

# **Risk Analysis Involving Life- Threatening Risks**

by

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# **What is the leading cause of death in the US?**

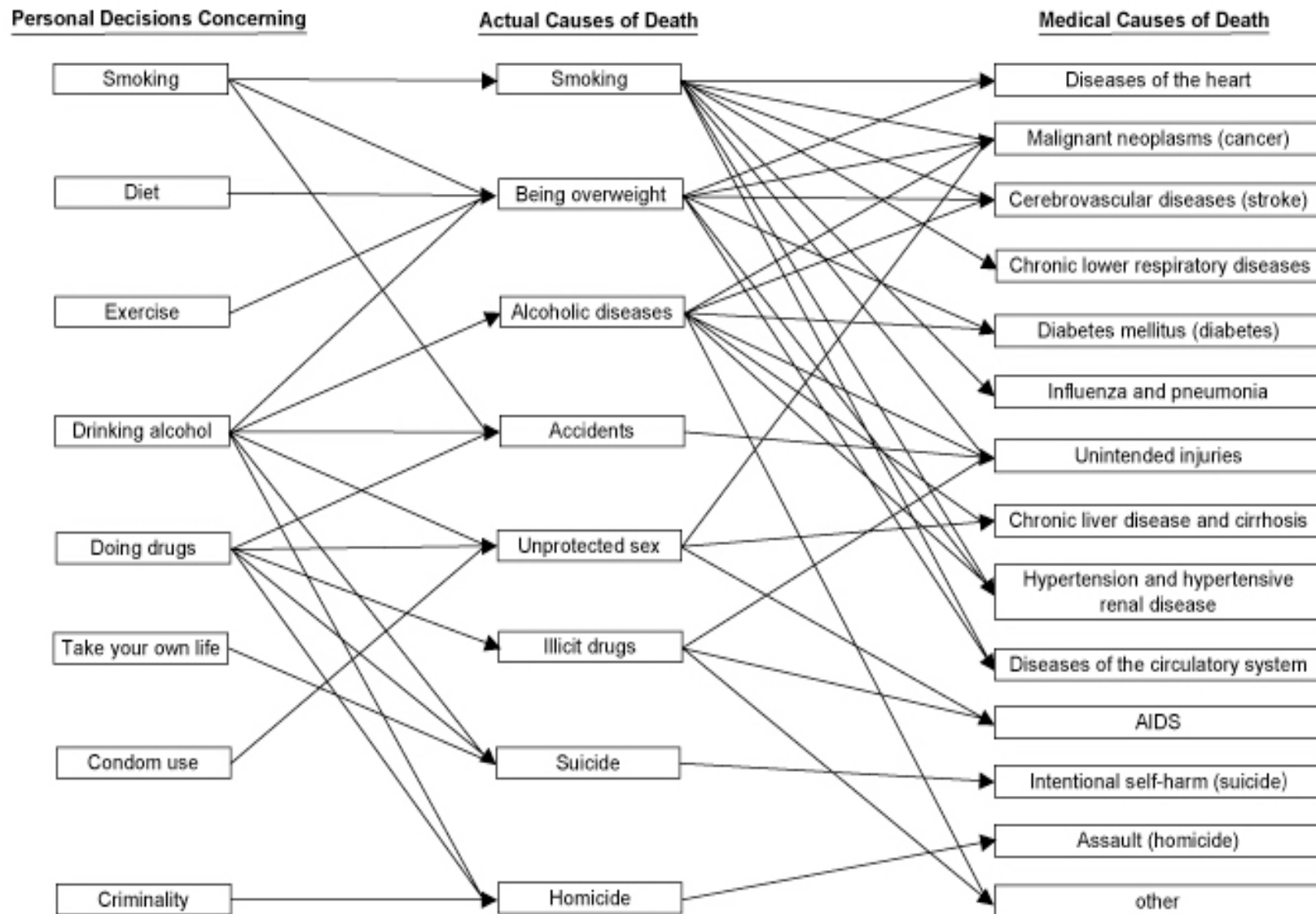
**Personal Decisions are the  
Leading Cause of Death**

