AHRQ Workshop for Washington State Policymakers

Evidence-Based Decisionmaking for Health Policy Leaders

Session 6. Cost Analysis Tools

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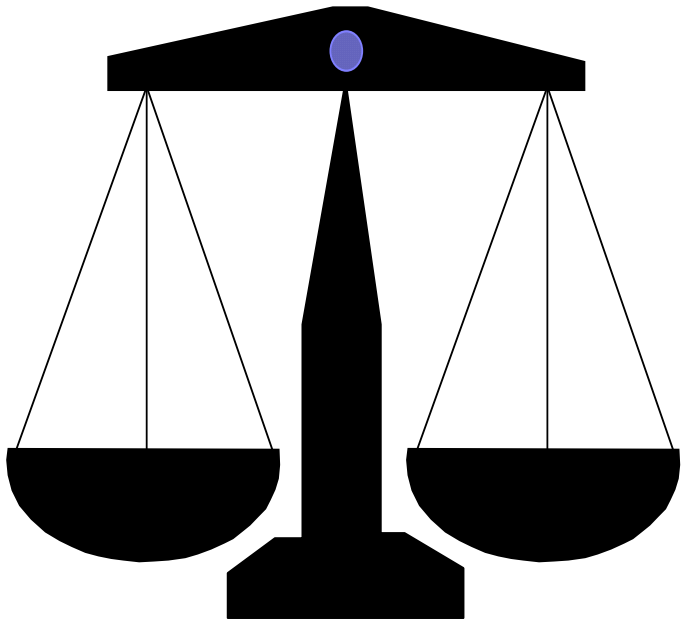
Session Outline

I. Why cost analysis?
II. Types of cost studies
III. Cost study characteristics
    A. Comparator
    B. Perspective
    C. Time horizon … and more
IV. Cost per Quality Adjusted Life Year (QALY) as investment metric
V. Selected issues in cost analysis
    A. Life on the flat of the cost-effectiveness curve
    B. Seeing through a cost-savings claim
    C. Economic efficiency vs budget impact: Fuzeon

Economic Evaluation

For some intervention (A) …

Costs

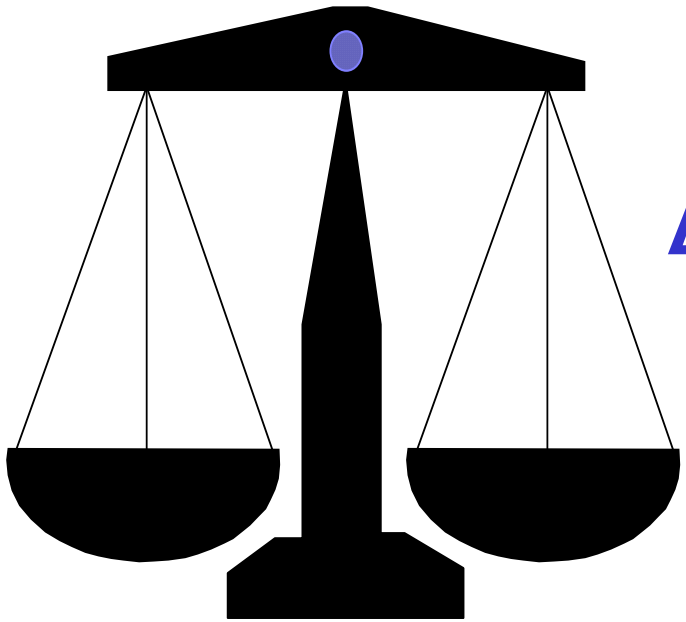


Consequences (Outcomes)

Economic Evaluation

… or for alternative interventions A vs B?

Δ Costs

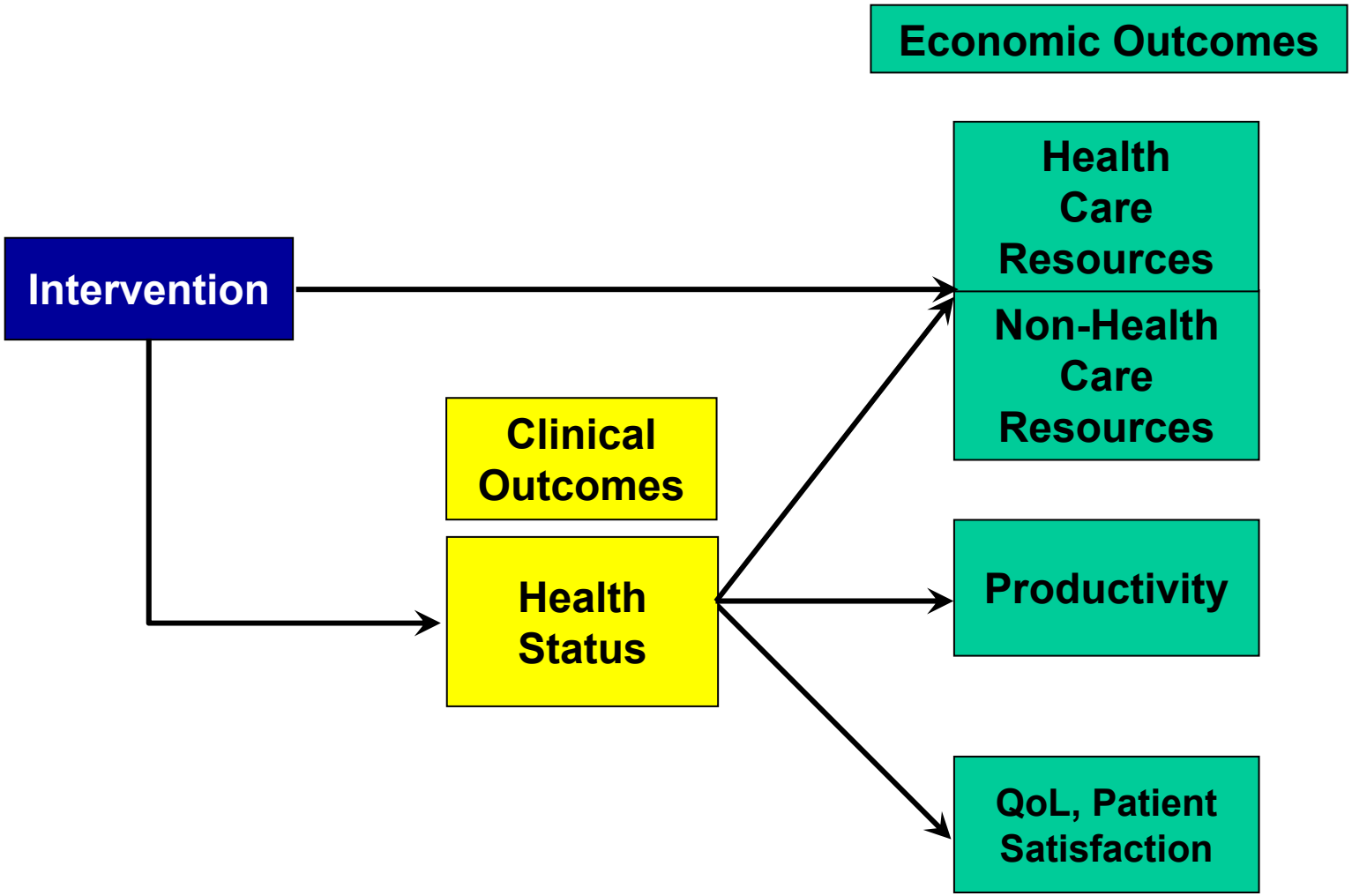


Δ Consequences (Outcomes)

Opportunity Cost

The cost of foregone outcomes that could have been achieved through alternative investments.

