UMDNJ University of Medicine & Dentistry of New Jersey

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Why Risk Communication often Fails the Cost-Benefit Test: 'Tis no Gift to be Simple

Strategies for risk communication:
Evolution, evidence, experience
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run in stocking; nuclear annihilation of planet; phone system down; balloon floats away; glass eye falls out during speech; condom breaks; hairdresser quits; wolverine attacks child; White Stripes release bad album; lose $60 at bus stop; fatal heart attack; meat goes bad; floor collapses; tsunami; train wreck kills hundreds; computer crashes during lengthy download; Statue of Liberty falls over; grain elevator explodes; comet hits earth; ammo runs out; gored by moose; fan belt breaks on interstate; sour cream runs out; gassy; mother-in-law hates you; hamburger tastes charred; ignored by waiter; check gets lost in mail; $2 winning scratch-off washed with pants; get caught in middle of knife fight; humidity makes hair frizzy; cola explodes all over you; UPS package isn't for you; gas grill explodes all over you; neck breaks while clowning around; Livestrong bracelet gets caught in revolving door; everyone finds out you're a fraud; leg cramps up in middle of big game; strike out with bases loaded; boss catches you masturbating in your office; earth gets thrown off axis; plane gets hijacked; girlfriend's new friend cuter, funnier; pen dries out in middle of class; laptop battery loses charge; favorite bill gets vetoed; asshole paints swastika on Hillel center; oversleep on first day of work; neighborhood goes to seed; double-dutch jump rope; meeting with ambassador postponed; greeting card not a Hallmark; water doesn't taste like water at all; attempts to help poor perceived as racist; suffer second-degree burns trying to set toppled candle in jack-o-lantern upright; rescue operation fails when helicopter blade tips strike water tower; die of exposure after unknowingly taking more arduous path to summit; bite violently down on inside of cheek while eating sloppy joe; get shortchanged at charity bake sale; blind date repulsed by toenail parings on futon; mother throws out beloved old stuffed hippo; leg gets amputated by dredger chain; wrong backing-vocals tape played; final exam directions misinterpreted; real mother appears out of nowhere; friends, family learn the truth; drunk tattoo artist uses Dremel tool instead of needle; president roofied; lycanthropy turns out to be real; one of your legs grows four inches; pants stay unzipped all day; nosebleed unnoticed for first 10 minutes of wedding; batteries in remote control die; favorite song used in aerosol-cheese ad; toilet paper stuck to shoe when firemen rescues you; tacky plastic animals at gift

Everything That Can Go Wrong Listed

FULLERTON, CA-A worldwide consortium of scientists, mathematicians, and philosophers is nearing the completion of the ambitious, decade-long project of cataloging everything that can go wrong, project leader Dr. Thomas R. Kress announced at a press conference Tuesday.

"We are mere weeks from finishing one of the most thorough and provocative scientific surveys of our time," Kress said. "The catalog of every possible unfortunate scenario will complete the work of the ancient Phoenicians and the early Christian theologians. Soon, every hazardous possibility will be known to man."

"And listed," Kress added.

From *The Onion, 7/05*

The design of the original levees, which dates to the 1960s, was based on rudimentary storm modeling that, it is now realized, might underestimate the threat of a potential hurricane. Even so, however, the levees were designed to withstand only forces associated with a fast-moving Category 3 hurricane. If a lingering Category 3 storm—or a stronger storm, say, Category 4 or 5—were to hit the city, much of New Orleans could find itself under more than 20 ft (6 m) of water.

-- Civil Engineering Magazine June 2003: "The Creeping Storm" (Greg Brouwer)

KING: All right, hold on. Dr. Forrest, your concept of how can you out-and-out turn down creationism, since if evolution is true, why are there still monkeys?

BARBARA FORREST, AUTHOR, "CREATIONISM'S TROJAN HORSE": Larry, creationism has long ago been discredited by science and it's long ago been declared to be unconstitutional by the Supreme Court. And so, this is an issue that should long ago have been settled. We shouldn't still be debating this.

