Risky business – Understanding and communicating risk

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How did humans survive this long?

- The *amygdala* is an area of the brain hardwired to protect you from harm
- *Fight, flight, or freeze*
- The amygdala enables you to make split-second, instinctive decisions
The amygdala

- The amygdala is rather primitive and generates a very simple, basic risk response
  - Fight, flight, or freeze
- Some fears come “standard” as a result of our evolutionary course
  - Large predators
  - Spiders
  - Snakes
- The amygdala was not built to assess complicated threats (e.g., technological)
Question

• Raise your hand if you remember what you did on March 11, 2001
Question

• Raise your hand if you remember what you did on September 11, 2001
Fear, body, and mind

• Fear is a powerful emotion
• Fear often trumps reason
  – Darwin and the snake
• Fear leads to the formation of strong memories
• Fear fuels the body and mind
  – Glucose release, stress hormones
Consequences of fear

• Fear results in the creation of a *Perception Gap* between reality and our fear
  – “Distance between fear and facts”
• We tend to underestimate large risks and overestimate small risks
• This Perception Gap leads to
  – Risky personal behavior
  – Stress
  – Social policies that do not maximize protection of public and environmental health
Evaluating complex threats

• This brings us to the substance of this talk
• How do humans evaluate risks and make decisions considering the complex nature of modern threats?
• How can we make better decisions by keeping the emotional (affective) risk response, driven by the amygdala, in check?
Question

• Raise your hand if you flew to this meeting
  – Did you:
    • Look up historical data on incidents on your route?
    • Look up historical data on major incidents at the airline you flew?
    • Look up historical weather for your departure and arrival airports?
    • Look up FAA fines levied on the airline you chose?
Bounded rationality

• If not, you applied *Bounded Rationality* to make your decision to fly
• Making decisions or judgments with only limited information
• We would never be able to make *any* decisions if we didn’t work off of limited information
• Mental shortcuts
Mental shortcuts that we use

• Framing
• Categorization
• Loss aversion
• Anchoring
• Ready recall
• Innumeracy
• Optimism bias
The Framing Effect

• Which is the best way to inform a patient:

• The dose you received from your CT was 10 times your annual background radiation dose

• The dose you received from your CT was half of the limit imposed by the American College of Radiology for this exam
Question

- I have developed a new preservative
- It contains chemicals, including methylglyoxal
- If I gave you food treated with this preservative, would you eat it?
Categorization

• I have developed a new preservative
• It contains chemicals, including methylglyoxal
• If I gave you food treated with this preservative, would you eat it?
Loss aversion

• In a study, participants were offered the following choice:

1. Take a chance, have 80% chance of winning $4,000 or 20% chance of winning nothing
2. Take a sure $3,000

• 80% chose option 2
Loss aversion

• In Part 2, participants were given $4,000 and offered the following choice:

1. Take a chance, have an 80% chance of losing the $4,000 or 20% chance of keeping it
2. Give back $3,000

• 92% chose option 1
Loss aversion

• Examples abound in real life
  – 4th down decisions in football
  – Stock market
  – Medical imaging

• Loss aversion means that we pay more attention to the risk side than the benefit side

• The *Endowment Effect* is a corollary
  – Health, home, etc.
Anchoring

• More than 5,000,000 people lived in the Chernobyl area

• WHO estimates of the number likely to die as a result of the accident ranged from 4,000 to 100,000

• To date, it is believed that 56 deaths are directly attributable to Chernobyl

http://www.iaea.org/Publications/Booklets/Chernobyl/chernobyl.pdf
September 21, 2005
Awareness/ready recall

- The greater our awareness, and more readily we can recall information, the more concerned we are about a threat.

- Hurricane Katrina devastated New Orleans on August 29, 2005.

- Hurricane Rita made landfall on September 23, 2005.
Awareness/read recall

- *The China Syndrome* was released on March 16, 1979

- What happened on March 28, 1979?

- Public reaction to TMI was most certainly influenced by the fact that *The China Syndrome* had just been released
Question

• You are considering two houses, both located in 100 year flood zones. Everything about the houses is identical, except that one experienced a 100 year flood last year and the other house last experienced a 100 year flood 80 years ago. Which house would you buy?
Question

• A family has two children. One child is a boy. What is the likelihood that the other child is a girl?
Question

• A family has two children. What is the likelihood that one child is a boy?
Question

• A family has two children. The oldest child is a boy. What is the likelihood that the other child is a girl?
Question

• A family has one child. What is the likelihood that the child is a girl?
Innumeracy

• First coined by John Allen Paulos
• Most people are bad with numbers
  – Except experts
  – Perhaps we are better if we resist an immediate Affective (emotional) reaction
• However, many people demand numbers
  – Contributes to Bounded Rationality
• Physicists are quick to resort to numbers
What if I told you

• There was a 1 in 10,000 chance you would develop (NOT get) cancer as a result of a medical procedure.

