Decision science and health care

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Plan for course

- Review the history and current state of the application of decision science to health care
- Discuss lessons from psychology and their impact
- Outline the frontiers of research into health decisions

Who studies health decisions?

- Clinicians
- Psychologists
- Economists
- Operations researchers/engineers
- Sociologists
- Anthropologists
- Philosophers

Three classic approaches

- **Normative**: standards for ideal decision making, often emerging from classical economics
- **Descriptive**: explanations for observed decision making, often emerging from psychology or behavioral economics
- **Prescriptive**: practices for improved decision making

Three classic problems

- Uncertainty and risk
- Value
- Choice

A case

- C, 39, consults his doctor after a public health screening program found him to have a total cholesterol of 260, with an HDL level of 35. His BMI is normal (24.6) and he has no other risk factors for heart disease.
  – He asks, “Am I likely to have a heart attack?”
  – His wife asks, “How likely is it that fish oil capsules could raise his HDL levels?”
  – A medical student asks, “How likely is it that Mr. C has cholestatis (a gall bladder problem)?”

Classic problem: Uncertainty

- A regular feature of health care, and of life itself
  - Often associated with anxiety, doubt, and fear. An obstacle that must be surmounted for successful care.
  - But also the engine of excitement, serendipity, and hope. A psychological space in which patients and clinicians can face the probable while energized by the possible.

Four types of uncertainty

- In the world
- In our knowledge about the world
- In the structure of the decision we face
- In the preferences and values that are brought to bear in making the decision

Normative theories for uncertainty

- Frequency of observed events
  - How common is cholestasis?
  - If we sampled a large number of patients at random, what proportion would have cholestasis?
- Subjective probability
  - What is our level of belief that a patient has cholestasis

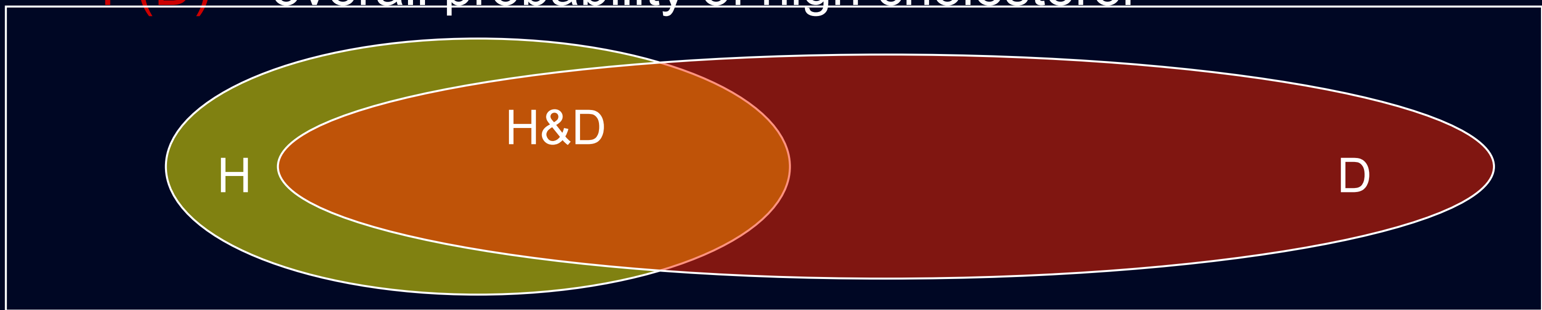
Normative theories of uncertainty

- Laws of probability theory
  - p(H&D) = p(H|D)p(D) = p(H)p(D|H)
- Bayes Theorem

p(H|D) = p(H&D) / p(D)

= p(H)p(D|H) / [p(D|H)p(H) + p(D|~H)(1-p(H))]

- How common is cholestasis, *given* high cholesterol?
  - P(H) = overall probability of cholestasis
  - P(D|H) = prob. of high cholesterol given cholestasis
  - P(D|~H) = prob. of high cholesterol given no cholestasis
  - P(D) = overall probability of high cholesterol



The Müller-Lyer illusion

Cognitive heuristics

- Illusion persists even among those who know that the two lines are equal length, because it's based on a deeply-embedded heuristic in our visual processing system.

- (The heuristic, size constancy, operates because our visual depth processing generally assumes (correctly) that objects that present themselves on our retina with angles pointing inward are closer than objects that present themselves with angles pointing out. If two lines of the same length are inferred to be at different distances, the "farther" line must actually represent a longer object.)