From **Tragic Choices**, Calabresi and Bobbitt, 1978

"We cannot know why the world suffers. But we can know how the world decides that suffering shall come to some persons and not to others. … For it is in the choosing that enduring societies preserve or destroy those values that suffering and necessity expose." (p 17)

"It is honesty which allows us to see clearly … the ways, some subtle and some not honest, by which societies must cope. We want to live, but we cannot. We want men to be equal, but they are not. We want suffering to end, but it will not. Honesty permits us to know what is to be accepted and, accepting, to reclaim our humanity and struggle against indignity." (p 26)

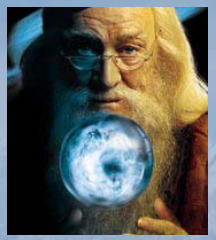
"No human activity can proceed without making choices– critical acts of the mind– and the ethical impulse in teaching any subject or discipline is to tell how to go about acquiring the edifice of a belief. And from the architectonics of choices a person will emerge, a person who knows how to cope with the vast population of decisions we all live in, a person who can carry on."

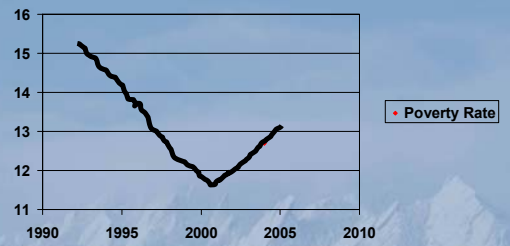
--A. Bartlett Giamatti
(from **A Free and Ordered Space: The World of the University,** 1988)

The all-time, bar-none, best quote ever about decision theory:

"It is not our abilities that show what we truly are– it is our choices"

--Albus Dumbledore





" 'Err on the safe side' scientific canons and default assumptions… help to convince environmentalists, press, and public that more should be done about known carcinogenic risks, even when those risks are tiny. Such public pressure, in turn, may encourage Congress… Congressional reaction provokes further public concern."

--Stephen Breyer, *Breaking the Vicious Circle,* 1993

"Small is Beautiful"– 20 Years and Counting

"The cumulative effect of following the upper-bound path, using a long series of conservative assumptions, can be monumental overestimates of health risks."

"The goal should be clear: Risk assessments should be as close to expected values… as the state of scientific knowledge permits."

- Albert Nichols and Richard Zeckhauser, "The Perils of Prudence," **Regulation,** Dec. 1986

"Using mouse terrorism, self-appointed 'environmentalists' and their allies in regulatory agencies … have been successful in dramatically inflating local, state, and federal budgets to underwrite … a far-reaching, taxpayer-supported, chemical witch hunt."

- Elizabeth Whelan, *Insight (*Washington *Times* magazine), 12/12/94

"Please Phrase your Question in the Form of an Answer"

"OMB requests comments on:

- Ways in which 'precaution' is embedded in current risk assessment procedures through 'conservative' assumptions in estimation of risk…
- Examples of approaches in human and ecological risk assessment methods addressed by U.S. regulatory agencies… which appear unbalanced."

-- 68 Federal Register No. 22 (Feb. 3, 2003)

"It became clear that policy decisions were heavily embedded within the existing risk assessment practices at some federal agencies, despite administrative requirements that risk assessments be objective, realistic and scientifically balanced. A subsequent informal 'staff paper' by EPA scientists documented in detail how its risk assessment practices were deliberately and thoughtfully intended to bias risk management decision-making."

-- Lewis and Hushka, abstract for 2004 SRA mtg.

Is "Humane Risk Analysis" an Oxymoron?

"Right now risk assessment is used to answer the following sort of question: "How much of these 41 carcinogens can we give industry the right to dump into public waters without killing an unacceptable number of citizens?" Anyone who helps the state answer such an immoral question is essentially keeping the death camp trains running on time."

--Rachel's Environment and Health Weekly 11/7/96

"To quiet the bereaved and turn this tragic toll into a form of publicly-sanctioned Russian Roulette, the government and industry are turning to a sham science called risk assessment."