• But what if I first told you there was a 1 in 2 chance you would develop cancer in your lifetime *anyway*.
Big numbers are especially troublesome

• The general population risk per year of dying in a commercial plane crash is 1 in 2,067,000

• How many is 2,067,000?
Big numbers

• One slide per second
• 24 hours a day: 24 days
• 8 hours a day, 5 days a week: 3.5 months
Absolute vs. relative risk

• Elements of both Framing and Innumeracy
  – Often exploited by the media
Absolute vs. relative risk

• You are **268x** more likely to die in an automobile crash than a commercial plane crash

• Worried?

• However, your risk (per year) of dying in an automobile crash is **1 in 7,700**
Question

• Raise your hand if you think you could be without a job for at least a year within the next 5 years
Question

• Raise your hand if you think the credit rating of the United States will be downgraded in the next 5 years
Optimism bias

• We tend to think bad things will not happen to us
• These factors contribute to optimism bias
• Optimism bias decreases as events draw closer
  – E.g., anticipated performance on exam
RISK PERCEPTION FACTORS
Risk perception factors

• Many factors influence how we perceive threats (i.e., risk from a threat)

• Risk perception factors can either increase our concern about a threat or decrease our concern

• Risk perception factors often work together
Trust

• Humans are social animals
  – Pack mentality
• Physical (hormonal) factors
  – Oxytocin
• Depends on who is communicating the risk
  – Those entrusted to protect us
  – Those who created the risk
• Are you more likely to trust a doctor telling you about side effects or a commercial from the drug manufacturer?
Risk vs. benefit

• The greater the benefit, the more likely we are to downplay the risk
  – And vice versa
• Rationalization is a powerful mental tool
• Smoking
Not understanding the benefit

• Just as detrimental as not understanding the risk
  − Water fluoridation
  − Medical imaging using ionizing radiation
Staging laparotomy in Hodgkin's disease.


Abstract

Staging laparotomy was performed at the University of Virginia Medical Center on 111 patients with Hodgkin's disease. The operation included multiple liver and lymph node biopsies and, excepting three patients, splenectomy. The histopathology was reviewed and the 111 patients were classified as follows: nodular sclerosis, 4; mixed cellularity, 26; lymphocyte predominance, 7; and undetermined, 2. There were no deaths. Wound, pulmonary or urinary tract complications occurred in 11 patients. One case of postoperative thrombophlebitis occurred and in another case small bowel obstruction developed, and resolved without reoperation. The pathologic stage (PS) following laparotomy was unchanged from the clinical stage (CS) in 64%, reduced in 20%, and advanced in 16%. The therapy, however, was altered in 38% of the patients. Lymphangiography in 103 patients was interpreted as showing lymph node involvement in 38, equivocal involvement in 11, and no involvement in 54. Among the 52 examinations reported as either positive or negative, 77% were confirmed histopathologically, 21% were falsely positive, and 2% were falsely negative. The spleen was positive for Hodgkin's disease in 39% of cases, and in these patients with positive spleens there was no reason to suspect intra-abdominal involvement preoperatively in 21%.

Full text

Full text is available as a scanned copy of the original print version. Get a printable copy (PDF file) of the complete article (89K), or click on a page image below to browse page by page. Links to PubMed are also available for Selected References.

PubMed articles by these authors

- Sandusky, W.
- Jones, R.
- Horsley, J.
- Hass, C.

PubMed related articles

- Staging laparotomy in Hodgkin's disease.
  [Ann Surg. 1990]
- Staging laparotomy and splenectomy for Hodgkin's disease.
  [Ann Surg. 1978]
- An assessment of laparotomy in the management of patients with Hodgkin's disease
  [C J Med. 1978]
- Review [Staging in Hodgkin's lymphoma. Exploratory laparotomy with splenectomy]
  [Z Lymphol. 1987]
- Review Long-term complications of laparotomy in Hodgkin's disease

Recent Activity

- Staging laparotomy in Hodgkin's disease.

