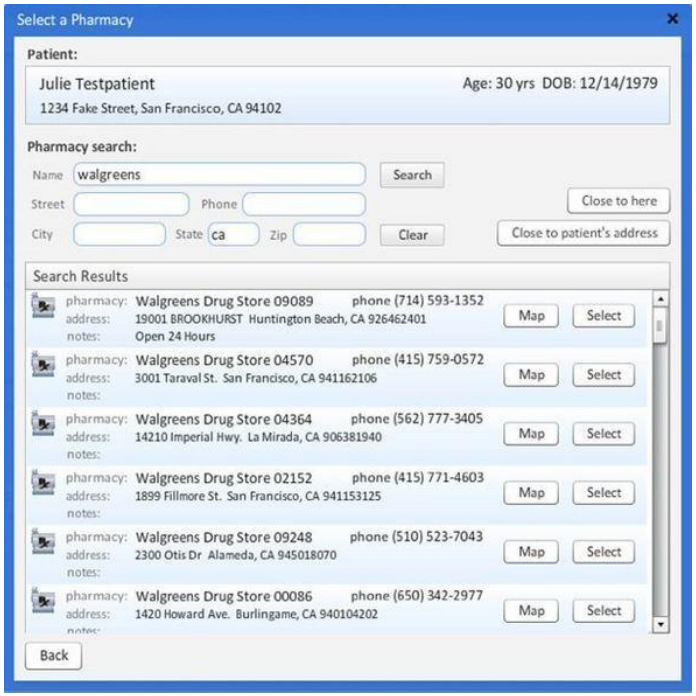
Hoffrage & Gigerenzer, *Science* 2000

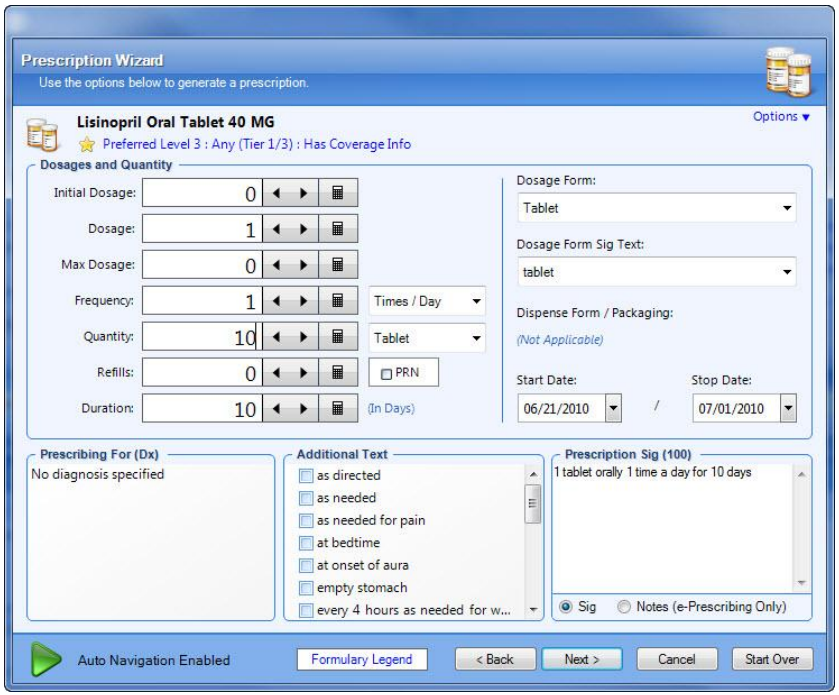
Medical student training exercises

- Take home points:
  - Screening and diagnostic tests are necessarily imperfect (false positives)
  - False positives are more likely when the test is administered to low risk populations as well as high risk populations (prior probability)
  - Clinical judgment therefore affects the interpretation of test results (effect of prior probability on positive predictive value)

Better healthcare information systems

- 2009 HITECH Act offers $ incentives for doctors and hospitals to adopt electronic health records
- Good user interfaces can improve physician performance and cognition





Better healthcare information systems

- E-prescribing reduced rates of medical errors sevenfold
  - Abramson et al. 2010
- E-prescribing user interface change doubled the rate of generic prescribing
  - Ancker et al. in progress
- But at what cost?
  - Overreliance on system dosing recommendations?
  - Effect on resident learning?

Summary

1. Why do doctors and other health care personnel need skills in numeracy?
   - prescribing, interpreting, communicating
2. What is the evidence that there's a problem?
   - error rates; poor performance on assessments
3. What are some of the potential solutions to the problem?
   - training; information system design