Know your chances:
A curriculum to help students become better consumers of statistics

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People need to understand statistics to make good decisions

Facts

Values

Good decisions
In the news

SPECIAL HEALTH ISSUE

U.S. News

THE END OF HEART DISEASE

How new treatments are helping beat a killer

October 2003

In public service announcements

My brother accidentally killed himself.
He died of skin cancer.
In medical center ads

The early warning signs of colon cancer:

You feel great.

You have a healthy appetite.

You’re only 50.

In the mail

Prostate Cancer Awareness

Annual Checkups and Tests
Healthy skepticism

Exaggerated messages

How to be a critical consumer?
What are the actual numbers?
Decide if you can believe them

A curriculum

Features
Example based
Quizzes
Learn more
Handy references

University of California Press
Talk outline

I. Know your chances: A curriculum
   Part 1 What is the risk?
   Part 2 Can risk be reduced?
   Part 3 Does risk reduction have downsides?
   Part 4 Developing a healthy skepticism

II. Testing "Know Your Chances"

Part 1 What is the risk?

The early warning signs of colon cancer:
You feel great.
You have a healthy appetite.
You’re only 50.
"Colon cancer will strike 50,000 Americans."

Out of how many?

Who could it happen to?

\[
\frac{\text{Numerator}}{\text{Denominator}} = \frac{50,000}{300,000,000} = 0.0002 = 0.02\%
\]

The number of people who experience the outcome
"The risk of colon cancer is 0.02%"
You need other information to give risk meaning

Risk of what?
getting or dying of colon cancer

Be clear about the outcome

Increasing importance to health

<table>
<thead>
<tr>
<th>Test results (X-ray, lab)</th>
<th>Diagnosis of disease</th>
<th>Complications of disease</th>
<th>Death from disease</th>
<th>Death period</th>
</tr>
</thead>
</table>
The risk of colon cancer is 0.02%

*Other information to give risk meaning*

**Risk of what?** *dying from colon cancer*

**When?** *next year*

next year? next 10 years? over a “lifetime”?  

**Whose risk?** *Americans of every age*

---

**Age matters**

*Imagine 1000 men your age. In the next 10 years, how many will die of....*

<table>
<thead>
<tr>
<th>Age</th>
<th>Colon cancer</th>
<th>998 in 1000 will NOT die from colon cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 yrs</td>
<td>1</td>
<td>“FRAMING”</td>
</tr>
<tr>
<td>50 yrs</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>60 yrs</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Imagine 1000 men your age. In the next 10 years, how many will die of....

<table>
<thead>
<tr>
<th>Age</th>
<th>Colon cancer</th>
<th>Prostate cancer</th>
<th>Heart disease</th>
<th>All causes combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 yrs</td>
<td>2</td>
<td>1</td>
<td>11</td>
<td>49</td>
</tr>
</tbody>
</table>

Risk Chart for men who have never smoked

Find the line closest to your age and smoking status. The numbers tell you how many of 1,000 men will die in the next 10 years from...

<table>
<thead>
<tr>
<th>Age</th>
<th>Smoking</th>
<th>Vascular Disease</th>
<th>Cancer</th>
<th>Infection</th>
<th>Lung Disease</th>
<th>AIDS</th>
<th>COPD</th>
<th>Accidents</th>
<th>All Causes Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>49</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td>19</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>32</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td>52</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>176</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td>87</td>
<td>18</td>
<td>6</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>137</td>
<td>32</td>
<td>8</td>
<td>13</td>
<td>19</td>
<td>12</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>

- A never smoker has smoked less than 100 cigarettes in his life and a current smoker has smoked at least 100 cigarettes or more in his life and smokes (any amount) now.
- The numbers in each row do not add up the chance of dying from everything combined, because there are many other causes of death besides the ones listed here.
Take home lessons

What is the risk?
Understand the outcome and consider how bad it is.
Learn the chance of the outcome, to whom it applies and when.
Get context by comparing this risk to others.

Part 2 Can risk be reduced?

"A clinical study among people with high cholesterol and heart disease found 42% fewer deaths from heart attack among those taking Zocor."

Fewer than what?
"Relative risk reduction" is like a sale

Would you go if selected items were....

Things like TV's, washing machines?

save $100's

Things like a pack of gum?

save pennies

"42% of what" matters!

know the REGULAR price!

Part 2 Can risk be reduced?

How will you take care of your high cholesterol and heart disease?

"A clinical study among people with high cholesterol and heart disease found 42% fewer deaths from heart attack among those taking Zocor."

