“Only those who will risk going too far can possibly find out how far they can go”

T S Eliot
(1885-1965)
CRACK

BOOM

WHOA! WE SHOULD GET INSIDE!

IT'S OKAY! LIGHTNING ONLY KILLS ABOUT 45 AMERICANS A YEAR, SO THE CHANCES OF DYING ARE ONLY ONE IN 7,000,000. LET'S GO ON!

THE ANNUAL DEATH RATE AMONG PEOPLE WHO KNOW THAT STATISTIC IS ONE IN SIX.
Some true headlines

“Bacon increases your risk of colorectal cancer by 20%”

“One extra unit a day increases a woman’s risk of breast cancer by 12%”

“Two units a day reduce the risk of heart disease by about 17%”
What do we mean by ‘risk’?

- To do with situations where ‘bad’ (or ‘good’) things may happen
- Mainly use our ‘gut feelings’ to deal with these situations and to make decisions
- These feelings can be influenced by experience, emotion, media coverage, etc.
What do we mean by ‘risk’?

• 2 main brain systems for decision making
  1. Instinctive (i.e. gut feelings, driven by emotions, lower than level of conscious control)
  2. Conscious/rational

  1. Instinctive – fast and effective (e.g. instantaneous integration of complex information, carrying out well-practiced actions)
  2. Conscious/rational – more useful in novel situations (e.g. situations requiring deliberative analysis)

SOMETIMES 1 KICKS IN WHEN 2 MAY BE BEST
What do we mean by ‘risk’?

- Gut feelings can be unreliable, especially when
  - We are being manipulated
  - The reasoning is complex
  - Much depends on our decisions

- Question: A bat and a ball cost $1.10. The bat costs $1 more than the ball. How much is the ball?
  - ~3500 US university students
  - < 50% gave the correct answer
  - Intuition suggests 10c. Rational system does little to correct unless conscious effort intervenes
Thought question:

• Suppose a newspaper article claimed that drinking coffee **doubled your risk** of developing a certain disease.
• Assume that the statistic was based on legitimate, well-conducted research.
• What additional information would you want about this risk before deciding whether to quit drinking coffee?
“Bacon increases your risk of colorectal cancer by 20%”

About five people in 100 have colorectal cancer in a lifetime

“Bacon increases your risk of colorectal cancer by 20%”

About five people in 100 have colorectal cancer in a lifetime

If all 100 eat three extra rashers of bacon every day...

...that rises to about six
"One extra unit of alcohol a day increases a woman's risk of breast cancer by 12%"

But how bad is that?

About 10 in every 100 women have breast cancer in a lifetime

If all 100 drink an extra unit of alcohol every day...

...that rises to about 11

"One extra unit of alcohol a day increases a woman’s risk of breast cancer by 12%"

is the same as saying

about one extra case in every 100 women
“Two units of alcohol a day reduce the risk of heart disease by about 17%”

But how good is that?

About 32 in every 100 women have coronary heart disease in a lifetime

If all 100 drink roughly two units of alcohol every day...

...that falls to about 27

“Two units of alcohol a day reduce the risk of heart disease by about 17%”

is the same as saying

about five fewer cases in every 100 women
So....

- Depending on the story
  - 20% or 12% can equal one person while
  - 17% can be the equivalent of five people

- Don’t think percentages, think REAL PEOPLE!
Risk – some quotes from the media

• One of the largest studies of the impact of food and drink on mental decline has found a Mediterranean diet cuts the risk of Alzheimer’s disease by up to 40%. *(NZ Herald, April, 2006)*

• One drink increased the risk of cancer of the oesophagus by almost a third. Low alcohol intake increased the risk of oral cavity and pharynx cancer by 17%, and breast cancer in women by 5%. *(NZ Herald, August, 2012)*

• People who live alone are twice as likely to have serious heart disease as those who live with a partner. *(NZ Herald, July, 2006)*
DOUBLE YOUR RISK

– Risk goes from 1 in 1,000 to 2 in 1,000?

OR

– Risk goes from 1 in 10 to 2 in 10?
Risk of something BAD happening

Please Note:
We can only show averages. It is impossible to predict whether your results will be positive or negative.