--Andre Carothers, *E Magazine,* May 1991

It's frightening to think that you might not know something, but more frightening to think that, by and large, the world is run by people who have faith that they know exactly what's going on."

-Amos Tversky, *Discover* magazine, June 1985

"The public concern reflects serious confusions, and when ordinary people disagree with experts, it is often because ordinary people are confused."

-Cass R. Sunstein, **Risk and Reason**, 2002

"Precisely because they are experts, they are more likely to be right than ordinary people… brain surgeons make mistakes, but they know more than the rest of us about brain surgery"

Sunstein's "The Experts"

…Any serious revolutionist must often deprive himself of the pleasures of self-expression. He must judge his actions by their ultimate effect on instutitions.

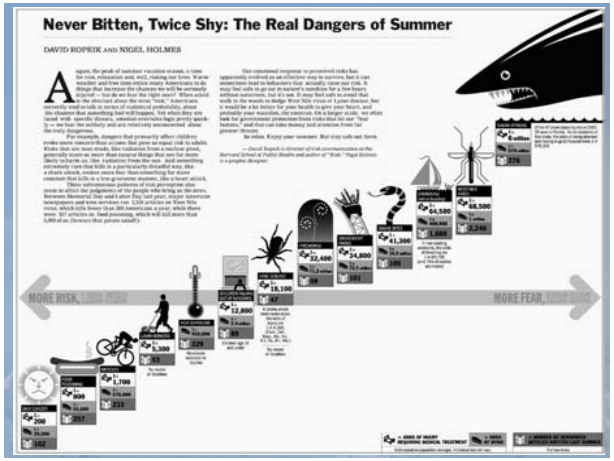
-Herbert Simon, *Models of My Life*

The American people are suffering from what could be called "a syndrome of paranoia and neglect" about potential risks to their health, safety , and the environment…. Large amounts of resources are devoted to slight or speculative dangers while substantial and well-documented dangers remain unaddressed.

-John Graham, *Making Sense of Risk*

We overreact to some risks and virtually ignore others. Often too much weight is placed on risks of low probability but high salience (such as those posed by trace carcinogens or terrorist action… Too little effort is placed ameliorating voluntary risks, such as those involving automobiles and diet…

-Richard Zeckhauser and W. Kip Viscusi, "Risk Within Reason"



Only Risk Assessors have Opposable Thumbs

- Risk expert David Ropeik will explore the fact that individuals are often more afraid of lesser risks and less afraid of bigger ones. This means that perception can actually make life more dangerous. Using neuroscience and cognitive psychology, he will explain the way we subconsciously "decide" what to be afraid of and the implications these fears have for government, the press, and public health.

  -- Dickinson College, Sept. 2003

- "I think I have an advantage over the rest of the public. I am a toxicologist and a risk analyst… I know what the risks are and what they are not… the fact that [chemicals] have kind of scary names seems to make people react more strongly."

  - G. Gray, techcentralstation.com, 3/12/01

- "There are people who for whatever reasons– early toilet training or genetics or whatever– are very risk averse."

  - J. Clarence Davies, *Los Angeles Times,* 9/13/94

July 13, 2004
PERSONAL HEALTH; Back to Basics: The Real Risks to Children
By JANE E. BRODY

Many parents worry that their children may be harmed by exposure to environmental factors they cannot avoid or control, including pesticide residues on fruits and vegetables, approved food additives, chlorinated drinking water and hormones in milk.

They fear electromagnetic fields as a cause of childhood leukemia, a mercury preservative in vaccines as a cause of autism, and alar, a growth stimulant on apples, as a cause of cancer.

None of these are actual hazards. But even if they were, they are hardly the main threats to the health and lives of fetuses, infants, children and adolescents, says Dr. Robert L. Brent, a professor at Thomas Jefferson University in Philadelphia and a leading expert on what is and is not known about the effects of environmental chemicals and physical agents on developing humans.

Most of the hazards that take the greatest toll on the health and lives of the young people in this country can be prevented, without any need for further research, legislation, environmental cleanup or any other measure that requires the action of anyone besides parents and caretakers. "Nearly every day a child in Florida dies in a swimming pool," Dr. Brent said. "No environmental agent exacts such a toll." Accidents are the leading cause of death in children under 15. But while the word accident implies an unexpected and unavoidable event, most accidents involving children could be prevented by vigilance. Here are the most important hazards.