In Operations Research, Nov-Dec. 2008

# Medical Causes of U.S. Deaths in 2000

Cause of Death	Number	Percent
All Causes	2,403,351	100.0
Diseases of the Heart	710,760	29.6
Malignant neoplasms (cancer)	553,091	23.0
Cerebrovascular diseases	167,661	7.0
Chronic lower respiratory diseases	122,009	5.1
Accidents (unintentional injuries)	97,900	4.1
Diabetes mellitus	69,301	2.9
Influenza and pneumonia	65,313	2.7
Alzheimer's disease	49,558	2.1
Nephritis, nephrosis	37,251	1.5
Septicemia	31,224	1.3
Intentional self-harm (suicide)	29,350	1.2
Chronic liver disease and cirrhosis	26,552	1.1
Hypertension and renal disease	18,073	0.8
Assault (homicide)	16,765	0.7
Pneumonitis due to solids and liquids	16,636	0.7
All other causes	391,904	16.3

# Influences of Personal Decisions on Causes of Death



Note: an arrow means 'influences'

# Illustration of Calculations for Deaths Attributable to Personal Decisions

<b>ACTUAL (CAPS) and Medical (lower case) Causes of Death</b>	<b>ICD-10 Code</b>	<b>Fraction Due to Medical Cause</b>	<b>Ages</b>	<b>Medical Deaths in 2000 for Ages 55-64</b>	<b>Medical Deaths in 2000 for Ages 55-64 Due to Actual Cause</b>
<b>SMOKING</b>					
<b>Ischemic heart disease</b>	<b>I20-I25</b>	<b>0.403</b>	<b>≥35</b>	<b>47,737</b>	<b>19,217</b>

# Premature Deaths Attributable to Personal Decisions (US 2000 data)

Personal decisions influencing (example decisions about)	Number of Premature Fatalities Caused
Smoking (starting, not quitting)	453,377
Weight (diet, exercise)	434,395
Alcoholic diseases (overdrinking alcohol)	67,779
Accidents (drunk driving, speeding, not using seatbelts, other activities under influence of alcohol and drugs)	38,246
Suicide (withdrawing, trying to commit suicide)	29,350
Unprotected sex (not using protection)	19,837
Homicide (criminality, joining gangs, carrying weapons)	16,765
Illicit drugs (using of illicit drugs)	9,411
Total	1,069,160
Deaths from all causes	2,403,351

# Deaths Attributable to Personal Decisions

Ages	5-14	15-24	25-34	35-44	45-54	55-64	65-74	All Ages
Deaths Attributable to Personal Decisions	2,301	17,629	22,192	50,898	90,539	141,807	219,696	1,069,160
Total Deaths	7,413	31,307	40,451	89,798	160,341	240,846	441,209	2,403,351
Percent Attributable to Personal Decisions	30.0	56.3	54.9	56.7	56.5	58.9	49.8	44.5

# Additional Analysis

- Over 1 million of the deaths not avoided by personal decisions are self-caused
- In 1900, maybe 5% of fatalities were avoidable by personal decisions; 20% in 1950



# Common Sense to Avoid Premature Death

*Make personal decisions that*• Avoid smoking (don't start, quit if you do smoke)• Avoid being overweight (exercise regularly, eat and drink responsibly)• Avoid becoming alcoholic (drink alcohol in moderation)• Reduce vehicle accidents (don't drink and drive, don't speed, use a seat belt)• Do not use illicit drugs (don't use narcotics or hallucinogens)• Do not commit suicide• Do not commit homicide• Avoid unprotected sex (use a condom, abstain)