- Red: Background risk (no coffee)
- Blue: Additional risk with coffee
Risk of something BAD happening

- Red: Background risk (no coffee)
- Blue: Additional risk with coffee

Please Note:
We can only show averages. It is impossible to predict whether your results will be positive or negative.
Heavy rain
Light breeze
Cool
Overcast
1995 Pill scare (UK)

- Research showed that the risk of developing deep vein thrombosis (DVT) was doubled in women taking the new ‘third generation’ contraceptive pill.
  - This was (correctly but misleadingly) described as a 100% increase in the risk of DVT.
  - Many women stopped taking it.
  - Result? A rise in the number of unplanned pregnancies.
1995 Pill scare (UK)

The facts:
Risk of DVT (2\textsuperscript{nd} generation pills) = 1/7000 = 0.000143
Risk of DVT (3\textsuperscript{rd} generation pills) = 1/3500 = 0.000286

Relative risk = 0.000286/0.000143 = 2.0
Increased risk = (2.0 − 1) \times 100\% = 100\%
1995 Pill scare (UK)

– DVT is also a well known complication of pregnancy, affecting around 60 of every 100,000 pregnant women.

– In fact, the chances of getting DVT on the ‘high risk’ Pill were less than half the chances of developing it during pregnancy.

– With unplanned pregnancies came a 9% jump in terminations, which (as with any surgical procedure) carry the usual risks associated with anaesthesia, including DVT!

Avoiding one risk can simply cause another
Risk of travel according to mode of transport

Air Travel

Rail

Water

Car

Pedestrian

RISK INCREASING

1 in 1 Trillion
1 in 1 Billion
1 in 10 Billion
1 in 10 Million
1 in 1 Million
1 in 100,000
1 in 10,000
1 in 1,000
1 in 100
1 in 10
1 in 1

Risks that most people are comfortable with

Risk Communication Institute
Helping People Understand Risks
Risks With Which We Are “At Home”

The Paling Perspective Scale®

“Solutions from a New Perspective”

1 in 1
Million
1 in 10
Million
1 in 1
Billion
1 in 10
Billion
1 in 1
Trillion
1 in 1

Risk of Drowning in Tub this Year

Extra Risk Of Cancer From Living in Denver
Compared to New York for 1 Year

Risk of Cancer from 1 Light Beer a Day for 1 Year

Risk of Cancer from Eating Peanut Butter Sandwich Every Day for 1 Year

Cancer Risk from Eating Charbroiled Steak Once a Week for 1 Year

U.S. FDA Point Below which any Risk from a Food Additive is Considered too Small to be of Concern

Risk of Resident Being Killed by Crashing Airplane (Pre 9-11)

Risk of Mother Dying in Birth of Single Child

Risk of Being Struck By Lightning

Risk of Death from Accidents At Home in 1 Year

Totally Safe For All Practical Purposes

Risk Effectively Zero

Minimal

Very Low

Low

Moderate

High

Very High

THE UNIVERSITY OF AUCKLAND
DEPARTMENT OF STATISTICS

THE RISK COMMUNICATION INSTITUTE
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Risk, reporting and media influence

• Media reporting of health-related news stories can be highly influential
  – priorities and decisions of policy-makers are often shaped by what they see on TV and read in the general and specialist press.

• Members of the public may alter their behaviour in ways that affect their health, at least partly as a result of information and advice they get from the media.
Risk, reporting and media influence

• The media is often uninterested in serious, proven health risks such as smoking, alcohol and obesity.

• More interested in ‘crises’ such as SARS, vCJD etc. which pose relatively little danger.

• Example: Study carried out in the UK found that 8,571 people died from smoking for each news story on the health risks of smoking, compared to 0.33 deaths for each news story on vCJD.
“One extra unit of alcohol a day increases a woman’s risk of breast cancer by 12%”

But how bad is that?

About 10 in every 100 women have breast cancer in a lifetime.

If all 100 drink an extra unit of alcohol every day...
...that rises to about 11.

“About 10 in every 100 women have breast cancer in a lifetime.