POINT SPREADS
Which will be higher: Tiger Woods' fourth-round score in the FBR Open or Hines Ward's receiving yards total?
Woods 4 point favorite

Which will be higher: Darrell Jackson's number of receptions or Tiger Woods' number of birdies in the FBR Open?
Jackson 1 point favorite

OVER/UNDERS
Total TDs for both teams: 5 1/2
Yardage of shortest touchdown: 2
Number of punts: 9
Number of third-down conversions: 11
Total number of penalties: 12
Which team will have the most first downs? Pittsburgh by 2 1/2
Who will have the most rushing yards, Shaun Alexander or Willie Parker? Alexander by 27 yards
Distance in yards of game's first field goal: 33
Number of Steelers who will score: 3
Number of Seahawks who will score: 3
Number of Steelers who will catch a pass: 7
Number of Seahawks who will catch a pass: 6

Uncertainty *versus* Variability

-- same mathematics and terminology (percentiles, standard deviation, expected value, range, etc.), but…

U

- A property of us
- Sometimes reducible through further study
- Forces decisions about whether to be "better safe than sorry"

V

- A property of nature
- Irreducible (but understandable)
- Forces decisions about "who ends up safe, who ends up sorry"

(from A. Finkel, *Environmental Health Perspectives,* 1995)

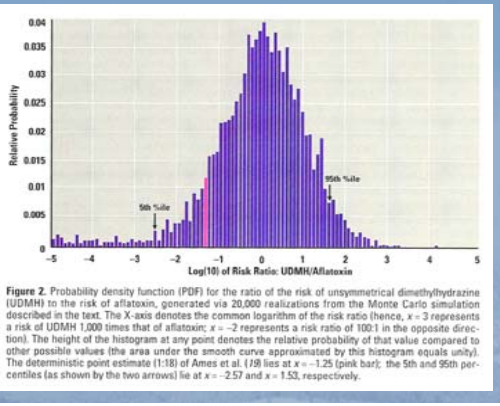


Figure 2. Probability density function (PDF) for the ratio of the risk of unsymmetrical dimethylhydrazine (UDMH) to the risk of aflatoxin, generated via 20,000 realizations from the Monte Carlo simulation described in the text. The X-axis denotes the common logarithm of the risk ratio (hence, $x = 3$ represents a risk of UDMH 1,000 times that of aflatoxin; $x = -2$ represents a risk ratio of 100:1 in the opposite direction). The height of the histogram at any point denotes the relative probability of that value compared to other possible values (the area under the smooth curve approximated by this histogram equals unity). The deterministic point estimate (1:18) of Ames et al. (*19*) lies at $x = -1.25$ (pink bar); the 5th and 95th percentiles (as shown by the two arrows) lie at $x = -2.57$ and $x = 1.53$, respectively.

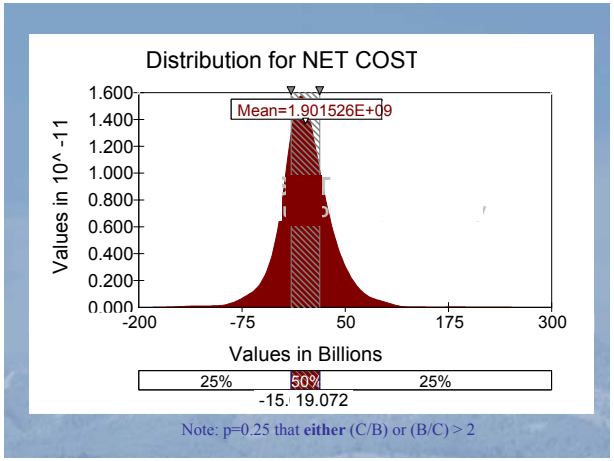
Are two (Broad) Similar Distributions "Equal"?