Sharks and airplanes

(Based on Plous, S. (1993). *The psychology of judgment and decision making.* New York: McGraw-Hill.)

- In the United States, in 1990, which was a more likely cause of death?
  - Attacked by a shark
  - Hit by falling airplane parts

Judgmental heuristics

- Powerful and adaptive features of the human cognitive system (Gigerenzer and Selten 2001)
- But can lead to biases when misapplied:
  - Doctors were less likely to prescribe warfarin to a patient with atrial fibrillation after one of their other patients on warfarin experienced a major hemorrhage (an uncommon but highly salient and available event) than before. (Choudhry, Anderson et al. 2006)
- Dr. Jerome Groopman's recent book, How Doctors Think, provides several illustrations of the failure of judgmental heuristics in clinical medicine. (Groopman 2007)

Anchoring and adjustment

- Rather than being Bayesian updaters, people often *anchor* on a salient number, and then *adjust* their judgment intuitively.
- However, anchors can be meaningless, and
- Adjustments are frequently insufficient

Systems 1 and 2

(Based on Kahneman D. 2003. Maps of Bounded Rationality. *Les Prix Nobel. The Nobel Prizes 2002,* Editor Tore Frangsmyr, Nobel Foundation, Stockholm.)

<table>
<tr><th></th><th>PERCEPTION</th><th>INTUITION
System 1</th><th>REASONING
System 2</th></tr>
<tr><td>PROCESS</td><td colspan="2">Fast
Parallel
Automatic
Effortless
Associative
Slow-learning</td><td>Slow
Serial
Controlled
Effortful
Rule-governed
Flexible</td></tr>
<tr><td>CONTENT</td><td>Percepts
Current stimulation
Stimulus-bound</td><td colspan="2">Conceptual representations
Past, present, and future
Can be evoked by language</td></tr>
</table>

Bat and ball

(Based on personal communication from Shane Frederick to Daniel Kahneman, 2003)

- A bat and a ball together cost 110 yen
- The bat costs 100 yen more than the ball
- How much does the ball cost?

Systems 1 and 2

- Formal processes for judgment rely on System 2 processing
- In practice, an intuitive response from System 1 is produced early in almost every judgment process, and then is:
  - endorsed wholly by System 2
  - used as an anchor for adjustments by System 2, or
  - ruled incompatible with valid reasoning by System 2, and prevented from being overtly expressed (Kahneman 2003).

Hypothesis testing

(Based on Wason PC. 1966. Reasoning. in Foss, B. M.. *New horizons in psychology*. Harmondsworth: Penguin.)

- Imagine a set of cards with characters (English or Japanese) on one side and numbers (odd or even) on the other
- Hypothesis: When there is an English letter on one side, there is an odd number on the other side
- Which cards must be turned over to prove this hypothesis?

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Other examples of heuristics in medical decisions

- Important or particularly harmful outcomes are more salient → value of an outcome may be confounded with its probability. Doctors overestimate the likelihood of very bad outcomes. (Wallsten 1981; Poses, Cebul et al. 1985).
- Standard order of workup builds up to confirmatory tests → Information presented or acquired late in a workup gets more weight, regardless of its diagnostic value (Chapman, Bergus et al. 1996).
- Data tends to appear in patterns → Doctors tend to seek information that confirms a hypothesis rather than data that facilitate efficient testing of competing hypotheses. (pseudodiagnosticity: Kern and Doherty 1982; “confirmation bias”: Wolf, Gruppen et al. 1985)

Support theory

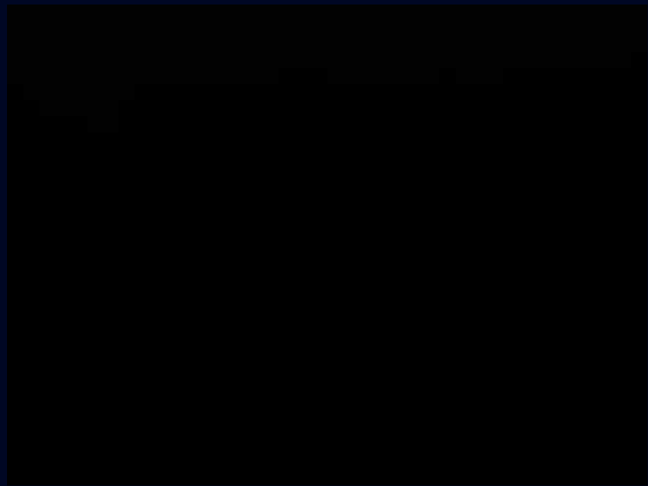
- Several heuristics are explained by support theory (Tversky and Koehler 1994; Rottenstreich and Tversky 1997).
- According to support theory, subjective estimates of the frequency or probability of an event are influenced by how detailed the description of the event is (or is imagined to be)
- Example:
  - Probability of experiencing a fever or other side effect from a flu shot, vs.
  - Probability of experiencing a fever, rash, headache, or other side effect from a flu shot