“One extra unit of alcohol a day increases a woman’s risk of breast cancer by 12%”

is the same as saying

about one extra case in every 100 women
The Breast Cancer Debate

- Breast cancer risk – top of national US health agenda
- Large activist movement
  - Emphasizing and exaggerating danger posed by breast cancer
- Heightened media attention
- Increased government funding
The Breast Cancer Debate

• Deaths from cancer in US in 1993:
  – 46,000 US women died of breast cancer
  – 38,000 US men died of prostate cancer

• Major media stories that year:
  – Breast cancer mentioned 5,800 times
  – Prostate cancer mentioned 1,800 times

• National Cancer Institute funding:
  – $213m for breast cancer research
  – $51m for prostate cancer research

~20% more
~220% more
~320% more
Conveying Risk

• Absolute risk
• Baseline risk
• Relative risk
• Risk difference
• Increased risk/Reduced risk
• Odds Ratio
• Number needed to treat
Conveying Risk

Absolute risk

– The incidence of an event in a particular group
  – For example, women in New Zealand have a 0.1 risk of developing breast cancer over their lifetime
  – (This risk will vary according to a woman’s age, family history, lifestyle,...)
Conveying Risk

Baseline risk

– This is the risk *without* a specified treatment or behaviour.

• If we want to find out *if* taking an *aspirin* helps prevent *heart attacks*, the baseline risk is...

  *the risk of having a heart attack *without* taking aspirin.*

• If we want to investigate the risk of *smoking* and getting *lung cancer*, the baseline risk is...

  *the risk of getting lung cancer *without* smoking.*
Conveying Risk

Relative risk
– The ratio of the risks for two groups

\[
\text{Relative risk of cancer due to smoking} = \frac{\text{Risk (prob) of Cancer for a smoker}}{\text{Risk (prob) Cancer for a nonsmoker}}
\]
Conveying Risk

Relative risk

– The ratio of the risks for two groups
  • Group of interest on top line
  • Comparison (baseline) group on bottom line
– often expressed as a multiple
  • A relative risk of 3 means that the risk of developing a disease for the group of interest is three times the risk for the baseline group
  • A relative risk of 1 would mean that the risk is the same for both groups
Conveying Risk

Relative risk

– It is useful to compare the risk of disease (e.g. heart attacks) for those with a certain characteristic (e.g. taking aspirin) to the baseline risk of that disease (e.g. heart attacks in those not taking aspirin).

– It doesn’t usually matter which way round we calculate the ratio, but relative risks of greater than 1 are easier to interpret than those between 0 and 1.
Conveying Risk

Example:

Relative Risk of Developing Breast Cancer
(Utts, Seeing Through Statistics, p224)

<table>
<thead>
<tr>
<th>First Child at age 25 or older?</th>
<th>Breast Cancer</th>
<th>No Breast Cancer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>31</td>
<td>1597</td>
<td>1628</td>
</tr>
<tr>
<td>No</td>
<td>65</td>
<td>4475</td>
<td>4540</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>6072</td>
<td>6168</td>
</tr>
</tbody>
</table>

Breast cancer risk for a woman

having first child ≥ 25 = \( \frac{31}{1628} = 0.0190 \)

having first child < 25 = \( \frac{65}{4540} = 0.0143 \)

Relative risk = \( \frac{0.0190}{0.0143} = 1.33 \)
Conveying Risk

In Words:

Relative risk = \( \frac{0.0190}{0.0143} = 1.33 \)

The risk of developing breast cancer for women who had their first child at age 25 or older is 1.33 times the risk of developing breast cancer for women who had their first child under the age of 25.
Conveying Risk

OR the other way up

i.e. comparing “under 25” to “over 25”

Relative risk = $\frac{0.0143}{0.0190} = 0.75$

The risk of developing breast cancer for women who had their first child under the age of 25 is 0.75 times the risk of developing breast cancer for women who had their first child at the age of 25 or older.
Conveying Risk

Risk difference

– The difference in risk, of lung cancer say, associated with smoking, is simply

Risk for those exposed (smokers) – Baseline risk (non-smokers)

Risk for the exposed – Risk for the unexposed

(simple difference between the 2 probabilities)

Seldom used and quoted

– because for small probabilities ratios tend to be much more stable measures of effect (from population to population) than differences
Conveying Risk

Risk difference (Attributable Risk)

– The difference in risk of breast cancer associated with a woman having her first child at the age of 25 or older (compared with under the age of 25) is:

Risk for those ‘exposed’ (first child > 25)

– Baseline Risk ‘unexposed’ (first child ≤ 25)

= 0.0190 − 0.0143 = 0.0047
Conveying Risk

Increased/Decreased risk

– Sometimes the change in risk is expressed as a percentage increase (or decrease) instead of a multiple.

\[
\text{Increased Risk} = \frac{\text{Change in Risk}}{\text{Baseline Risk}} \times 100\%
\]

Or

\[
\text{Increased Risk} = (\text{Relative Risk} - 1) \times 100\%
\]
Conveying Risk

Increased risk

The risk of developing breast cancer for women who had their first child at age 25 or older is 1.33 times that for those who had their first child under the age of 25.