(first 2 quotes from Cohen and Graham, 2003)

- "The central estimate result suggests that banning cell phone use while driving is virtually a break-even proposition…"
- "The fact that the net benefits of the ban are close to zero…"
- "We estimate that a ban on nonemergency use by drivers would save $43 billion in reduced deaths, injuries and property damage. But by estimating how much time a month cellphone customers are driving while phoning, we estimate that people are willing to pay about the same amount — $43 billion per year — to use their mobile phones while they drive. The benefits and costs of a ban are about the same." (Hammitt and Weinstein, *Los Angeles Times,* 2/25/04)

Monte Carlo Simulation of Cell Phone Costs/ Benefits

	COST	BENEFIT	NET COST
Mean	47 ($billion)	45.1	1.9
1st %ile	13.1	21.3	-86.7
5th %ile	17.9	24.6	-48.7
25th %ile	29.7	32.2	-15.7
Median	41.7	39.5	0.18
75th %ile	58.4	51.1	19.1
95th %ile	93.9	84.2	55.0
99th %ile	129	132.6	89.8



Note: p=0.25 that **either** (C/B) or (B/C) > 2

Risk to "Groundlings" (pre-9/11)

Goldstein *et al.* (1992): $\frac{150\ U.S.deaths}{11\ years} = 4.2x10^{-6} / lifetime$

John Graham, founding director of the Harvard Center for Risk Analysis, summed up the human health risk from pesticides when he noted that the U.S. regulatory safety standard for pesticide residues is no more than one additional theoretical cancer per million people, yet a person is 5 times more likely than that to be killed while standing on the ground by a crashing airplane.

Thompson *et al.* (2002):

$$4.2x10^{-6} = 0.97(6.2x10^{-7}) + 0.03(1.2x10^{-4})$$

more than 2 mi. from airport

less than 2 mi. from airport

In Vitro Outcomes as *f*(transfers, *p*)

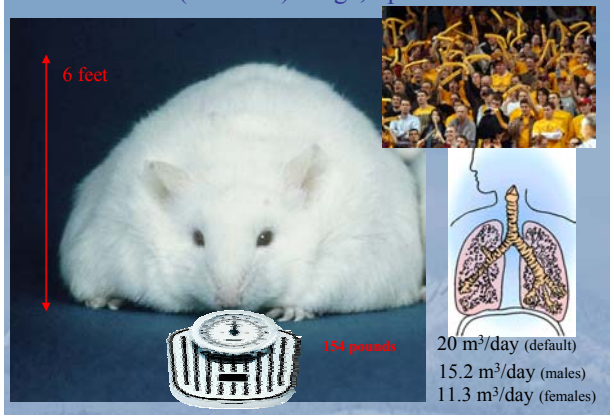
# Transferred \ # Fetuses	0	1	2	3
1	0.5 0.4 0.3	0.5 0.6 0.7	X	X
2	0.25 0.16 0.09	0.5 0.48 0.42	0.25 0.36 0.49	X
3	0.125 0.06 0.03	0.375 0.29 0.19	0.375 0.43 0.44	0.125 0.22 0.34

Green: p=0.5 ; Black: p=0.6 ; Red: p=0.7

Arenas where Interindividual Variability is Sometimes Wholly Ignored

Arena	Example(s)
Exposures	"Groundlings"
Susceptibility	EPA Cancer Guidelines
Medical Decision-Making	*In Vitro* Fertilization/ Schneider book
Regulatory Cost	Alar/ HACCP

260 Million (Identical) Large, Spherical Rodents



20 m^3/day (default)
15.2 m^3/day (males)
11.3 m^3/day (females)

Ways we Misuse Information about Interindividual Variability

Pitfall	Example
Fractionating population via an irrelevant characteristic	FDA and sperm donors
Fractionating via a weak cause	Exposure *vs.* susceptibility
Fractionating via a group characteristic	Sentencing guidelines
Fractionating via a characteristic for which $\sigma_w > \sigma_B$	EPA cancer guidelines
Treating continuous characteristic as discrete	Birth weight cutoffs
Scapegoating variability	"Maximally Exposed Individual"? Larry Summers on women in science?