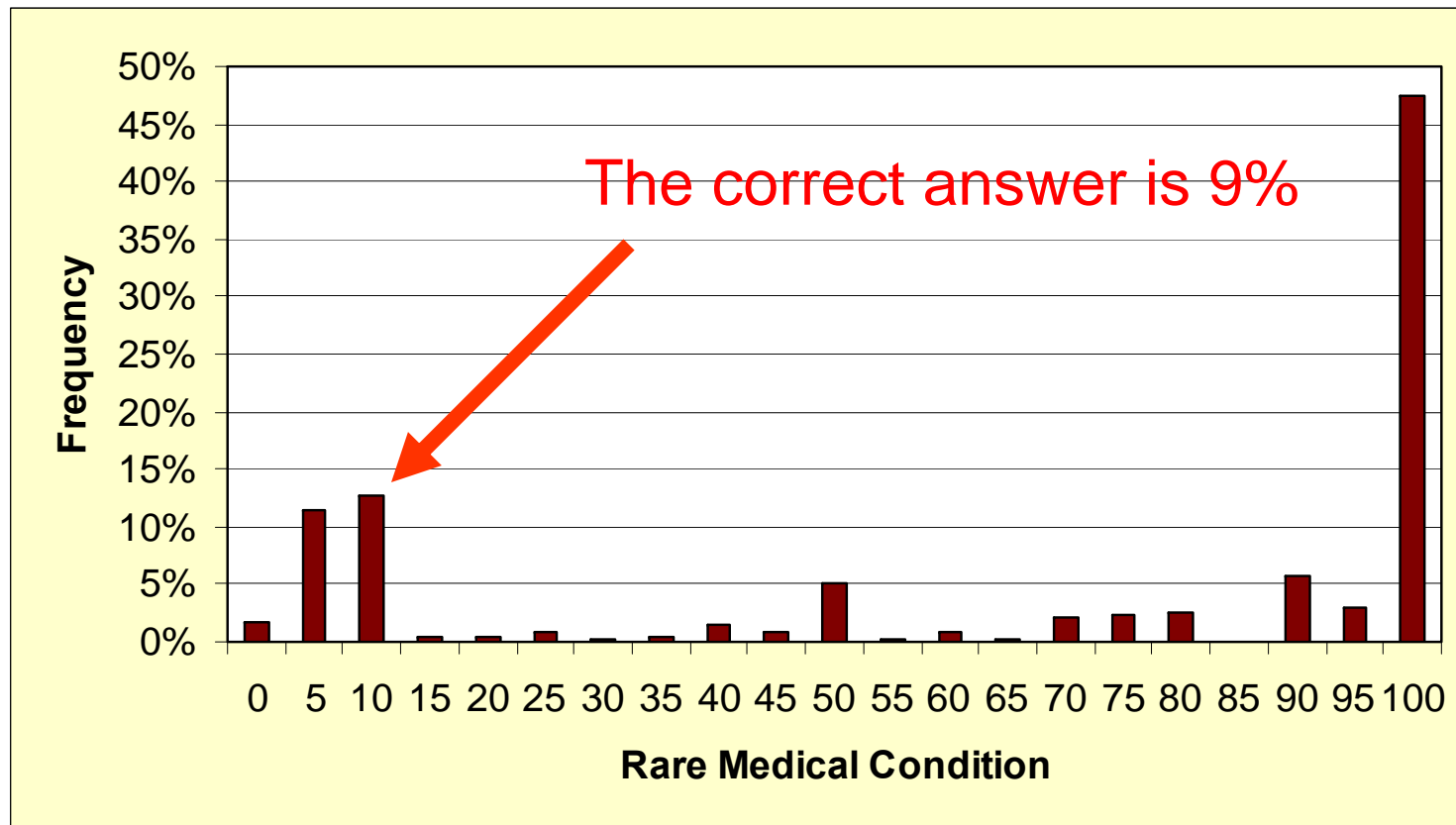
# **Risk Analysis: Rare Medical Condition**

Suppose:

1. A rare medical condition is present in 1 of 1,000 adults.
2. A recently developed test to check for the condition is 99% accurate.
3. You take the test and the result is positive (i.e. indicates condition present.)

What is your judgment of the probability that you have the condition?

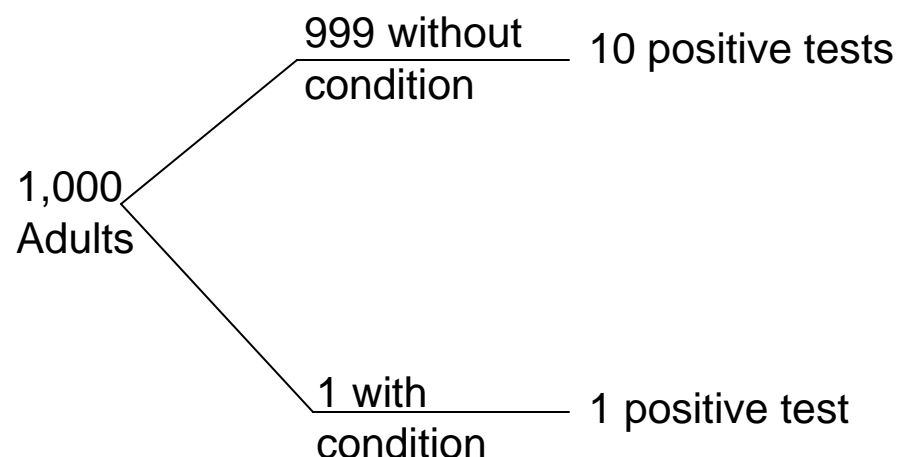
# Summary of Poll Results on a Rare Medical Condition