Links

- PubMed
Question

• Would you rather

• Be driving a car
• Be riding in the front passenger seat
Control

• The more control (or perceived control) we have, the less risk we perceive
  – Lack of control – overestimate risk
  – Control – underestimate risk
• Drivers *perceive* that they have complete control
• Passengers lack any control
• Flying vs. driving post-9/11
Choice

• The more involuntary a risk seems, the more worrisome it is
• Vaccination

• Patients should be informed of the risks and benefits of a medical imaging procedure and allowed to make a decision
  – Even if we are certain of the decision the patient will make
  – Even if we believe the patient will make the wrong decision
    • Not wrong to them – based on evidence
Question

• Given the choice, would you buy a product labeled “Contains Genetically Modified Organisms” or one labeled “Non-GMO”, or do you not care either way?
Natural or man-made?

• Threats that are man-made seem scarier than those that are natural

• All food we consume today is genetically modified
  – Either through Mendelian genetics or otherwise

• UV vs. cell phone radiation

• Radon vs. nuclear waste

• Reflected in government policies
  – “Natural” supplements vs. prescription drugs
Pain and suffering

• The risk of a threat that is associated with pain or suffering is likely to be overestimated

• Cancer (and its treatment) is frequently associated with pain and suffering

• The risk from exposure to low doses of ionizing radiation is cancer
Uncertainty

• The more uncertainty associated with a threat, the higher the perceived risk
  – SARS, West Nile, Fukushima, etc.

• Can’t detect it
  – D.C. sniper

• Can’t understand it
  – Radiation

• Nobody knows
  – Economic calamity
The Precautionary Principle

• Governmental/societal policy
• If there *might* be a risk associated with something, it is best to treat it with extreme caution
• Better safe than sorry

• Prostate cancer treatment?
Catastrophic or chronic?

• Catastrophic threats tend to be perceived as more risky than chronic threats

• *Great, often sudden, calamity*
Catastrophic or chronic?

• Tenerife
  – 583 people died

• Heart disease
  – 1800 deaths per day in U.S.

• Chernobyl
  – 56 people died

• Skin cancer
  – 8,000 deaths per year in U.S.
Can it happen to *me*?

- Threats that are personal seem more risky than others
- The risk of dying in a commercial fishing accident is 116 per 100,000
- The risk of dying in an automobile accident is 1 in 7,700 (13 per 100,000)
- The risk of dying in a bicycle accident is 1 in 410,000 (0.25 per 100,000)

US Dept. of Transportation and BLS
Does this concern you?

• The risk of dying in a commercial fishing accident is $9x$ higher than in an automobile accident

• The risk of dying in an automobile accident is $268x$ the risk of dying in a plane crash
Question

• Which risk are you more worried about

\[
\frac{1}{1,000} \quad \text{or} \quad \frac{1}{?}
\]
Is the risk new or familiar?

• New threats are more worrisome because we don’t know what the risk really is
  – West Nile, SARS

• As the threat is studied more and understood better, concern levels off and eventually declines
  – Media coverage of West Nile
Risks to children

• Threats that involve risks to children are often perceived as being greater than they actually are
  – Children are used by the media to play to our fears
  – Progeny, carry on species

• Children have become the face of dose reduction in medical imaging
Question

• If I told you that during the past 5 years, approximately 200 patients were overexposed during CT perfusion exams, would you refuse a perfusion scan for your spouse if a stroke was suspected?
What about now?

http://latimes.image2.trb.com/lanews/media/photo/2009-12/50945817.jpg
Question

• If I told you that during the last 5 years one child had been overexposed during a head CT, would you refuse an indicated exam for your child?
What about now?

Personification

- Threats that are made personal, with individual names, are more worrysome than a threat that affects a nameless “number of people”
Fairness

• Risks that affect the poor, weak, or disadvantaged seem worse
Immediacy*

- Threats that are imminent are scarier than threats that are distant (temporal or spatial)
- Iran developing nuclear weapon
- Global warming
Risk

Risk = Hazard × Exposure

• Polonium exposure
• Small amounts of radiation exposure

Cultural factors influence perception

• Goiana

• Media
  – Don’t tell you what to think, but what to think about

• Political views
  – Egalitarian vs hierarchist
  – Communitarian vs individualist

• Groupthink
CONSEQUENCES
Individual perception gap

- Stress when we overestimate risks
- Detriment to health when we underestimate risks
  - UV exposure
- Detriment to health when overestimate risks
  - Overuse of ciprofloxacin during anthrax attacks
Question

• Which is more risky:

• Getting a CAP CT
• Getting an abdominal MRI
Small Town Reels From Boy's M.R.I. Death

By DAVID W. CHEN
Published: August 01, 2001

It was a beautiful summer day today, the kind of day that Michael Colombini would have savored. He might have gone swimming. Gamboled in nearby Sunset Park. Made new friends to add to his ever-growing circle.

