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

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

- 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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- 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