Introduction to Cost-Effectiveness Analysis

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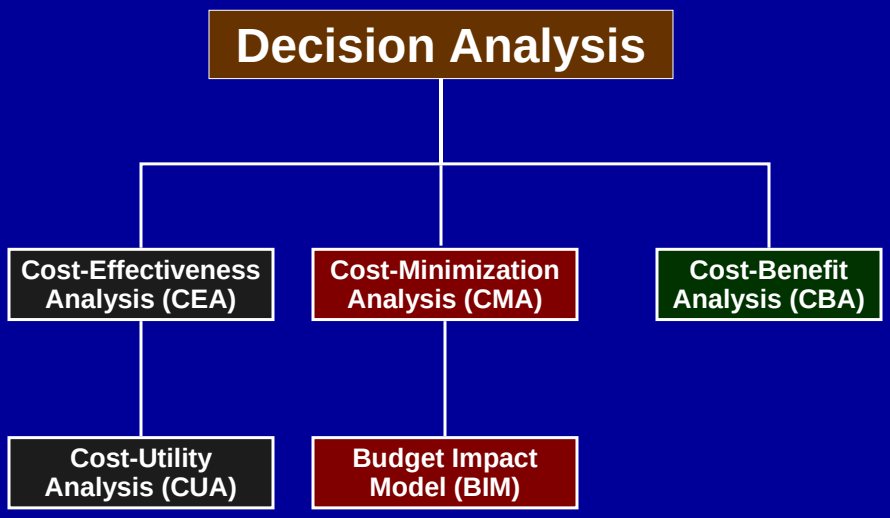
Objectives

- Define types of health-economic models
- Introduce decision analysis
- Introduce utilities and QALYs
- Review solution to "competing choice" problem
- Examine role of sensitivity analysis
- Discuss shortcomings of cost-effectiveness analysis
  - Introduce budget impact models as alternative

Taxonomy of Health-Economic Analyses



Health Economic Models

Type of Model	Numerator	Denominator	Example
CEA	$	Health Outcome	Cost per ulcer bleed prevented
CUA	$	QALY	Cost per QALY
CBA	$	$	Cost per willingness-to-pay (WTP) for IBS symptom relief
CMA	$	None	Overall cost of using cox-2 inhibitor instead of ibuprofen
BIM	$	None	Per member per month (PMPM) cost of screening for varices in cirrhosis

Example Questions

- Is it cost-effective to screen for esophageal varices in cirrhosis?
- What is the cost-utility of of using cox-2 inhibitors instead of non-selective NSAIDs in arthritis?
- How sensitive and specific must a hypothetical pancreatic cancer tumor marker be in order for it to be cost-effective?
- What is the incremental PMPM cost of using rifaximin instead of lactulose for hepatic encephalopathy?

Guiding Principles of Health Economics

- Resources are limited
- If you spend money in one place, then you can't spend it in another
- Aim to provide the most good to most people
- Litmus test: "Is the juice worth the squeeze"
- Dying younger is cheaper
- "Rule of rescue" can throw off a perfectly rationale argument
  - Computers are amoral. Humans are not.

When Does Money Matter?

- When budgets are tight (*e.g.* always!)
- When competing strategies are equally effective (principle of CMA)
- When one strategy is significantly more effective than another, but also more expensive
- When people live a long time with a condition
- When a condition is highly prevalent

Ways to Save Money

- Don’t do things that are ineffective & expensive
- Skip low yield steps or cut corners
- Use lower cost stuff, even if it’s less effective
- Use lower cost people, even if it’s less effective
- Downgrade to a less expensive settings
- Do nothing at all

Decision Analysis Example: Irritable Bowel Syndrome

- 45 yo with irritable bowel syndrome
- Symptoms severe
- Co-morbid depression

Which therapy to start with?