# Analysis of the Rare Medical Condition

Consider 1,000 adults:

How many are expected to have the condition? **1**



**How Many Positive Tests?**

For without the condition? **9.99 (~ 10)**

For with the condition? **0.99 (~ 1)**

**1 of 11 (9%) of those with a positive test have the condition**

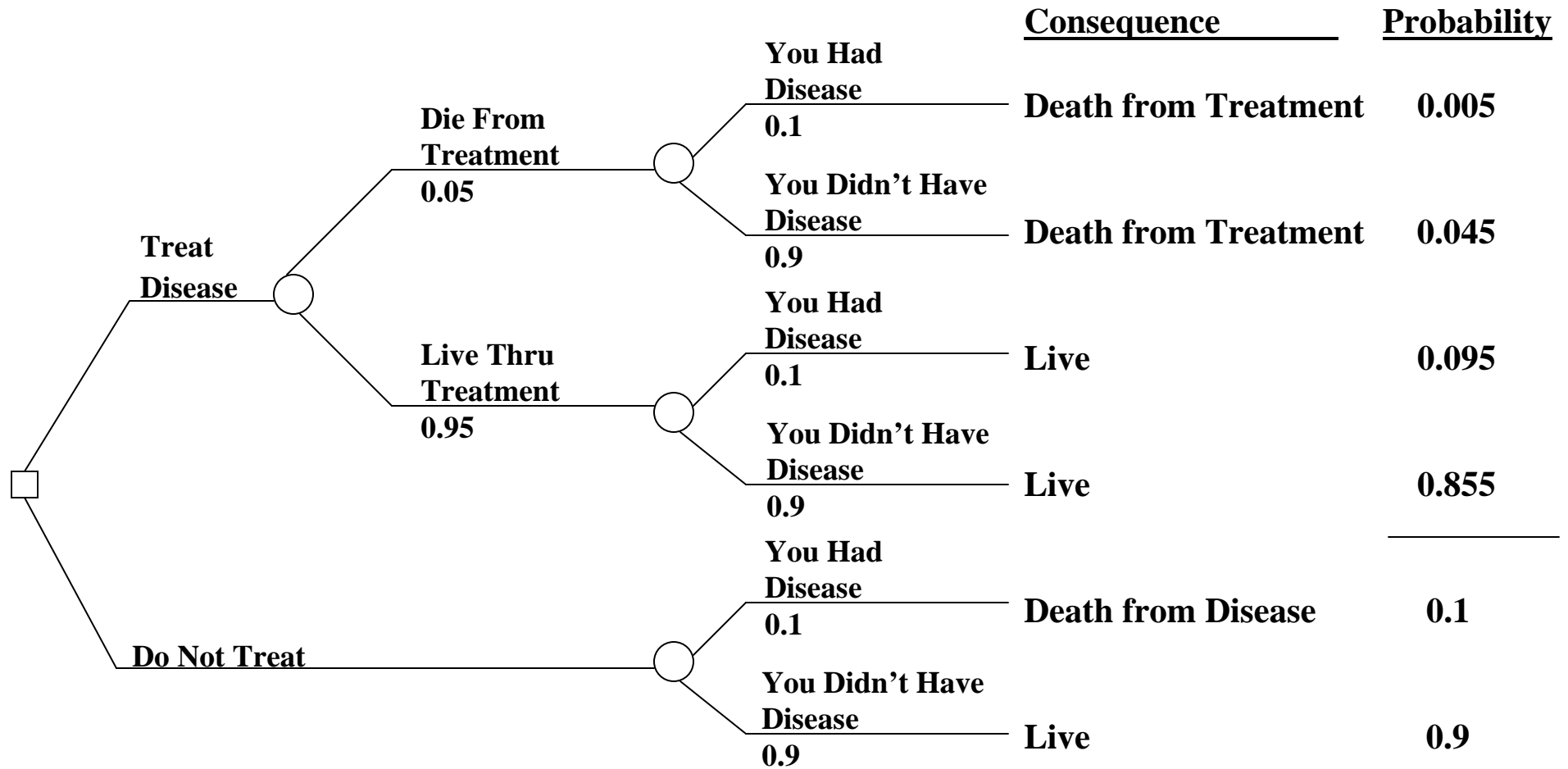
# Risk Management: The Fatal Disease Problem