Measuring Value in Health Care



Types of Cost Studies

Cost of Illness Analysis (COI): economic impact of illness/condition, including treatment costs

Cost Minimization Analysis (CMA): least costly among alternatives that produce equivalent outcomes

Cost Effectiveness Analysis (CEA): costs in monetary units, outcomes in quantitative non-monetary units, e.g., reduced mortality, morbidity; life-years saved

- **Cost Consequence Analysis (CCA): form of CEA, but without aggregating or weighting across costs or outcomes**
- **Cost Utility Analysis: form of CEA, outcomes in terms of utility or quality of life, e.g., quality-adjusted life-years (QALYs)**

Cost Benefit Analysis (CBA): costs and outcomes in common monetary units

Types of Cost Studies

	Valuation of costs		Valuation of outcomes
Cost of Illness	**$**	**vs.**	**None**
Cost Minimization	**$**	**vs.**	**Assume same**
Cost Effectiveness	**$**	**÷**	**Natural units**
Cost Utility	**$**	**÷**	**Utilities (e.g., QALYs)**
Cost Benefit	**$**	**÷ or -**	**$**

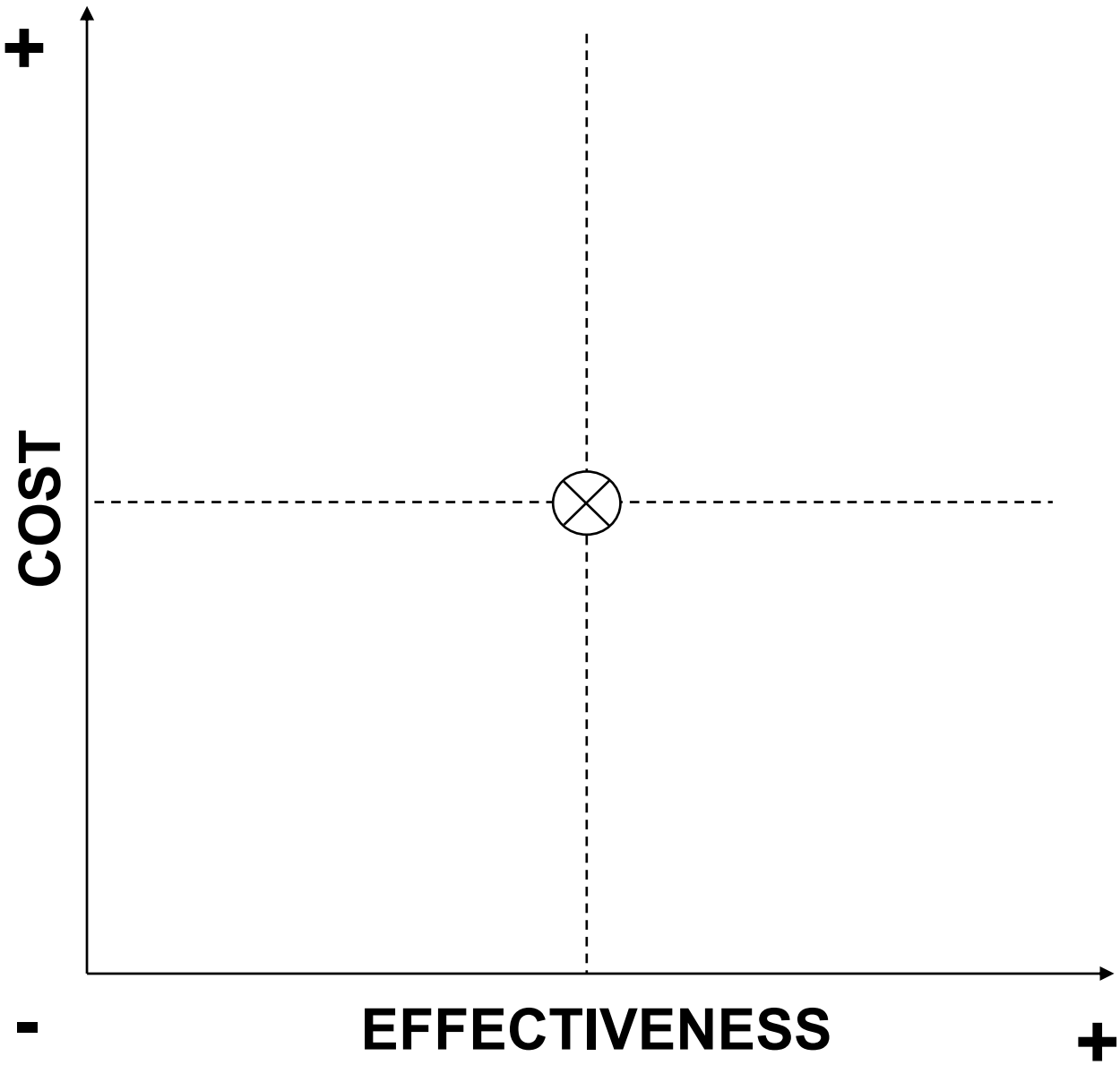
Cost-Effectiveness Ratio

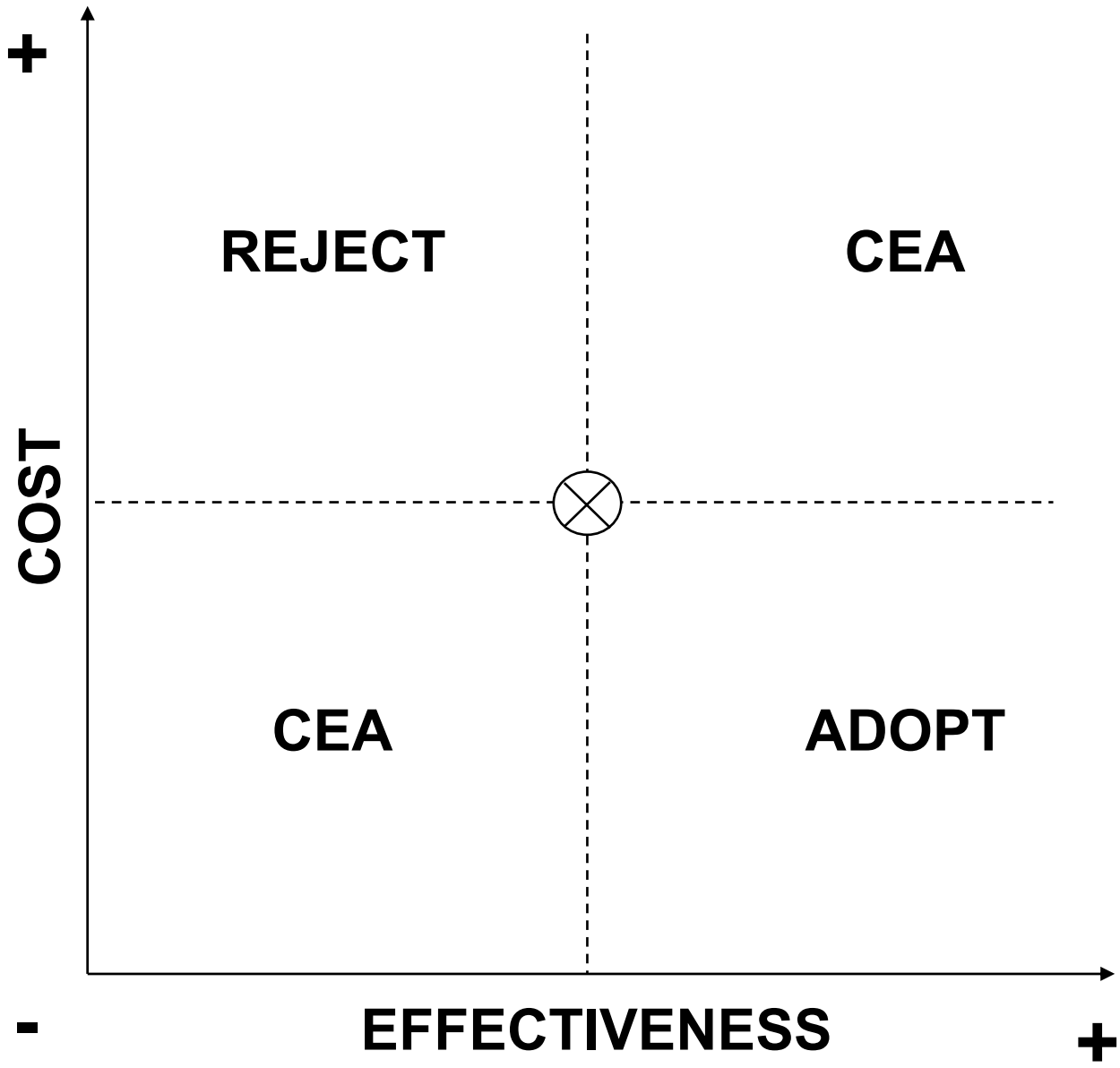
$$\text{CE Ratio} = \frac{\$\text{Cost}_{\text{Int}} - \$\text{Cost}_{\text{Comp}}}{\text{Effect}_{\text{Int}} - \text{Effect}_{\text{Comp}}}$$

For example:

- **"$45,000 per life-year saved"**
- **"$10,000 per lung cancer case averted"**

Int: Intervention
Comp: Comparator


+
COST
-
EFFECTIVENESS
+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REJECT
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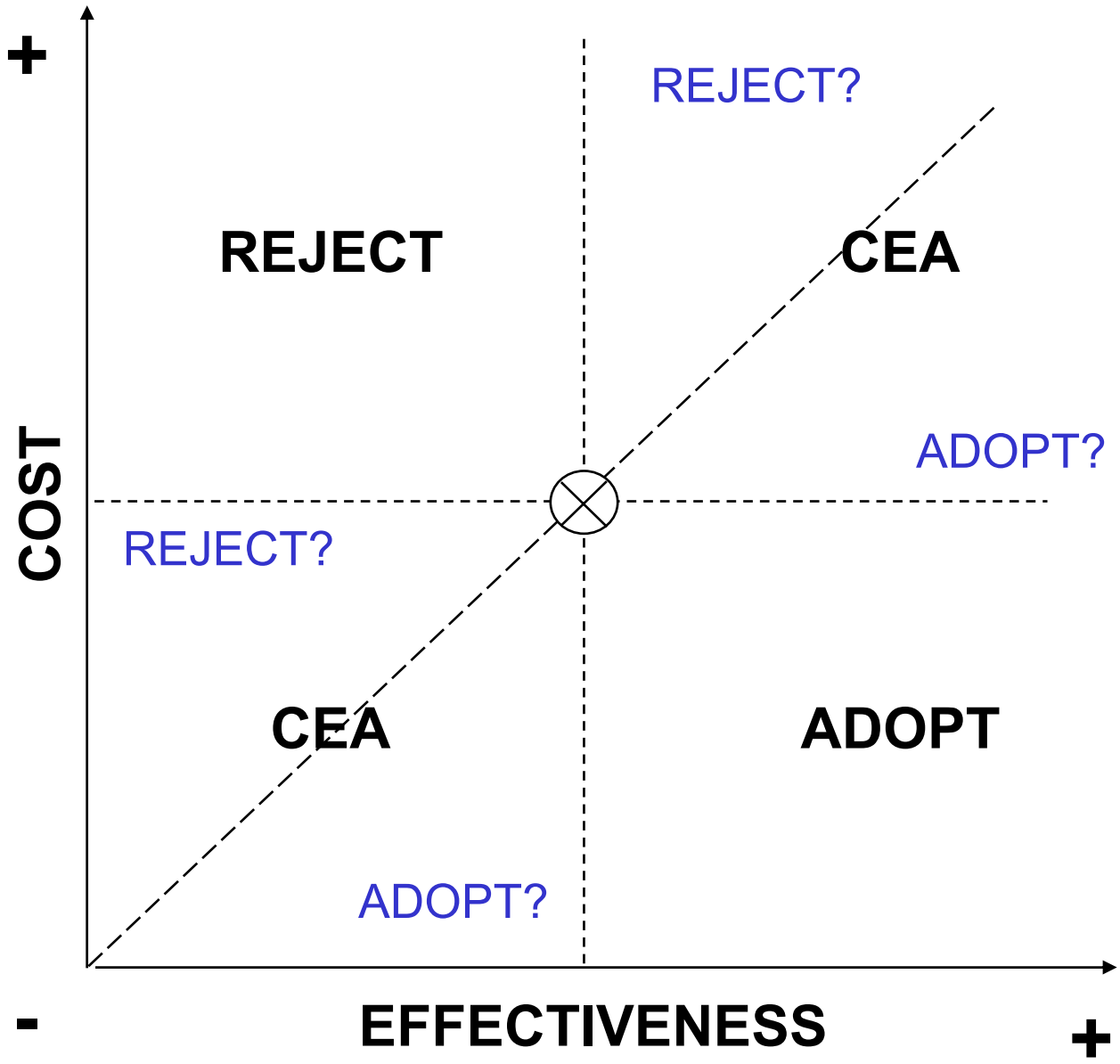
EFFECTIVENESS
+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Cost Study Attributes: Look for These

- ❑ Comparator
- ❑ Perspective
- ❑ Effectiveness vs. efficacy
- ❑ Data capture method
- ❑ Direct costs (health care and non-health care)
- ❑ Indirect costs (e.g., loss of productivity)
- ❑ Actual costs vs. charges/prices
- ❑ Marginal costs vs. average costs
- ❑ Time horizon of analysis
- ❑ Discounting
- ❑ Correction for inflation
- ❑ Modeling use
- ❑ Sensitivity analysis
- ❑ Reporting results
- ❑ Funding source

Comparator

Comparator(s) may include:

- **Current practice**
- **Minimum practice**
- **No intervention**

Which is most relevant to your decision?

Perspective

Costs and outcomes/benefits accrue differently to:

- **Patient**
- **Family**
- **Clinician**
- **Provider institution**
- **Payer (Medicaid, Medicare, MCOs, etc.)**
- **Society at large**

Data Capture Method

Range of recommended preferences:

- **RCTs or meta-analyses of RCTs**
- **RCTs with "naturalistic" design**
- **Clinical studies under realistic conditions**

Consider relevance of RCT source data:

- **protocol-driven costs and outcomes**
- **populations**
- **compliance**
- **indication creep**

Direct Costs

- **Value of all goods, services, other resources consumed in providing intervention or dealing with side effects or other current and future consequences**
- **All types of resource use, including professional, family, volunteer, or patient time**
- **Includes direct health care and direct non-health care costs**

Direct Costs: Two Main Types

- **Direct health care costs: health care facilities, health care personnel, medications, tests, supplies, etc.**
- **Direct *non*-health care costs: patient time, child care, transportation, family member or volunteer time for home care**

Indirect Costs

Sometimes known as "productivity costs"

- **Lost work (absenteeism, early retirement)**
- **Impaired productivity at work**
- **Lost/impaired leisure activity**
- **Premature mortality**

Average Cost vs. Marginal Cost Analysis

Cancer Screening & Detection Costs with Sequential Guaiac Tests

No. tests	No. of cancers detected	Total cost of diagnosis	Average cost per cancer detected
1	65.9469	$77,511	$1,175
2	71.4424	107,690	1,507
3	71.9004	130,199	1,810
4	71.9385	148,116	2,059
5	71.9417	163,141	2,268
6	71.9420	176,331	2,451

Assume: 72 true cases in 10,000 pop. Single guaiac true +: 91.667%; false +: 36.508%. For any positive guaiac, barium enema test performed, assumed to yield no false + and no false -. Costs: first stool guaiac: $4; each subseq. guaiac: $1; barium-enema: $100.

Source: Neuhauser D, Lewicki AM. NEJM 1975;293:226-8.

Average Cost vs. Marginal Cost Analysis

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5	71.9417	0.0032	163,141	15,024	2,268
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3	71.9004	0.4580	130,199	22,509	1,810	49,150
4	71.9385	0.0382	148,116	17,917	2,059	469,534
5	71.9417	0.0032	163,141	15,024	2,268	4,724,695
6	71.9420	0.0003	176,331	13,190	2,451	47,107,214

Assume: 72 true cases in 10,000 pop. Single guaiac true +: 91.667%; false +: 36.508%. For any positive guaiac, barium enema test performed, assumed to yield no false + and no false -. Costs: first stool guaiac: $4; each subseq. guaiac: $1; barium-enema: $100.

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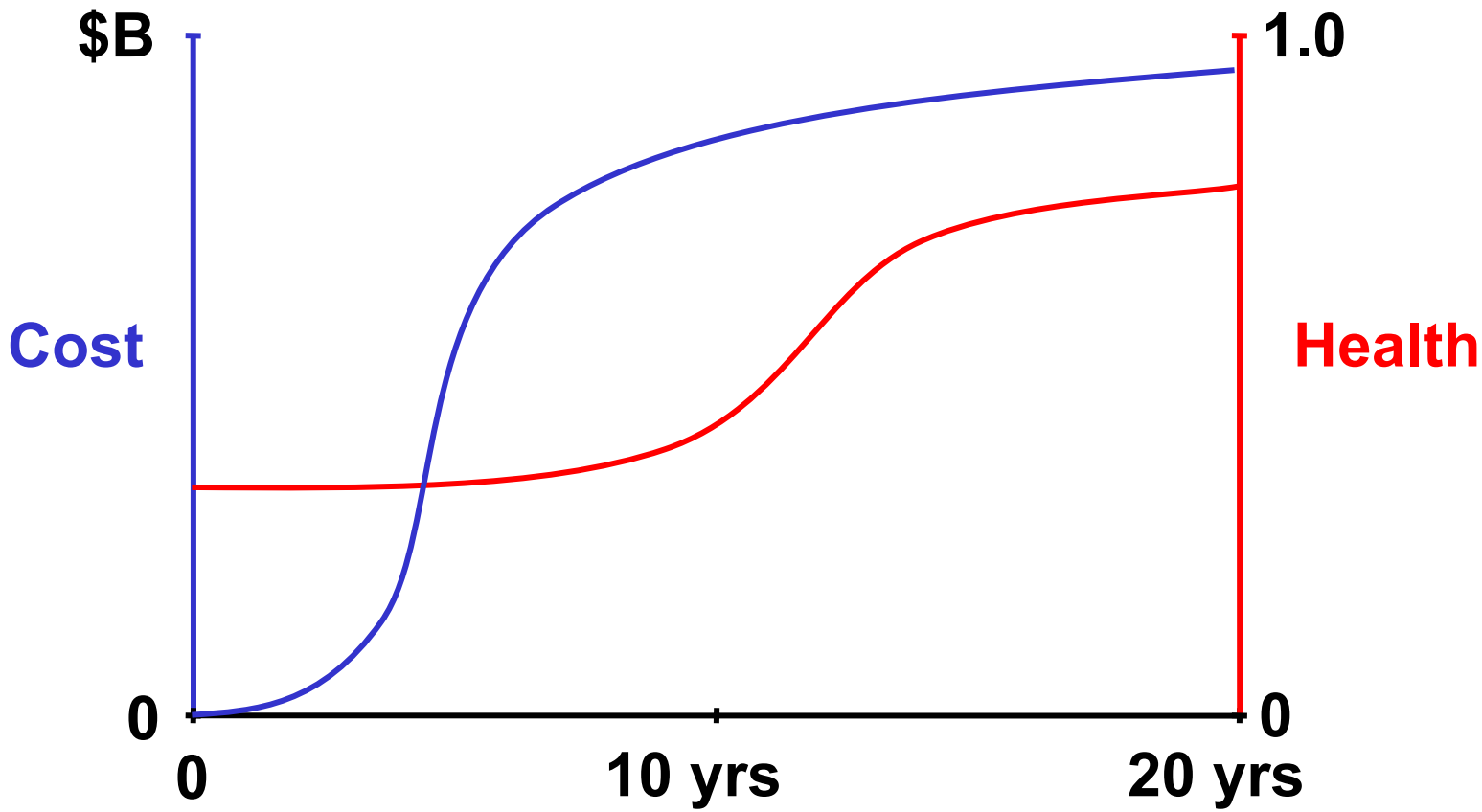
Time Horizon of Analysis