Chance of heart attack death in next 5 years

Zocor No Zocor

5.0% 8.5%
Take home lessons

What is the risk?
Understand the outcome and consider how bad it is.
Learn the chance of the outcome, to whom it applies and when.
Get context by comparing this risk to others.

Can risk be reduced?
To understand the size of the risk reduction, get the chance of the outcome with and without the intervention.

Part 3 Does risk reduction have downsides?

Women taking Nolvadex were 2 to 3 times more likely to develop uterine cancer or blood clots in the lungs and legs...

...Stroke, cataracts, and cataract surgery were more common with Nolvadex.
Take home lessons

What is the risk?
Understand the outcome and consider how bad it is.
Learn the chance of the outcome, to whom it applies and when.
Get context by comparing this risk to others.

Can risk be reduced?
To understand the size of the risk reduction, get the chance of the outcome with and without the intervention.

What are the downsides?
Understand the downsides and weigh them against the benefit.
Part 4 Developing a healthy skepticism

Can you believe the numbers?

Where are they from (observational studies vs. randomized trials)?
Are the findings preliminary (scientific meeting reports)?
Who is behind the numbers (conflicts of interest)?

Special Topic: The benefit of early detection

Misleading use of survival statistics

Los Angeles Times

Study calls for routine CT scans for smokers:
Imaging can detect lung cancer early, boosting survival rates.

"Imaging yielded an estimated 10-year survival rate of more than 90%, researchers said. Currently, about 5% of the 174,000 lung cancer patients diagnosed each year survive 10 years…"
Understand the statistics

It is tempting to assume that:

\[
\text{survival} = (1 - \text{mortality})
\]

Survival = \(\frac{\text{Number alive X years after diagnosis}}{\text{Number diagnosed}}\)

10-year survival = 10% of people diagnosed with lung cancer are alive 10 years later
Understand the statistics

**Survival** = Number alive X years after diagnosis / Number diagnosed

**Mortality** = Number dead after X years / Number in study population

10-year mortality = 50 dead / 5,000 = 1% of people in the study population died over 10 years – or the 10-year risk of death was 1%

Increased 10-year survival, no real improvement

**Without screening**
- Cancer starts
- Lead time bias: Mathematical certainty whenever you diagnose disease earlier
- Dead at age 70
- 10-year survival = 0%

**With screening**
- Cancer starts
- Cancer diagnosed because of screening at age 57
- Dead at age 70
- 10-year survival = 100%
Increased 10-year survival, no real improvement

**Without screening**

- 1000 people with progressive lung cancer
- 10 years later
- 10 yr survival = \( \frac{100}{1000} = 10\% \)
- 900 dead
- 100 alive

**With screening**

- 4,000 with non-progressive cancer
- 1000 people with progressive lung cancer
- 10 years later
- 10 yr survival = \( \frac{4100}{5000} = 82\% \)
- 900 dead
- 100 alive

**Overdiagnosis**

- 4,000 alive
- 100 alive

**Take home lessons**

*What is the risk?*
- Understand the outcome and consider how bad it is
- Find out the chance of experiencing the outcome over what time
- Get context by comparing this risk to others

*Can risk be reduced?*
- To understand the size of the risk reduction, get the chance of the outcome with and without the intervention.

*What are the downsides?*
- Understand the downsides and weigh them against the benefit.

*Develop a healthy skepticism*
- Don't take improved survival with screening as evidence that screening works (i.e. lower mortality)
Talk outline

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II. Testing "Know Your Chances"
Alumni of Dartmouth public lecture series
Ages 35-79

Veterans and their families at the White River Junction VA
Ages 35-79

Randomization

Primer

Control

High SES trial

n=153
(95% completion)

Low SES trial

n=169
(98% completion)

Randomization

Primer

Control

n=98
(85% completion)

n=102
(96% completion)

Testing the curriculum

General information about risk
(and reducing risk with prevention/screening)

- No training on how to interpret data

- Similar to primer in length
(70 page booklet) and reading level

The control booklet
Primary outcome measure: Medical data interpretation scores

18-item test developed at the same time as primer and validated in separate study. Scored on a 0-100 scale.

Asks people to interpret real world information (e.g. drug ads, news stories).

Tests the same skills as the primer - but requires respondent to apply skills with variety of messages that DO NOT appear in the primer.


Did the curriculum work? Percent with a passing score (> 75)

[Bar chart showing passing rates for High SES and Low SES in control and primer groups.]

Ann Intern Med 2007
Summary

The magnitude of the effect is in line with successful educational interventions like use of practice exams prior to standardized testing.

Curriculum improved data interpretation skills in both the high and low SES populations.