Concerns about Misuse of Individual Genetic Information

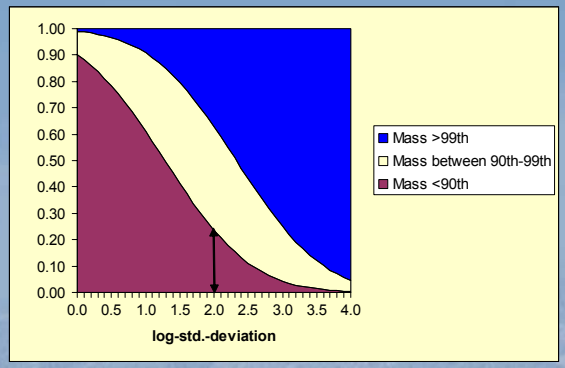
- stigmatization
- insurability (family and/or self)
- job loss
- loss of autonomy
- "debasement" of society

From Executive Order 13145, signed Feb. 8, 2000 by W.J. Clinton

"The employing department or agency shall not discharge, fail or refuse to hire, or otherwise discriminate against any employee with respect to the compensation, terms, conditions, or privileges of employment of that employee, because of protected genetic information with respect to the employee, or because of information about a request for or the receipt of genetic services by such employee."

In general, protected genetic information means: information about an individual's genetic tests; information about the genetic tests of an individual's family members; or information about the occurrence of a disease, or medical condition or disorder in family members of the individual.

Genetic test means the analysis of human DNA, RNA, chromosomes, proteins, or certain metabolites in order to detect disease-related genotypes or mutations.



Arguments in Favor of Protecting for "Unidentifiable Variability"

- provides impetus to advance the science
- already being done for exposure variation
- already being done for economic variation
- Congressional intent
- evidence of public perception
- done, without challenge, in OSHA's MC rule

ALL Estimates are "Biased"

Estimate	Corresponding Value Judgment (Airplane ex.)	(Unc. in risk)	(Var. in risk)
Mode	Max. probability of arriving just as plane leaves	Max. probability that risk is exactly "acceptable"	Protect "most common person"
Median	50/50 chance of catching or missing flight	50/50 intervention is too risky/ too costly	Protect "typical person"
Mean	X minutes late and X min. early are equally bad	X units "overspending" = X "underspending"	Protect population on avg.; max net benefit
95th %ile	X min. late = 19 times worse than X min. early	X units "underspending" = 19x worse than converse (precaution)	Protect persons at increased exposure +/or susceptibility

These are BOTH Policy Statements:

- "Policy makers should base their decisions about most health risks on the expected value of the risk, not the upper bound"

  -Nichols and Zeckhauser, 1986

- "Verily I say unto you, inasmuch as ye have done it unto one of the least of these my brethren, ye have done it unto me … Inasmuch as ye did it not to one of the least of these, ye did it not to me"

  -Matthew 25: 40, 43

Ultra-conservative Assumptions about Risk Come Naturally

"We have every reason to assume the worst, and we have an urgent duty to prevent the worst from occurring"

-President Bush, 2002

"Even if there was even a 1 in 10 chance that Saddam Hussein was behind the 9/11 attack maximum priority should be placed on eliminating that threat"

- Paul Wolfowitz, 2001

Not a trick question: "What do you call a well-conducted epidemiologic study where the best estimate of the odds ratio is 3.0 and there is a 94% chance that the OR > 1 ??"

NSF Proposal: "Transferring to Regulatory Economics the Risk-Analysis Approaches to Uncertainty, Interindividual Variability, and other Phenomena"

Project Team:

- Adam Finkel (risk science and policy)
- Eldar Shafir (cognitive psychology)
- Winston Harrington (Resources for the Future/ environmental economics
- Sandra Hoffman (RFF/agricultural economics)
- W. Troy Tucker (Applied Biomathematics/ anthropology)
- Scott Ferson (Appl. Biomath./ mathematical ecology)
- Carl Cranor (U-Cal Riverside/ philosophy, ethics)
- Dale Hattis (Clark University/ genetics)

Premises of Proposed Work on Risk Science/Regulatory Economics:

1. The "science" side of cost-benefit analysis, as opposed to the "economics" side, increasingly uses sophisticated methods (or clear caveats) to acknowledge:
   - uncertainty in parameter estimation and model selection;
   - interindividual variability and distributional inequality;
   - non-linearities in implicit utility functions; *and*
   - second-order effects that may offset primary ones.
2. Errors or deficiencies in cost estimation can mislead, or ruin decision-making, in exactly the same ways that errors in risk estimation can.
3. Inattention to interindividual variability in cost estimation is particularly ironic, because the theoretical last stage of Kaldor-Hicks optimality ("winners" compensate "losers" following an intervention that increases total net benefit) *cannot even be contemplated* if winners and losers are not informed as to who is who.

Research Tasks for NSF Risk/Economics Work:

Blue: WWS with Applied Biomathematics, Cranor, Hattis Red: WWS with Resources for the Future

Green: WWS

1A. Define typical and best-case examples of treatment of uncertainty, variability, and second-order equilibria in regulatory economics.

1B. Examine published regulations, and interview agency staff about ideas rejected due to cost concerns, to impute utility functions for risk and for cost.

2A. Complete two detailed case studies (CGE model of DC economy under air pollution regulations; model of poultry industry after "HACCP" rules) to explore the household- and firm-level distribution of regulatory costs.

2B. Review literature and interview experts to examine possible normative assumptions that permit inattention to U and V.

Research Tasks for NSF Risk/Economics Work (cont.):

3. Improve software and graphical tools to help explore how laypeople and experts process information about U and V.

4A. Conduct psychometric surveys to explore the "cost literacy" of laypeople, toxicologists, and economists.

4B. Perturb baseline psychometric experiments to explore how enriched info. about U and V in cost affects perception and preferences.

5. Revisit "The Politics of Regulation" in light of insights from previous tasks.

Hypothetical Case Involving Inter-individual Variation in Risk and in Cost

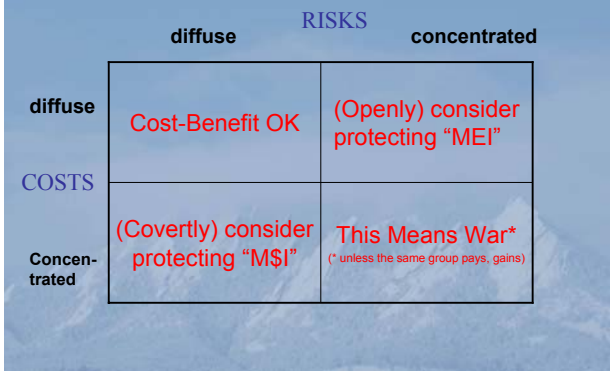
"It will cost the nation $10 billion to save 1000 lives"

Gets "translated" as:

"It will cost **me** $40 to eliminate a risk of 4 x 10^{-6} "

Variability in Risk and Cost

Variability in Risk and Cost



Adam M. Finkel is a professor of environmental and occupational health at the University of Medicine and Dentistry of New Jersey (UMDNJ) School of Public Health, and a visiting professor at Princeton University's Woodrow Wilson School of Public and International Affairs. Finkel has a doctoral degree in environmental health sciences and a master's degree in public policy, both from Harvard University, and has written many articles in the medical, legal, economics, and statistical literature. For ten years he was a senior executive at the U.S. Occupational Safety and Health Administration (OSHA), serving as OSHA's national director of regulatory programs in Washington and later as chief OSHA administrator in the six-state Rocky Mountain region, based in Denver. He has pioneered methods to quantify and communicate the uncertainties in risk and cost estimation, and to explore the variation in environmental and medical risks individual citizens and patients face due to differences in susceptibility, exposure, and other factors. His research has shown that traditional methods of risk assessment and cost-benefit analysis often underestimate risks and overestimate the economic costs of sensible interventions to reduce them. He designed OSHA's most sophisticated health regulations, as well as its first "enforceable partnerships" that brought government, industry, and labor together to craft protections beyond what traditional regulation could offer.