- Long enough to capture streams of health and economic outcomes (intended and unintended)
- Could be a disease episode, patient life, or multiple generations
- Consider: emergency appendectomy vs. cholesterol lowering in high-risk adults vs. smoking cessation in teenagers
- Modeling may be needed to capture outcomes beyond available data
- The higher the discount rate, the less important are far-future outcomes

Time Horizon:
Health Benefits Lagging Costs



Discounting: Reducing Future Costs and Benefits to Their Present Value

- **Not a correction for inflation**
- **Reflects time preference**
  - **desire to have benefits earlier vs. later**
  - **opportunity costs of capital, i.e., returns that could be gained if $ invested elsewhere**
- **Allows comparisons involving costs *and benefits* that flow differently over time**
  - **Less relevant for pay-as-you go benefits**
  - **More relevant for pay-today for benefits later**
- **Rates based on, e.g., gov't bonds, market interest rates for cost of capital whose maturity is about same as duration of program being evaluated**
- **Sensitivity analysis used to test rate assumptions**

Discounting

Present Value

	Discount Rate		
Year	**3%**	**5%**	**10%**
1	0.97	0.95	0.91
5	0.86	0.78	0.62
25	0.48	0.30	0.09
50	0.23	0.09	0.009

For example, the present value of a cost (or benefit) of $1,000 occurring:

- **5 yrs from now, using 3% discount rate, is $860**
- **50 yrs from now, using 5% discount rate, is $90**

Use of Modeling

- **Account for future lifetime costs and outcomes**
- **Account for patient conditions, treatment, costs not present in primary data**
- **Bridge efficacy to effectiveness**
- **Types, e.g., Markov chain process, decision tree, Monte Carlo simulation**
- **Must be carefully, specifically explained**

Quality Adjusted Life Years (QALYs) … Investment Metric?

- **A way to think about the value of investing in alternative health care programs/interventions that may affect different types of impact on health status, quality of life, functional status, etc..**
- **Other analogous units are:**
  - **DALYs: disability-adjusted life-years**
  - **HYEs: healthy years equivalents**

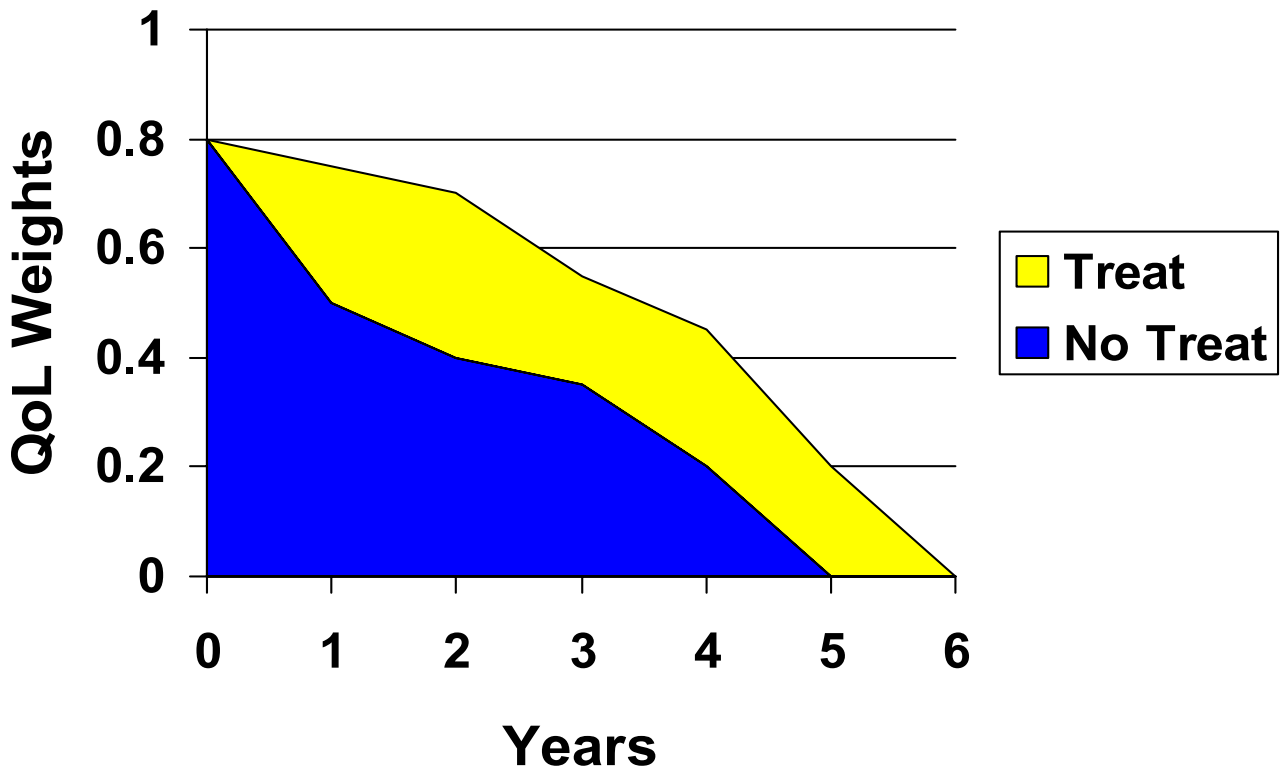
QALYs … Investment Metric?

May be based on one or more of:

- **Multi-attribute HRQL indexes (e.g., Quality of Well-Being, Health Utilities Index, EuroQol)**
- **Patient/individual utilities for health states assessed using game theory, e.g.:***
  - **"standard gamble"**
  - **"time trade-off"**

***See Appendix**

QALY = Length of Life X Quality Weight



Use to capture changes in length of life (mortality) and quality of life (e.g., utility for state of health)

Estimated Cost per Quality Adjusted Life Year (QALY) Gained by Investing in Different Treatments