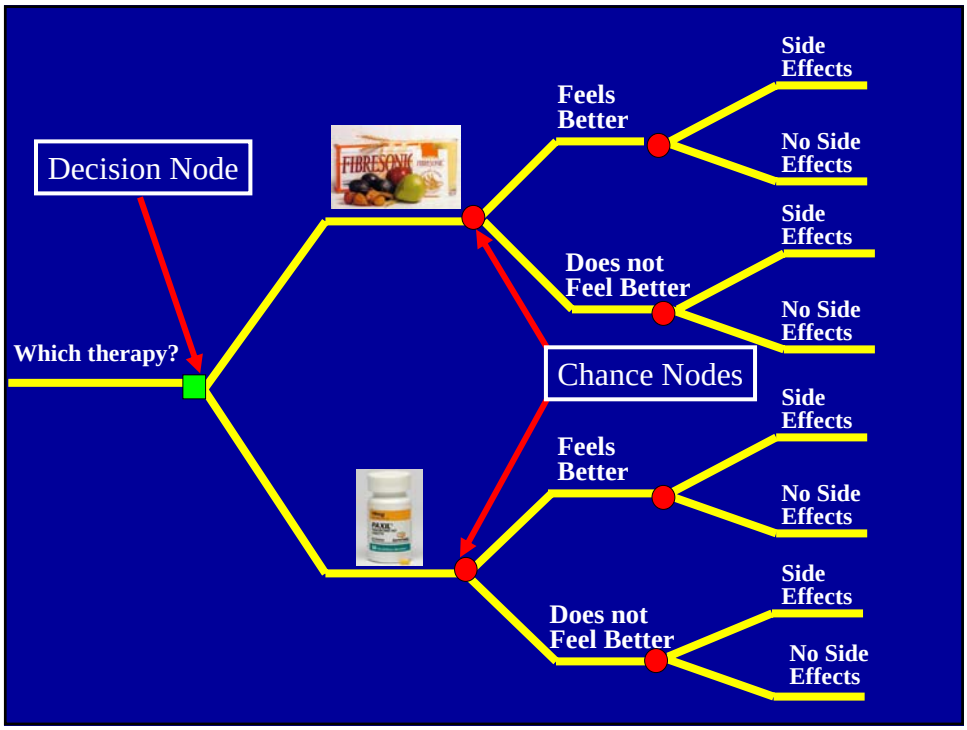
"Usual Care"

Paroxetine

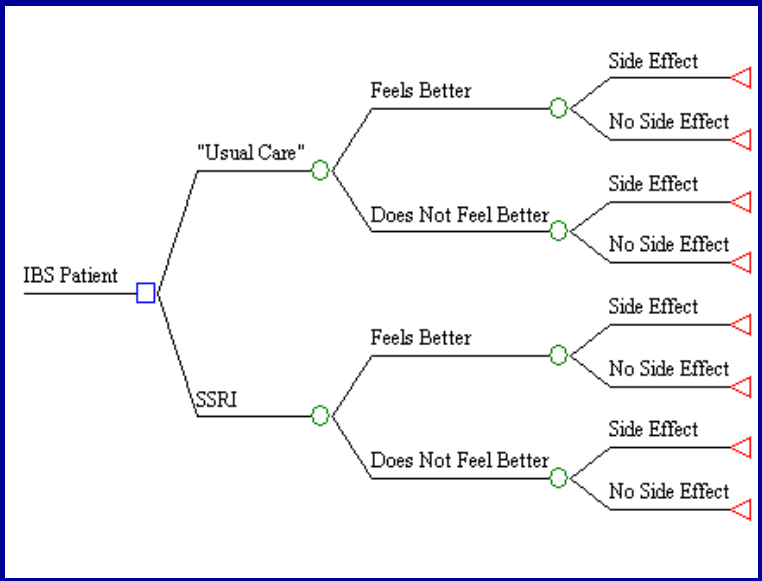
Suppose there are two factors that drive the decision