"He wasn't the kind of boy who'd just say hello," a family friend said. "He'd smile and jump into your arms."

But today, instead of bubbling with the effervescence of a happy 6-year-old, Michael was mourned at a funeral here in his hometown, less than 48 hours after he died from injuries caused by a freakish accident at Westchester Medical Center.

By all accounts, Michael had always been a supremely healthy child. But he suffered a nasty fall in recent weeks that precipitated a CAT scan, according to family friends. A benign brain tumor was diagnosed and removed. Then on Friday, when Michael went in for a routine postoperative magnetic resonance imaging test, an oxygen tank mistakenly placed in the examination room became magnetized, flying through the air at 20 to 30 feet per second and fracturing his skull.
MRI Scanner Accidents on the Rise

Aug. 22, 2005

Magnetic resonance imaging has been called the most important tool for doctors since the X-ray was invented more than 100 years ago, but an article in The New York Times on Friday is calling the safety of the machines into question.

The number of MRI scanners in the United States has soared from a handful in 1980 to about 10,000 today, and the magnets have quadrupled in power during that time. With the increase of diagnostic scans being performed, which can detect dozens of serious ailments such as tumors and stroke, medical experts are concerned about the number of careless accidents that have caused serious injury and even death.

In 2001, Michael Colombini, 6, was killed while undergoing an MRI when an oxygen tank flew out of the hands of an anesthesiologist toward the machine, hitting him in the head.

In 2003, a New Mexico woman sued a Los Alamos hospital, claiming the magnetic pull of an MRI caused an oxygen tank to hit her in the back.

In 1992, a 74-year-old woman hemorrhaged and died after an aneurysm clip in her brain shifted while she was on a table preparing for an MRI.
Societal perception gaps

• Misguided policy/use of funds
• Fluoridation
  – What are the risk perception factors?
• Nuclear energy vs. fossil fuels
  – 24,000 die per year in U.S. from burning of fossil fuels*
  – 56 confirmed deaths from nuclear power
• Political views
  – Climate change – cap and trade, gas tax, renewable energy research, regulate CO$_2$, fuel efficiency stds

Unfinished Business: A Comparative Assessment of Environmental Problems
Overview Report
Intangible aspects of risk play a very important part in the way the public values environmental problems, particularly those related to groundwater. However, we do not understand them very well and perhaps underestimate them.
RISKS AND EPA's CURRENT PROGRAM PRIORITIES DO NOT ALWAYS MATCH. In part, these differences seem to be explainable by public opinion on the seriousness of different environmental problems.
Narrowing the perception gap

• Open mind
• Take time (remember the amygdala)
• Get **more** information from **reliable** sources
• What does the risk mean (hazard x exposure)
• Get relative and absolute risk
  – Lifetime? Annual? Exposure?
  – Consider tradeoffs
• Understand your risk response
CATARACTS

LINK BELOW PROVIDES THE REASON

LINK BELOW PROVIDES THE PROTECTION

NORMAL VISION

CATARACT VISION
Cataract warning

• What are the Mental Shortcuts and Risk Perception Factors in play here?
LIFETIME ODDS OF DEATH FOR SELECTED CAUSES, UNITED STATES, 2007

Total, any cause
1 in 1

Heart disease 1 in 6

Cancer 1 in 7

Stroke 1 in 28

Motor vehicle accidents 1 in 88

Intentional self-harm 1 in 112

Accidental poisoning by and exposure to noxious substances 1 in 130

Falls 1 in 171

Car occupant 1 in 303

Assault by firearm 1 in 306

Pedestrian 1 in 649

Motorcycle rider 1 in 770

Accidental drowning and submersion 1 in 1,123

Exposure to smoke, fire and flames 1 in 1,177

Pedalcyclist 1 in 4,717

Firearms discharge 1 in 6,309

Air and space transport accidents 1 in 7,032

Exposure to electric current, radiation, temperature, and pressure 1 in 9,943

Exposure to excessive natural heat 1 in 12,517

Cataclysmic storm 1 in 46,044

Contact with hornets, wasps, and bees 1 in 71,623

Lightning 1 in 84,079

Legal execution 1 in 96,691

Bitten or struck by dog 1 in 120,864

Earthquake and other earth movements 1 in 148,756

Flood 1 in 175,803

Fireworks discharge 1 in 386,766
Acknowledgements

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• How Risky Is It, Really? by David Ropeik