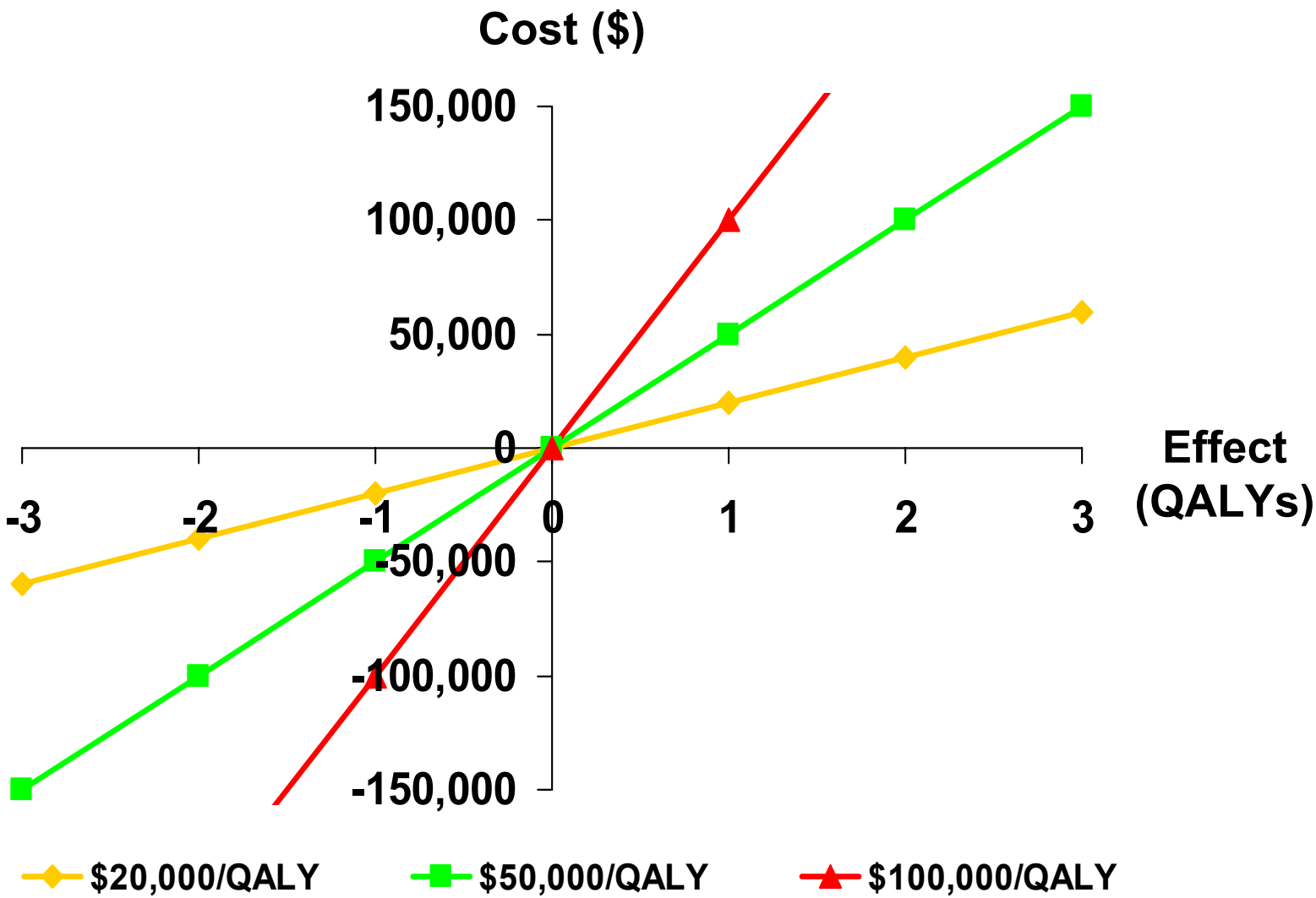
	Cost per QALY (£ 1990)
Cholesterol testing and diet therapy (all 40-69 yrs)	220
Neurosurgery for head injury	240
General practitioner advice to stop smoking	270
Neurosurgery for subarachnoid hemorrhage	490
Antihypertensive therapy to prevent stroke (45-64 yrs)	940
Pacemaker implantation	1,100
Hip replacement	1,180
Valve replacement for aortic stenosis	1,140
Cholesterol testing and treatment	1,480
CABG (left main disease, severe angina)	2,090
Kidney transplant	4,710
Breast cancer screening	5,780
Heart transplantation	7,840
Cholesterol testing and treatment (incremental) (all 25-39 yrs)	14,150
Home hemodialysis	17,260
CABG (one-vessel disease, moderate angina)	18,830
Continuous ambulatory peritoneal dialysis	19,870
Hospital hemodialysis	21,970
EPO for dialysis anemia (with 10% reduction in mortality)	54,380
Neurosurgery for malignant intracranial tumors	107,780
EPO for dialysis anemia (with no increase in survival)	126,290

Source: Maynard A. The Economic Journal 1991;101:1277-86

Cost per QALY: Current Estimates for Some Common Health Care Interventions

	Incremental Cost/QALY
Laparoscopic v. open cholecystectomy for gallstone disease	$ < 0
Warfarin v. aspirin in 65 yr w/ nonvalvular atrial fibrillation (NAF) and high stroke risk	< 0
Eradicate *H. pylori* empirically using omeprazole, clarithromycin and amoxicillin v. no treatment for adults w/ dyspepsia	1,300
Warfarin v. aspirin in 65 yr w/ NAF and medium stroke risk	8,800
Driver-side air bags v. no air bags	27,000
Neonatal int. care v standard neonatal care in infants 0.5-1.0 kg	47,000
Dual air bags v. driver-side air bags	69,000
MRI v. CT of head for 35 yr women with single episode of asymmetric neurological symptom	110,000
Screening for carotid dis., w/ carotid endarterectomy if positive v. no screening in 65 yr men with no symptoms of carotid dis.	130,000
Warfarin v. aspirin in 65 yr w/ NAF and low stroke risk	410,000
Omeprazole alone empirically v. check serum H. pylori; if positive, eradicate *H. pylori* for adults w/ dyspepsia	780,000

Cost-Utility Threshold?



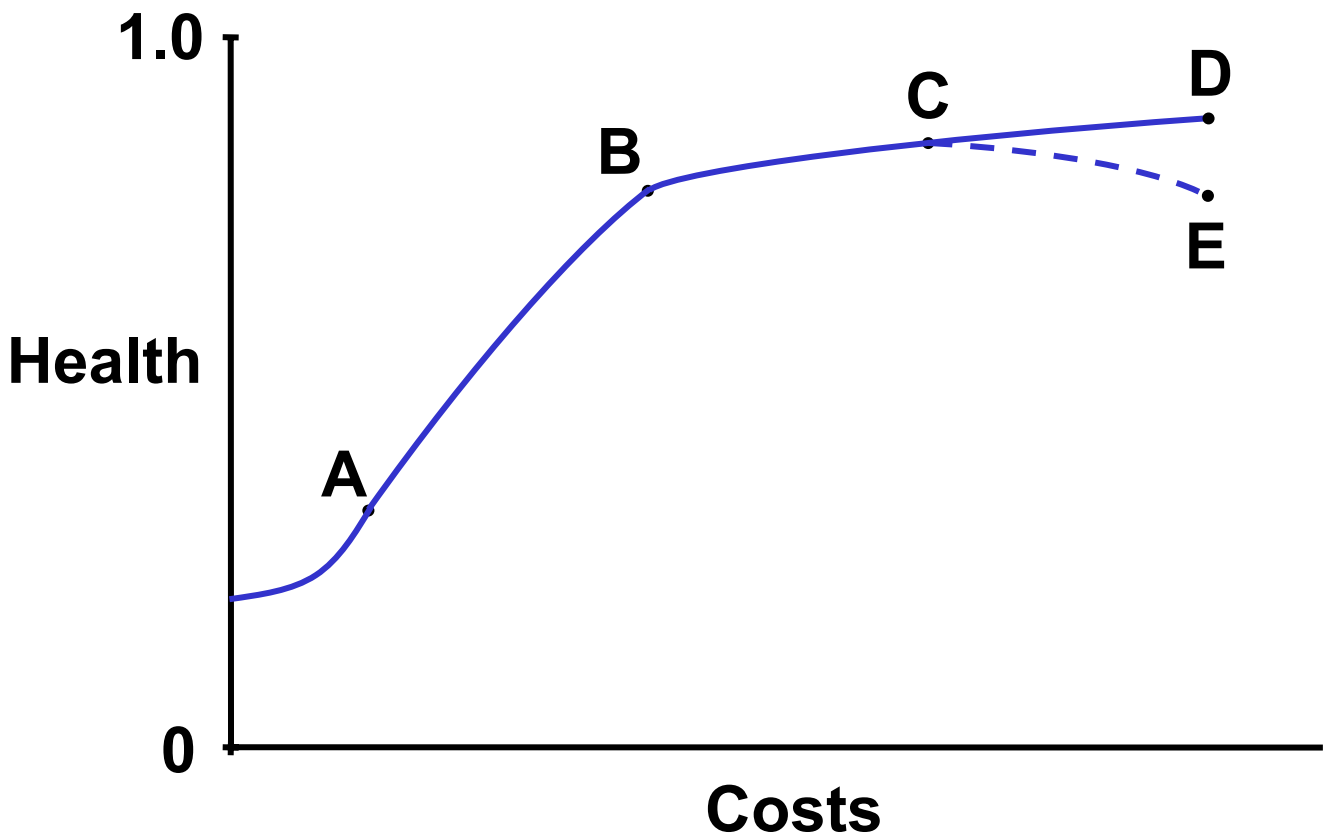
Source: Laupacis A, et al. CMAJ 1992;146:473-81.