- There is a 10 percent chance (probability 0.1) that you have a fatal disease
- A treatment, if successful, cures the disease for sure
- The treatment has a 95 percent chance (probability 0.95) of success and a 5 percent chance (probability 0.05) of causing death
- You will learn if you had the disease after the treatment

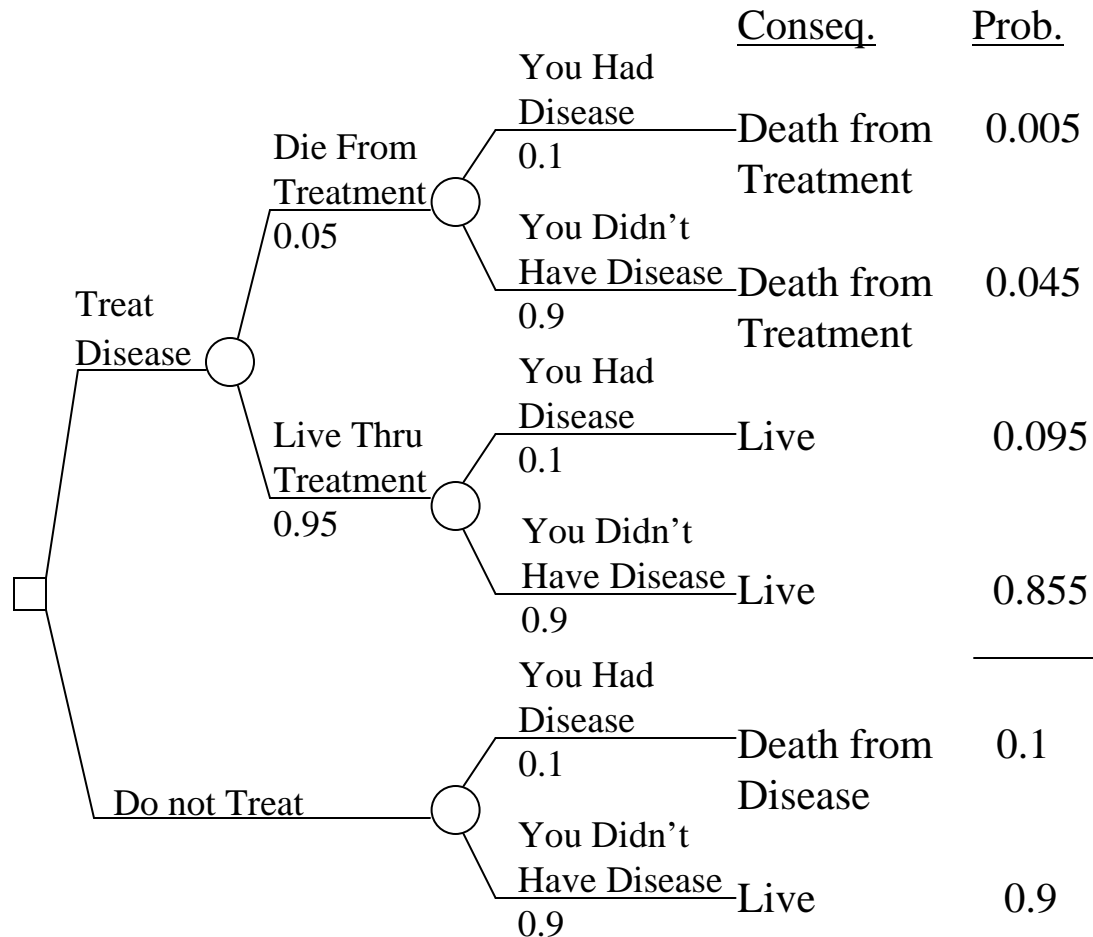
Facing this, what would you choose?