Thus

$$\text{Increased Risk} = \frac{0.0190 - 0.0143}{0.0143} \times 100\% = 33\%$$

or $$(1.33 - 1.0) \times 100\% = 33\%$$

In words: There is an increased risk of 33% of developing breast cancer for women who had their first child at age 25 or older compared to those who had their first child under the age of 25.
Conveying Risk

Decreased risk

For women who have their first child under the age of 25, the risk of developing breast cancer is 0.75 times that for women who had their first child at age 25 or older. Thus

Decreased Risk = \frac{0.0143 - 0.0190}{0.0190} \times 100\% = -25\%

or (0.75 - 1.0) \times 100\% = -25\%

In words: There is a reduced risk of 25% of developing breast cancer for women who had their first child under the age of 25 compared to those who had their first child at age 25 or older.
Conveying Risk

Odds Ratio

– Popular in epidemiology where comparative risk is presented as an odds ratio instead of a relative risk.
– Also popular in gambling!
Conveying Risk

• Odds Ratio
  – Very common in technical reporting of risk
  – **Idea** is more complicated than that of “relative risk”

  – **BUT** when we are *comparing small probabilities*
    • the **Relative risk and odds ratio**
      are numerically almost identical
Conveying Risk

• Lots of important forms of statistical analysis naturally produce odds ratios
  (e.g. logistic regression)

Relative risk of cancer due to smoking

\[
\text{Relative risk} = \frac{\text{Prob of Cancer for a smoker}}{\text{Prob of Cancer for a nonsmoker}}
\]

Odds ratio

\[
\text{Odds ratio} = \frac{\text{Odds of Cancer for a smoker}}{\text{Odds of Cancer for a nonsmoker}}
\]
Odds Ratio

\[
\text{Odds of Cancer} = \frac{\text{Prob of getting Cancer}}{\text{Prob of not getting cancer}}
\]

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Odds of cancer risk for a woman having first child ≥ 25

\[
= \frac{31}{1628} \div \frac{1597}{1628} = \frac{31}{1597}
\]
Odds Ratio

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Breast cancer **odds** for a woman

- Having first child < 25: \( \frac{31}{1597} = 0.0194 \)
- Odds Ratio: \( \frac{0.0194}{0.0145} = 1.34 \) (cf. RR=1.33)
Conveying Risk

• Odds
  – If the risk of disease is small, the odds ratio and the relative risk will be approximately equal.
  – Relative risk is more intuitive, but the odds ratio is easy to deal with statistically.
Conveying Risk

• What is the benefit of a cholesterol-lowering drug on the risk of coronary heart disease?

• “People with high cholesterol can rapidly reduce...their risk of death by 22% by taking a widely prescribed drug.”

What does this mean?
Conveying Risk

“22% risk reduction”

- Does it mean that out of 100 with high cholesterol, 22 can be prevented from becoming heart attack victims?

- No!

- Here are some results from the trial:

<table>
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<th>Deaths (per 1,000 with high cholesterol)</th>
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<td>Active drug</td>
<td>32</td>
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<tr>
<td>Placebo</td>
<td>41</td>
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\[
RR = \frac{32}{41} = 0.78 \\
(22\% \text{ reduction})
\]
Conveying Risk

Other ways of making sense of the numbers

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Absolute Risk (Reduction) (ARR):

- “What is the effect of treatment?”
  - If we treat 1000 people .... (on average and taking everything at face value)
  - instead 41 dying (as would if untreated) we’d have 32 die
  - a saving of 41-32 = 9 lives per 1000 people treated
    - (0.9%)
Actually, shading a random 41 people
Then removing a random 9 of them...
Conveying Risk

• Number Needed to Treat (NNT)
  – The number of patients that need to be treated to prevent one bad outcome.
Conveying Risk

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Number needed to treat (NNT):

- “How many people do we need to treat to prevent one death?” (on average and taking everything at face value)

9 deaths per 1,000 treated are prevented by the drug

so on average etc, we need to treat

$\frac{1000}{9} = 111$ people to prevent one death