Life on the Flat of the Cost-Effectiveness Curve

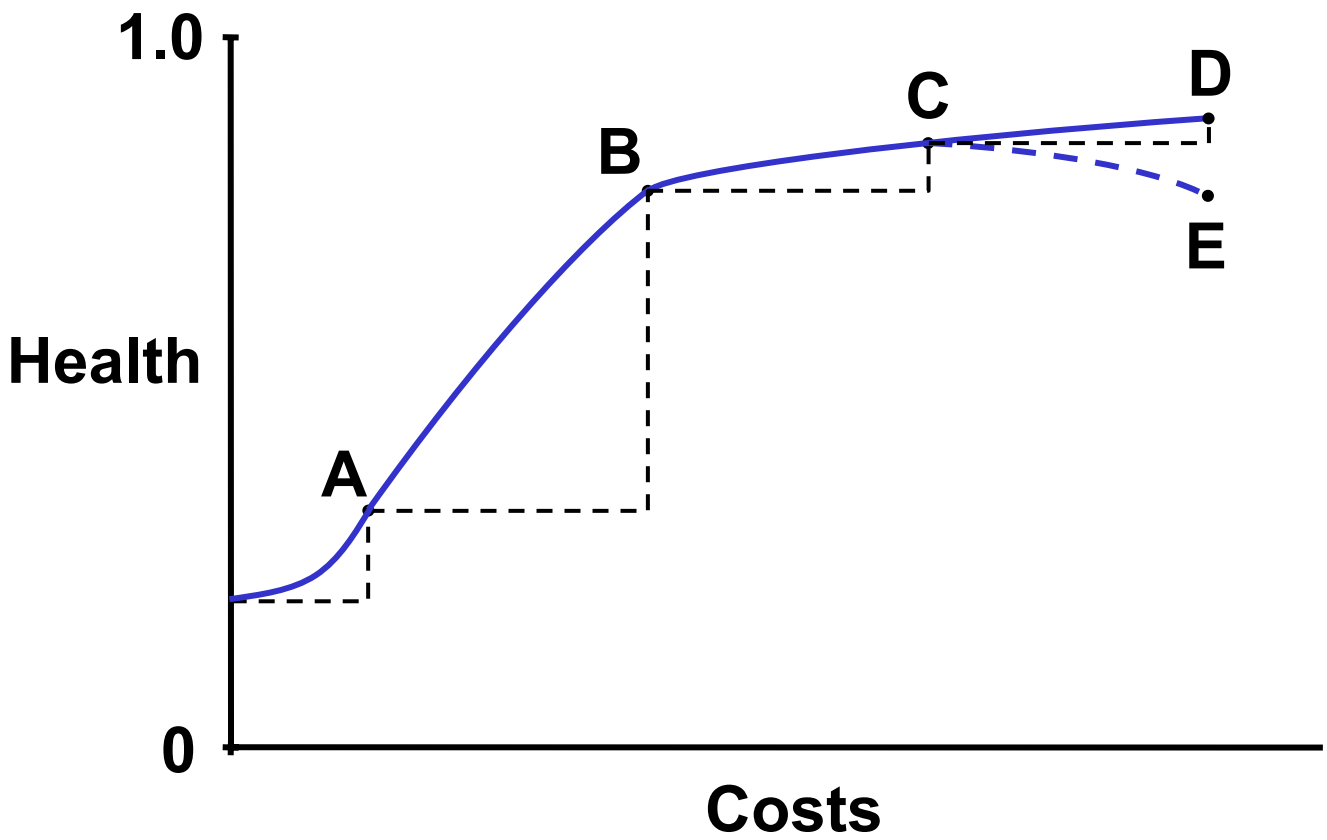
Series of advancements in new technologies and programs often provide diminishing returns.

- **How do diminishing returns occur?**
- **Diminishing returns may be at odds with public awareness, patient advocacy, industry interests, and health care payment**
- **When and how do policy makers act?**

Incremental Cost-Effectiveness of Next Technology: Often …



Incremental Cost-Effectiveness of Next Technology



Cost-Effectiveness: Cervical Cancer Screening

	Screening Frequency (age 20-70)		
	None⇨4 yrs	4 yrs⇨3 yrs	3 yrs⇨ 3 yrs after 3 normal 1 yr[3]
↑ LE[1] (days)	93.8	1.6	0.3
↑ LE discounted (5%)	9.54	0.18	0.06
↑ Cost[2] discounted	$264	$91	$112
Cost / life-year saved	$10,101	$184,528	$681,336

[1]LE: life expectancy (days)

[2]Costs of Pap, follow-up, treatment, as needed

[3]Change from screening every 3 yrs to schedule that begins with 3 annual tests, reverting to screening every 3 yrs only if all 3 initial annual tests are normal

Source: Eddy 1990; Gold et al. 1996

Cost-Effectiveness: Cervical Cancer Screening

And then there were …

- **Liquid-based, thin-layer cytology (ThinPrep, AutoCyte)**
- **Computerized rescreening (PAPNET)**
- **Algorithm-based computer rescreening (AutoPaP)**
- **Visual screening (PapSure … vinegar)**
- **Human papillomavirus (HPV) DNA testing**

Life on the Flat of the Cost-Effectiveness Curve

"Catching the last case of cervical cancer in North America is going to take the whole gross national product .... Screening can never wipe out a disease."

- David Grimes, Family Health International, Research Triangle Park, NC. Putting the Pap to the Test. USA Today, May 21, 2002.

Budget Impact Analysis

- **Allocating resources efficiently (e.g., maximizing cost-effectiveness) may not be consistent with affordability, i.e., remaining within budget**
- **Budget impact analysis can complement economic evaluation to inform decisions**
- **Budget "silos" and inability to transfer funds among services undermines system-wide efficiency**
- **Short-term budgeting and frequent changes of direction (due, e.g., to political change) reduce opportunities to maximize efficiency, focusing attention on budgets themselves**

Cost Effectiveness and Potential Budget Impact: A Hypothetical Example

Subgroup Age (yrs)	Δ Cost / life-year gained	Net cost of interven. 'A' over existing treatment (£/case)	No. of patients per year	Potential budget impact (£/ year)
<45	200,000	500	250	125,000
45-60	75,000	500	1,000	500,000
61-75	25,000	500	1,750	875,000
>75	15,000	500	2,000	1,000,000

How do you allocate a £500,000 annual budget?

Source: Trueman P, Drummond M, Hutton J. Developing guidance for budget impact analysis. Pharmacoeconomics 2001;19(6):609-21.

Types of Cost Studies

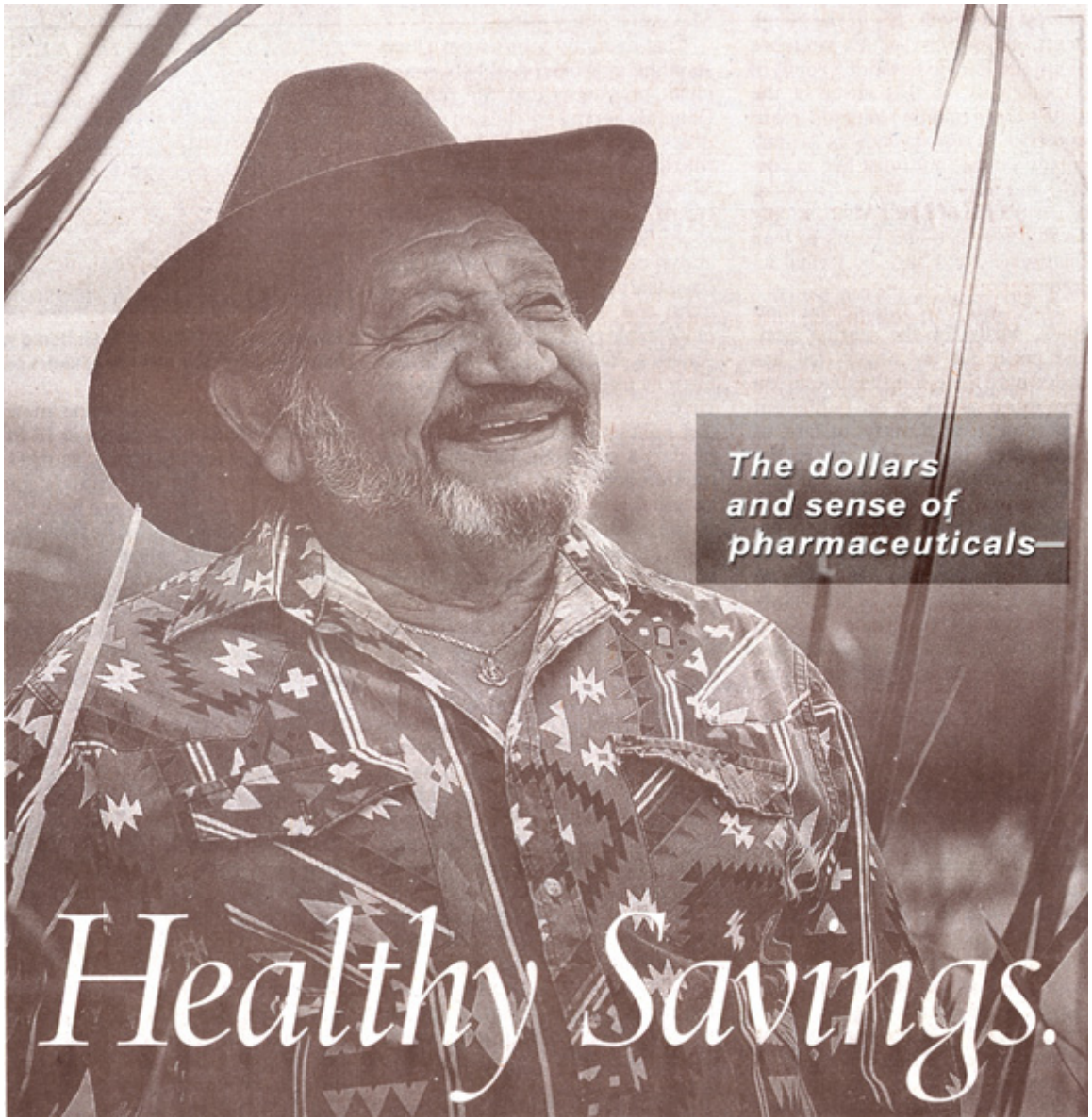
	Valuation of costs		Valuation of outcomes
Cost of Illness	**$**	**vs.**	**None**
Cost Minimization	**$**	**vs.**	**Assume same**
Cost Effectiveness	**$**	**÷**	**Natural units**
Cost Utility	**$**	**÷**	**Utiles (e.g., QALYs)**
Cost Benefit	**$**	**÷ or -**	**$**
Budget Impact	**$**	**vs.**	**Budget cap ($)**

Fuhrmans V. Wall Street Journal. January 13, 2004.