**Disease Probability = 0.1**  
**Successful Treatment Cures Disease**  
**Successful Treatment Probability = 0.95**  
**Disease Revealed after Treatment**

# Analysis of the Problem



**Disease Probability = 0.1**  
**Successful Treatment Cures Disease**  
**Successful Treatment Probability = 0.95**  
**Disease Revealed after Treatment**



# Evaluation of Choices

## Patient's Perspective

Pr (death given treatment) = 0.05

Pr (death given no treatment) = 0.1

## Physician Perspective

Pr (death due to treatment given treatment) = 0.05

Pr (death due to treatment given no treatment) = 0.0

## Legal Perspective

Pr (you did not have the disease given that you accepted treatment and died from the treatment) = 0.9

A Fact about Life-Threatening Risks

# **Identifiable Fatalities are Not the Same as Statistical Fatalities**

- Public risks versus personal risks
- Prevention versus cure



A Fact about Life-Threatening Risks

# **The Economic Costs of Risk Reduction Induce Risks**

- Richer is safer
- Some expensive regulations take more lives than they save

# Relationship between Personal Mortality Risk and Income

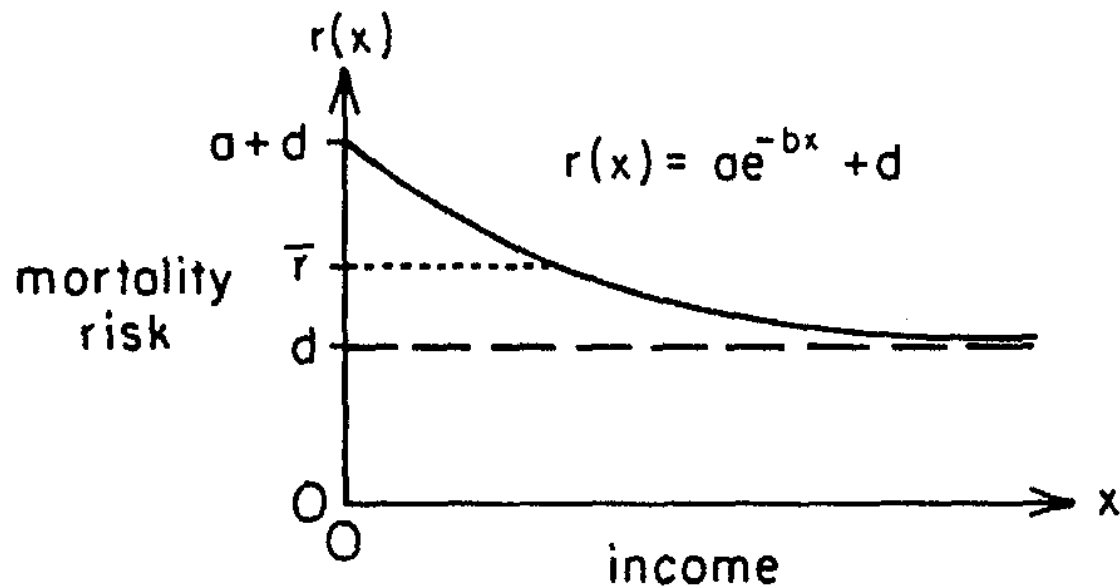


Fig. 1. Component model for the annual mortality risk.