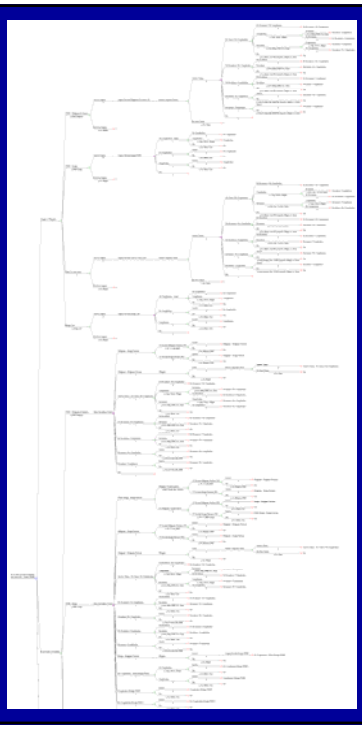
Will the symptoms improve?

Will there be side-effects?



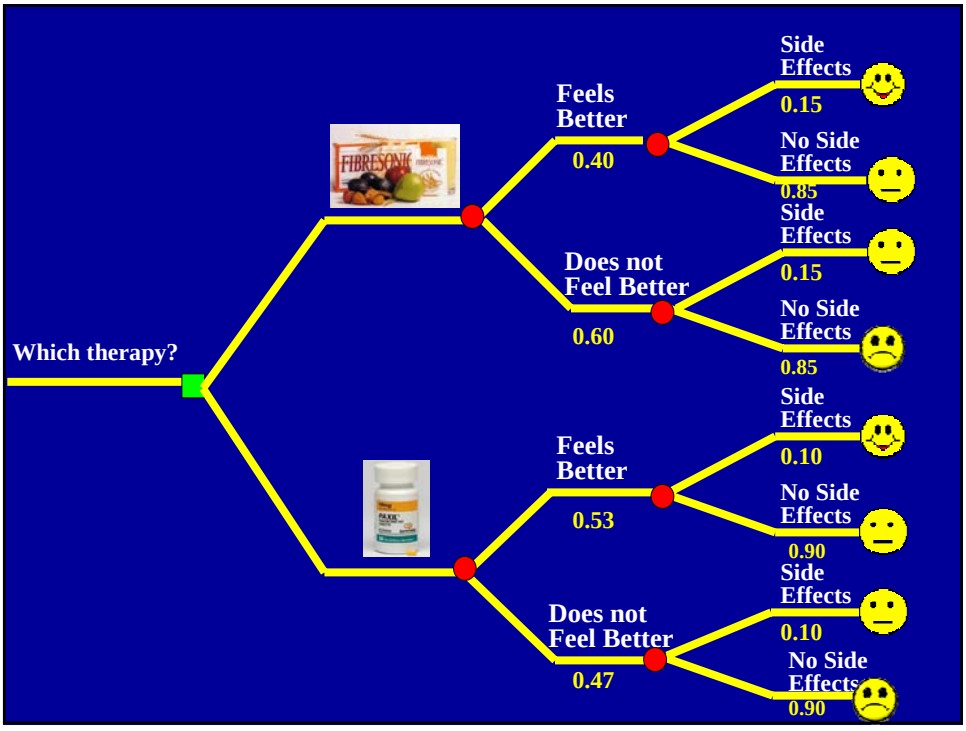
Software Depiction



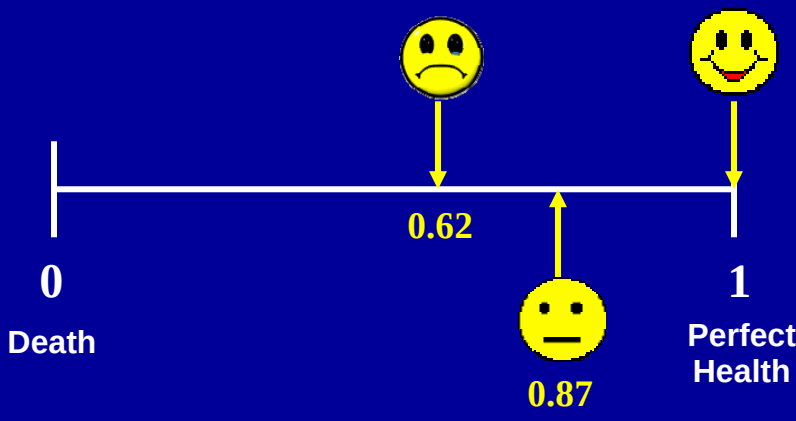


Defining the Outcomes

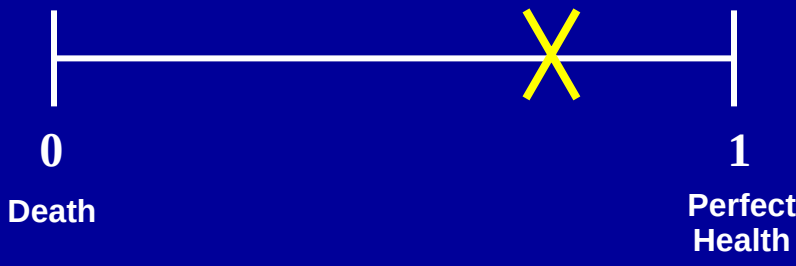
	No Side Effects	Side Effects Occur
Symptoms Improve		