Costly New Drug for AIDS Means Some Go Without

Programs for the Uninsured Are Facing Tough Choices With Advent of Fuzeon

North Carolina doctors and health officials met last year to tackle a wrenching dilemma. Roche Holding AG's new AIDS drug, called Fuzeon, was beating the toughest strains of the virus, giving patients who didn't respond to other medications a new chance to live. But at roughly $20,000 a year, it costs three times as much as most AIDS medicines. For every new Fuzeon patient North Carolina took on, it would soon have to turn away two or three others who need a less-expensive traditional AIDS cocktail. The state's cash-strapped AIDS Drug Assistance Program, which buys medicine for 3,400 North Carolinians …. reached a painful compromise: buying Fuzeon for a limited number of patients – knowing that it would have to create a waiting list for other HIV-infected patients that it couldn't afford to treat …. As the AIDS epidemic moves deeper into low-income populations, expensive drugs such as Fuzeon are helping to create a kind of rationing of HIV care …. Struggling with increased demand and limited budgets, 13 states have shut enrollment to new patients, leaving patients with few options.


The dollars
and sense of
pharmaceuticals—
Healthy Savings.

We're America's pharmaceutical companies. You can measure the value of what we do in dollars ... And quality of life.

The breakthrough medicines we've developed for treating ulcers has reduced the need for costly and invasive surgery or lengthy hospital stays. That's a healthy savings in quality of life.

A new ulcer medicine costs $140. Ulcer surgery costs $28,000 and requires a hospital stay. That's a healthy savings — in dollars and quality of life.

Treatment of ulcers with these innovative new medicines costs $140. The surgical procedure to treat the same ulcer would cost $28,000.

That's healthy savings measured in dollars.

With more than 1,000 medicines in clinical trials, America's pharmaceutical companies will invest more than $30.5 billion this year in research and development.

You can measure the value of what we do in dollars ... And quality of life.

PhRMA

Pharmaceutical Research and Manufacturers of America

New Medicines. New Hope.

www.phrma.org

Appendix

Additional concepts

Cost-Utility Ratio

$$\text{CU Ratio} = \frac{\$\text{Cost}_{\text{Int}} - \$\text{Cost}_{\text{Comp}}}{\text{Utile}_{\text{Int}} - \text{Utile}_{\text{Comp}}}$$

Utiles, units of utility or preference, are usually measured in QALYs. So, for example:

- **"$50,000 per QALY"**
- **"$12,000 per QALY"**

Cost-Benefit: Ratio vs. Net Benefit

$$\text{CB Ratio} = \frac{\$\text{Cost}_{\text{Int}} - \$\text{Cost}_{\text{Comp}}}{\$\text{Benefit}_{\text{Int}} - \$\text{Benefit}_{\text{Comp}}}$$

For example: "Cost-benefit ratio of 10.0"

CB Net =

$$(\$\text{Cost}_{\text{Int}} - \$\text{Cost}_{\text{Comp}}) - (\$\text{Benefit}_{\text{Int}} - \$\text{Benefit}_{\text{Comp}})$$

For example: "Net increase of $9,000"

Cost-Benefit: Value of Life

Usually estimated by:

- **Human capital approach**
  - **based on lifetime earnings**
  - **raises discrimination problems**
- **Willingness to pay, also known as "contingent valuation," revealed by:**
  - **willingness to pay for life-saving or health improving interventions (poor vs. wealthy bias?)**
  - **extra pay for extra risky jobs**
  - **population cost of life-saving products divided by lives saved in the population**