# Distribution of Family Income

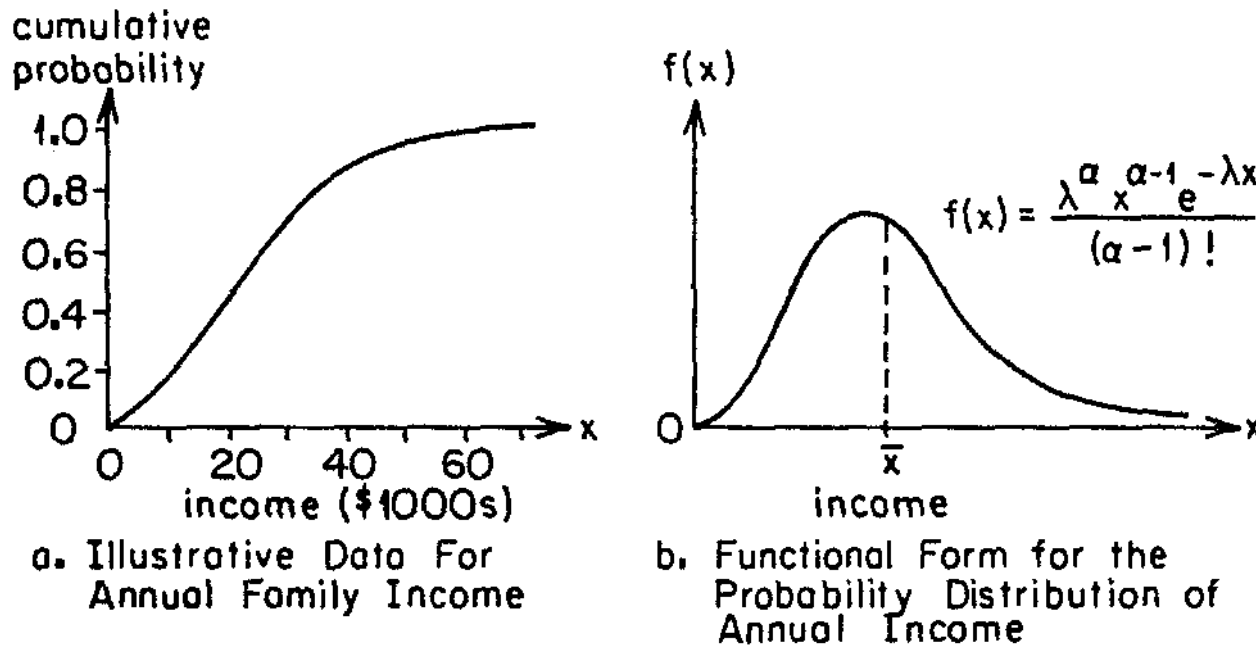


Fig. 2. Component model for the probability distribution of annual income.