Symptoms Persist		



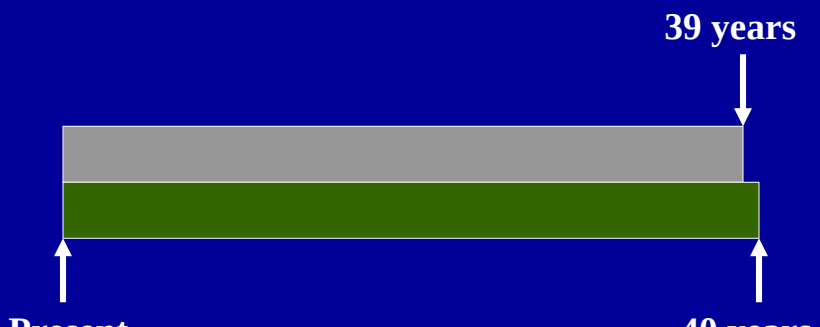
Defining the Outcome: Utilities



Direct Rating Scale



Indirect Rating: Time Trade-Off



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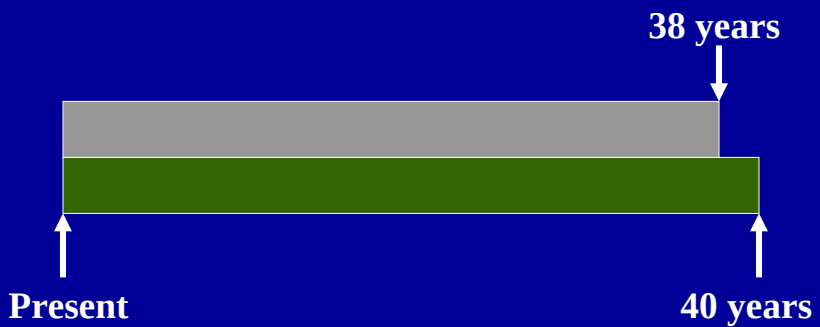

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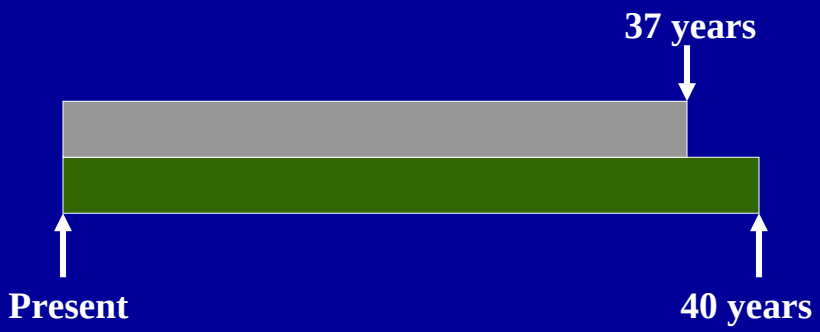