Discounting

Compiling the discounted stream of costs (or benefits) over time

$$P = \sum_{n=1}^{n} \frac{F_n}{(1+r)^n}$$

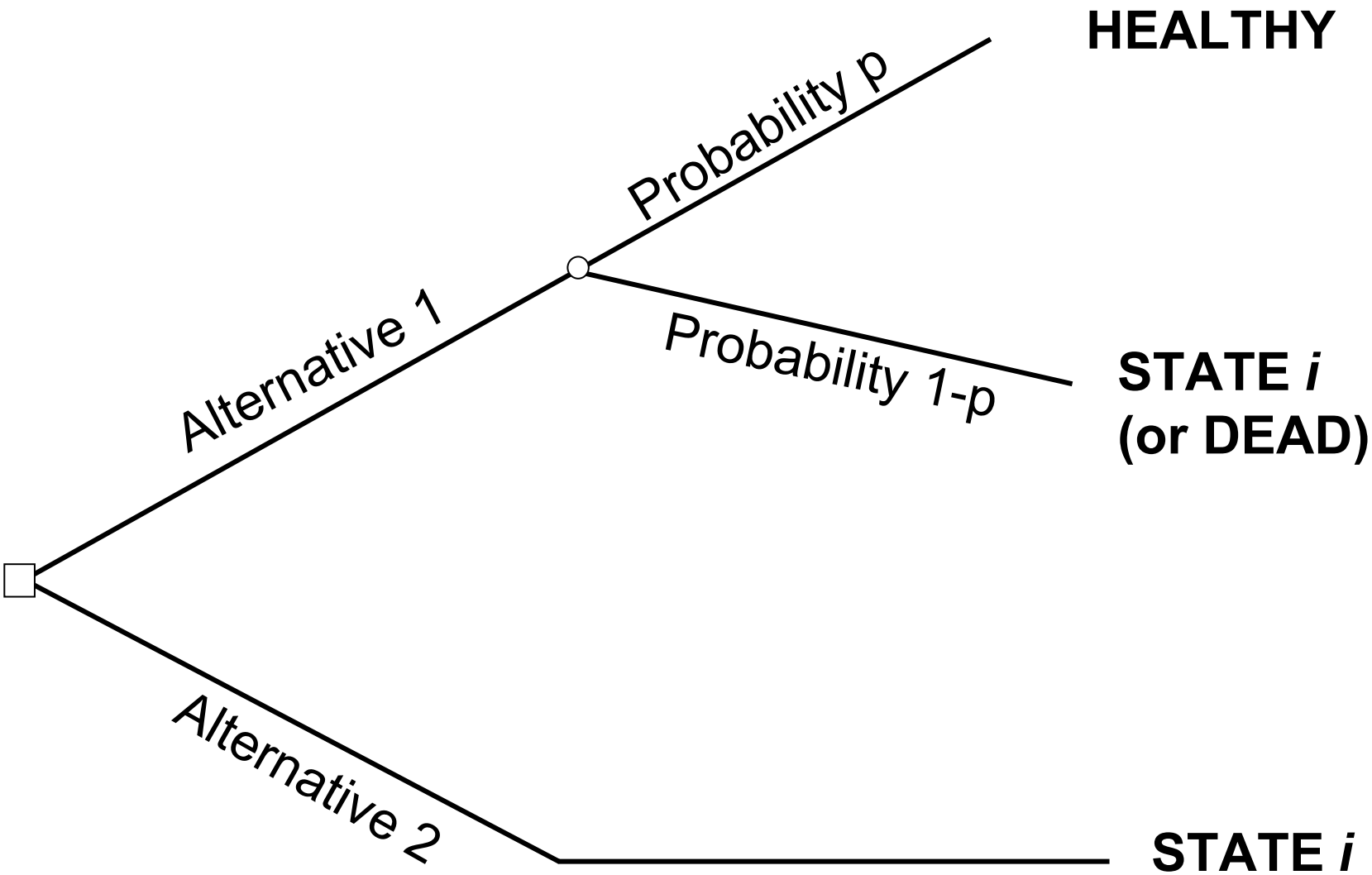
P = present value

F = future cost (or benefits) at year n

r = annual discount rate

Implications: think about long-term prevention …

Standard Gamble



Standard Gamble

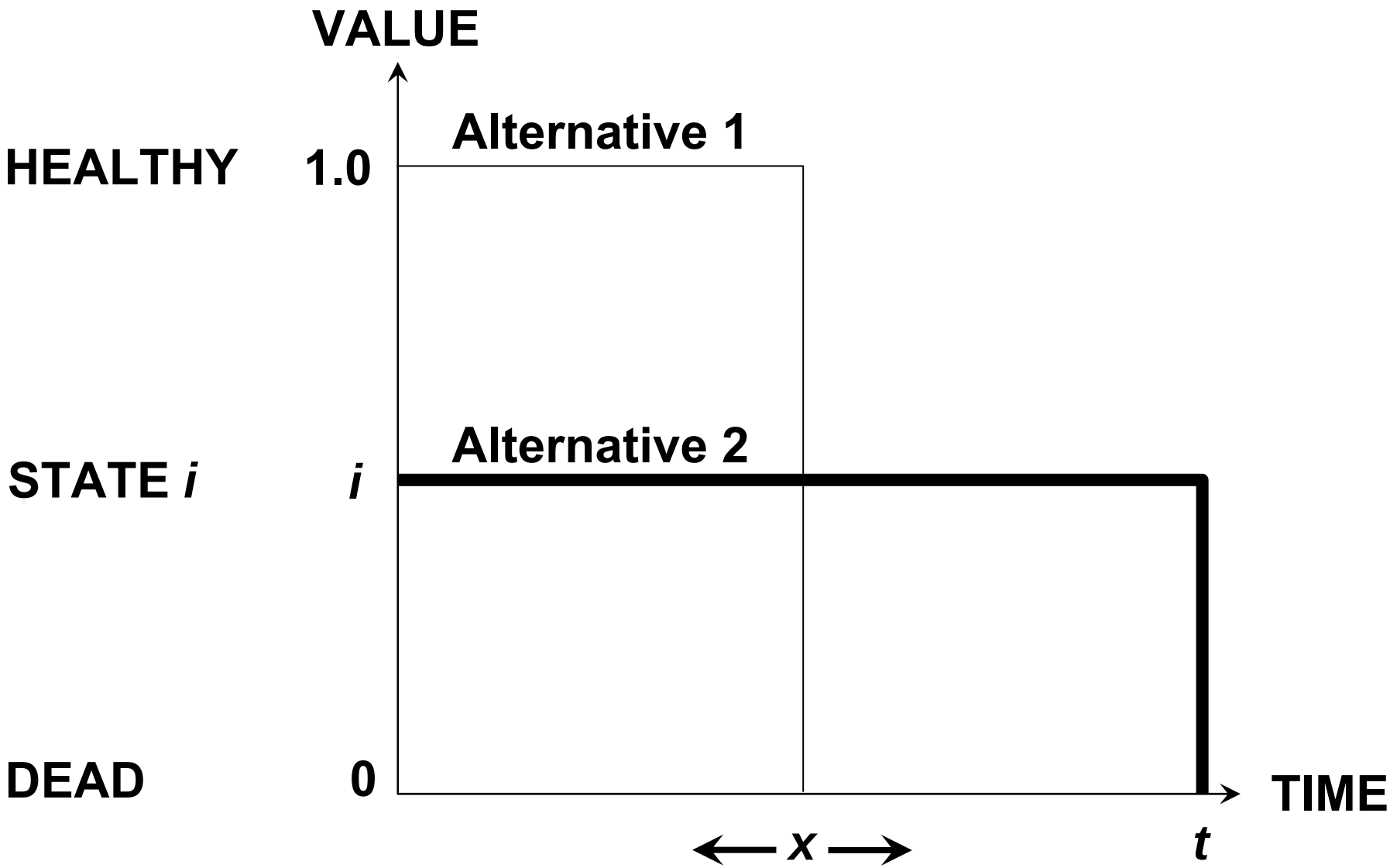
Individual is offered two alternatives:

- **Alternative 1 has two branches:**
  - **Full health for the remaining life years with a probability *p***
  - **Defined health state *i* (including death) for *t* years with probability (1 – *p)***
- **Alternative 2 has one certain outcome of chronic health state *i* for the remaining life years.**

Probability p is then varied until individual is indifferent between the two alternatives. At that point:

Utility for state *i* = *p*

Time Trade-Off



Time Trade-Off

Individual is offered two alternatives:

- **Alternative 1 is full health for time *x* (*x* < *t*) followed by death.**
- **Alternative 2 is to remain in health state *i* for time *t* (life expectancy for that condition) followed by death.**

Time *x* is then varied until the individual is indifferent between the two alternatives. At that point:

Utility for state *i* = *x*/*t*

Hawkins L Jr. Wall Street Journal. March 11, 2004.

GM's Liabilities for Retiree Health Top $60 Billion

General Motors Corp., the nation's largest private purchaser of health care, will soon report that its future health-care liabilities for retirees have surpassed $60 billion − even after recent Medicare legislation that has reduced retiree health-care obligations for many companies.... Health care is one of the single biggest costs GM faces each year − representing about $1,400 per vehicle produced....

(A) number of factors are driving up these costs. One is that GM is using a lower discount rate in its latest 10-K to calculate the present value of its future retiree health-care obligations, reflecting today's lower interest-rate environment. The lower the assumed discount rate, the greater the assumed present value of the future retiree health-care expenditures. When rates rise, the effect is to reduce the size of the reported retiree health-care liability.

Factors Influencing Cost-Effectiveness of Genetic Testing

Prevalence of the genetic mutation and the disease in the population

Severity and cost of the disease or outcome the test is designed to predict or diagnose

Strength of the association between the genetic mutation and clinical outcomes (penetrance)

Availability of effective interventions that can be implemented on the basis of genetic information and that provide a reduction in the relevant event rate compared with standard care

Whether testing is for prediction of future risk or for immediate diagnostic or prescribing decisions

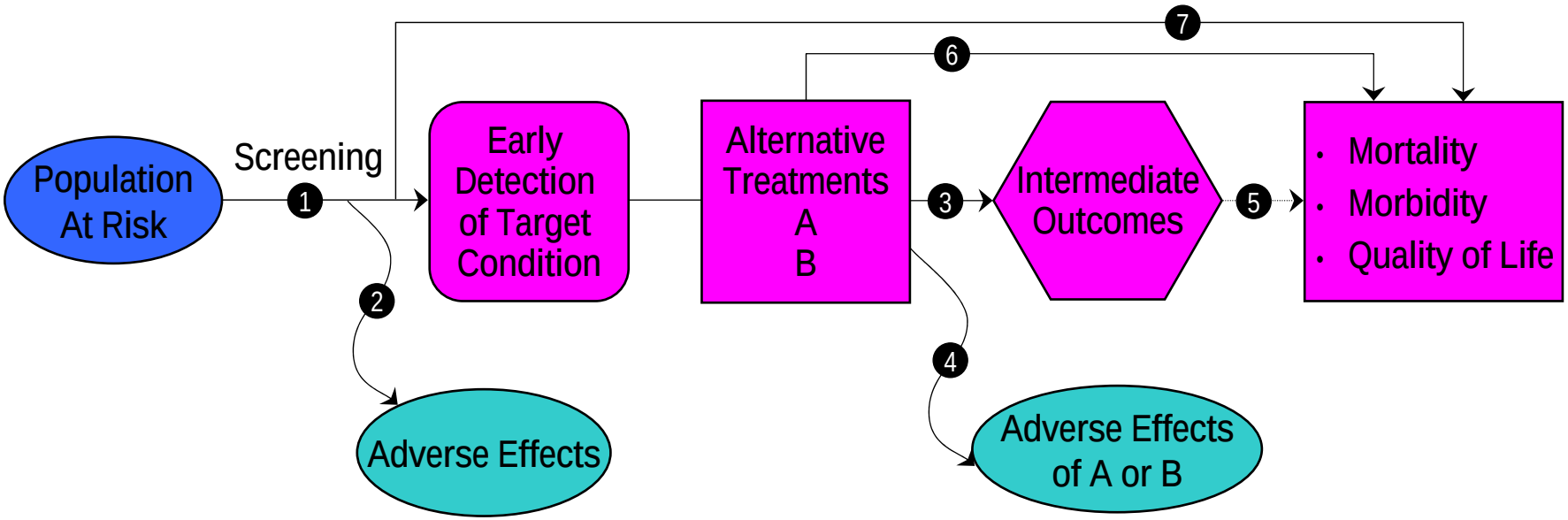
Cost, turnaround time, and accuracy of the test and whether the results provide information for a single condition or multiple conditions

The cost of counseling (if relevant)

The potential downstream and indirect costs and benefits such as the extent to which family members are tested, the potential ramifications of loss of privacy if genetic results are disclosed, etc.

Source: Phillips KA, Veenstra DL, et al. Genetic testing and pharmacogenomics: issues for determining the impact to healthcare delivery and costs. Am J Mgd Care 2004;10(7):425-32.

Causal Pathways: Beyond One Step



1. **Is screening test accurate for target condition?**
2. **Does screening result in adverse effects?**
3. **Do treatments change intermediate outcomes?**
4. **Do treatments result in adverse effects?**
5. **Are changes in intermediate outcomes associated with changes in health outcomes?**
6. **Does treatment improve health outcomes?**
7. **Is there direct evidence that screening improves health outcomes?**

Source: Adapted from Harris, Helfand, Woolf, et al. 2001