Support theory

- More explicit descriptions yield higher probability estimates than compact, condensed descriptions, even when the two refer to exactly the same events
- For clinicians, support theory implies that a longer, more detailed case description will increase the suspicion of a disease more than a brief abstract of the same case, even if they contain the same information about that disease (Redelmeier, Koehler et al. 1995; Reyna and Adam 2003).

Using biases to help people

- *Choice architecture* in behavioral economics
- Engineer choice situations so that cognitive biases lead to improved decisions
- Example: Using loss aversion to stay healthy
- Key book in this area: *Nudge* by Cass Sunstein and Richard Thaler



Preventing biases?

- No universally effective methods for debiasing these judgmental tendencies have been developed;
- Because they are so deeply rooted in our intuitive system, and because our intuitive system is essential to everyday operation, it seems unlikely that such methods could ever be developed
- Instead, we must pay close attention to the learning environments in which we come to associate events
- And we must develop good ways to communicate risk information

Educating Intuition (Hogarth, 2001)

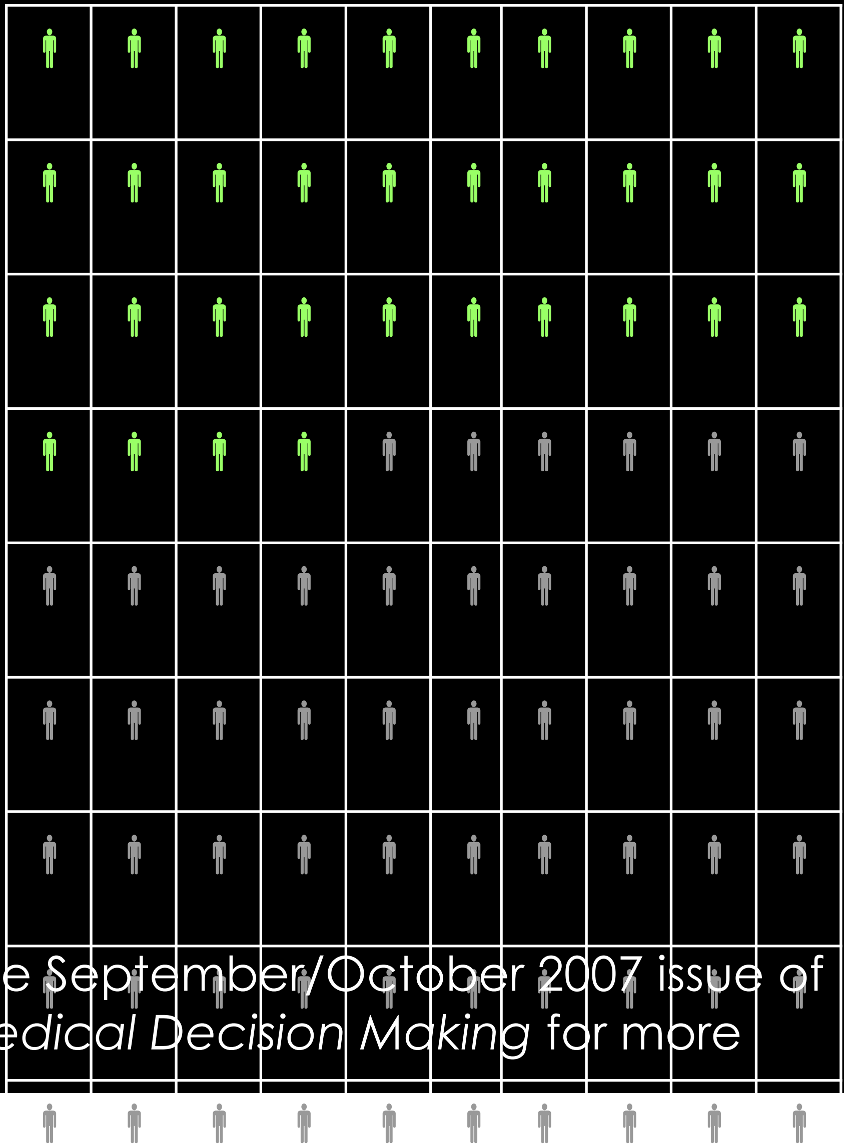
- Kind vs. Wicked learning environments
  - Kind environments are associated with:
    - Relevant feedback, which provides the information necessary to learn correctly
    - Exacting costs of error, which provides the motivation to refine associations.
  - Wicked environments provide
    - Irrelevant feedback
    - Leniency with error, which prevents the irrelevancies from coming to our attention and being remediated.