# Data from Large National Study over Time

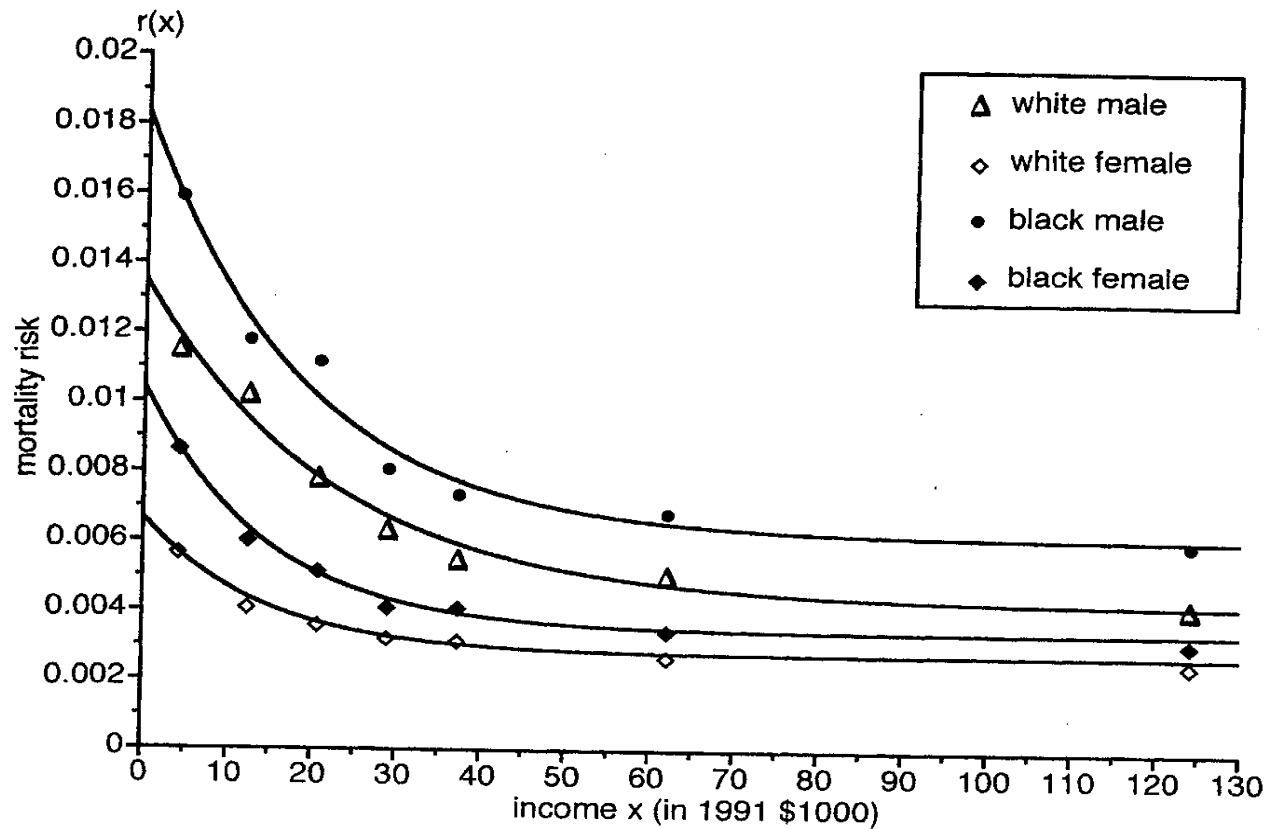


Figure 3. Model for the annual mortality risk fit to data.

# Induced Fatalities Due to \$1 Billion of Reduced Income

Table 9. Induced fatalities for different income groups due to economic costs (expected fatalities due to \$1 billion in 1991 dollars)

Income range	Relative cost allocation						
	Percentage of households	Equal		Proportional to Income		Proportional to income with a luxury tax above \$50,000	
		Expected fatalities	Percentage of expected fatalities	Expected fatalities	Percentage of expected fatalities	Expected fatalities	Percentage of expected fatalities
Under \$5,000	4.8	34.62	16.8	2.28	2.6	1.90	2.5
\$5,000–\$9,999	10.1	52.16	25.3	10.31	11.7	8.60	11.5
\$10,000–\$14,999	9.4	35.59	17.3	11.73	13.3	9.77	13.0
\$15,000–\$24,999	17.4	43.44	21.1	22.91	26.0	19.08	25.4
\$25,000–\$34,999	15.2	22.22	10.8	17.59	20.0	14.64	19.5
\$35,000–\$49,999	17.3	13.25	6.4	14.85	16.9	12.37	16.5
\$50,000–\$74,999	15.4	4.37	2.1	7.19	8.2	7.19	9.6
\$75,000 plus	10.4	0.41	0.2	1.11	1.3	1.42	1.9
Total	100.0	206.06	100.00	87.97	100.0	74.97	99.9

# Economic Cost that Induces a Fatality

Table 11. Cost that induces a fatality over time

Relative costs <sup>a</sup>	Year of mortality risk data					
	1960 <sup>b</sup>	1980 <sup>c</sup>	1979–1985 <sup>d</sup>			
	Whites only	Whites only	All races	Whites only	Blacks only	Whites only fit income distribution <sup>e</sup>
Equal	\$ 5.20	\$ 5.64	\$ 4.85	\$ 5.63	\$2.36	\$ 5.85
Proportional to income	\$12.00	\$10.74	\$11.37	\$12.62	\$4.92	\$12.32

<sup>a</sup>All costs in millions of 1991 dollars.

<sup>b</sup>Cross-sectional census tract data from Chicago area (Kitagawa and Hauser, 1973).

<sup>c</sup>Cross-sectional census tract data from Los Angeles area (Frerichs et al., 1984).

<sup>d</sup>Longitudinal individual data from all areas in the United States (Rogot et al., 1992).

<sup>e</sup>The 1991 income data directly used in the other calculations for the 1979–1985 results were first fit to parameters for a gamma probability distribution describing income and this was used in calculating the results. This was the method used with the 1960 and 1980 results in the table.

# Making Sense of Uncertainty

- Uncertainty is the lack of complete knowledge of what is or what might occur
- Because of uncertainty, you won't know for sure the consequences of alternatives until after you choose an alternative
- Do you face any important decisions without uncertainties?

# Quantifying Uncertainty

- Uncertainties concern your state of knowledge (i.e. your information) rather than the state of nature (i.e. truth)
- Qualitative descriptions of uncertainty are often inadequate
- Probabilities are quantitative descriptions of uncertainty
- Your probabilities can change with new information



# What's the Big Picture

- Decision making is complex
- It requires skill and information to do it well
- Each of us has some “natural skill”
- But we can all improve
- Decision analysis is a logically sound common-sense tool to gather and integrate information (and a way to think) that can help manage risks

**Thank You**