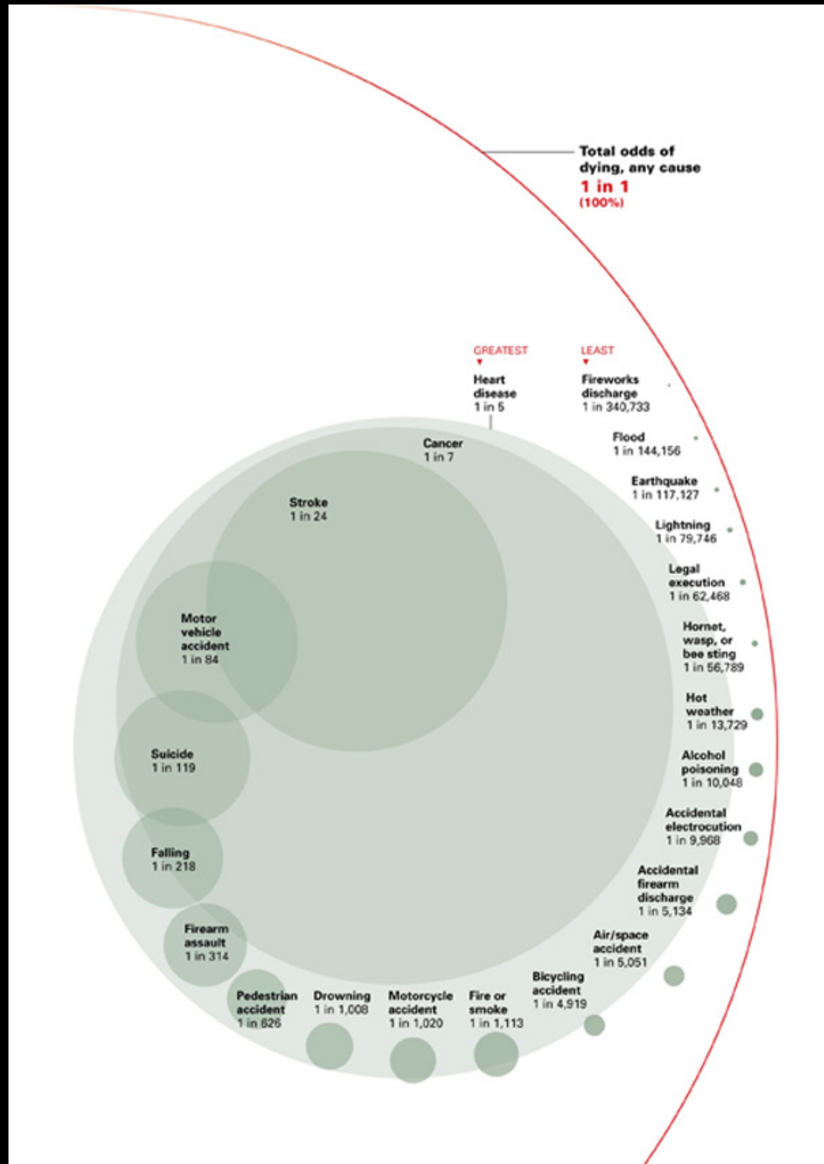
Communicating uncertainty

- How would you explain to someone that there is a 34% chance that a treatment will cure them, and a 2% chance that it will make them worse?
- Create a table, graph, or other explanation

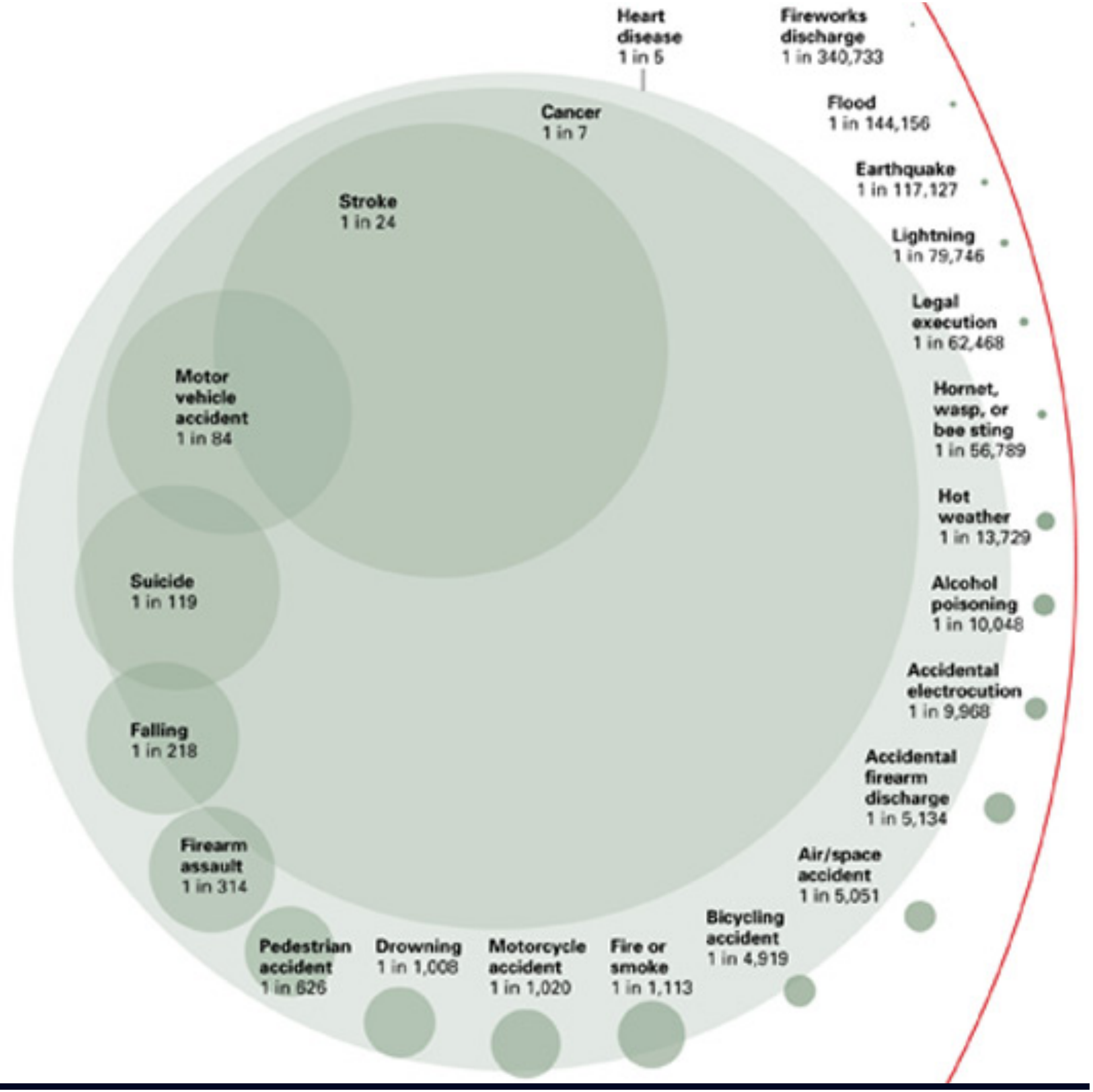
Communicating uncertainty

(Source for right image: National Safety Council, 2009)





See September/October 2007 issue of *Medical Decision Making* for more



Heart disease 1 in 5
Cancer 1 in 7
Stroke 1 in 24
Motor vehicle accident 1 in 84
Suicide 1 in 119
Falling 1 in 218
Firearm assault 1 in 314
Pedestrian accident 1 in 626
Drowning 1 in 1,008
Motorcycle accident 1 in 1,020
Fire or smoke 1 in 1,113
Bicycling accident 1 in 4,919
Air/space accident 1 in 5,051
Accidental firearm discharge 1 in 5,134
Accidental electrocution 1 in 9,968
Alcohol poisoning 1 in 10,048
Hot weather 1 in 13,729
Hornet, wasp, or bee sting 1 in 56,789
Legal execution 1 in 62,468
Lightning 1 in 79,746
Earthquake 1 in 117,127
Flood 1 in 144,156
Fireworks discharge 1 in 340,733

Questions before lunch?