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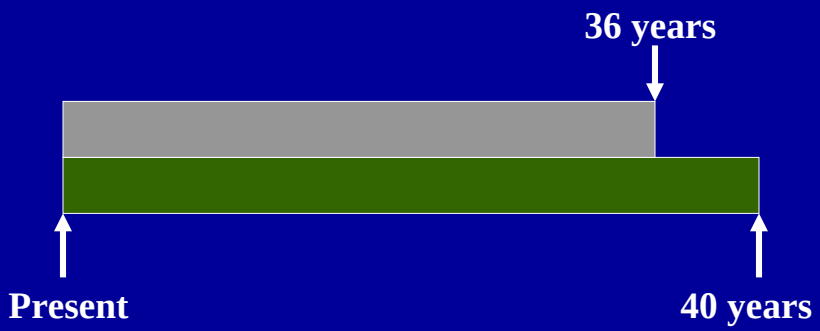

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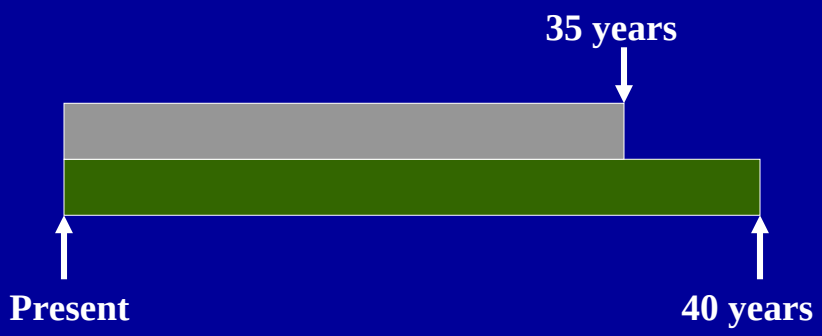


Calculating the Time Trade-Off Utility

$$\text{Utility} = \frac{\text{time willing to spend in perfect health}}{\text{total remaining lifespan}}$$

$$\text{Utility} = \frac{35 \text{ years}}{40 \text{ years}} = \boxed{0.87}$$

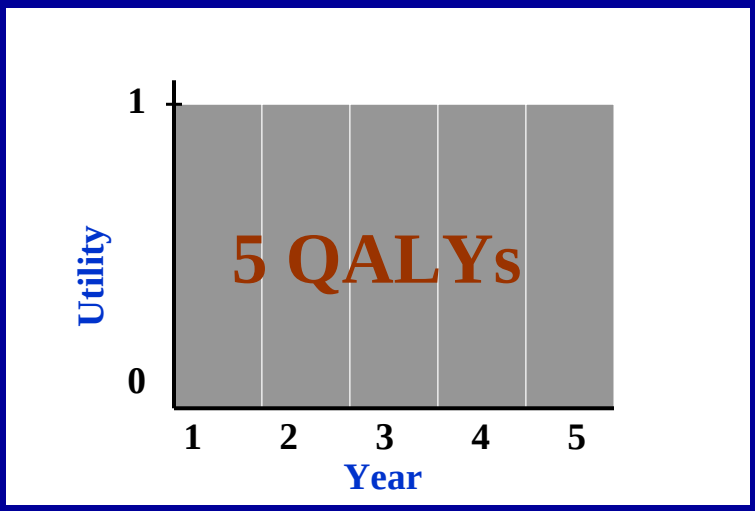
Other Utility Elicitation Techniques

- Standard gamble
- Multi-attribute scales (EuroQol, HUI)
- SF-36 conversions
- Conjoint analysis

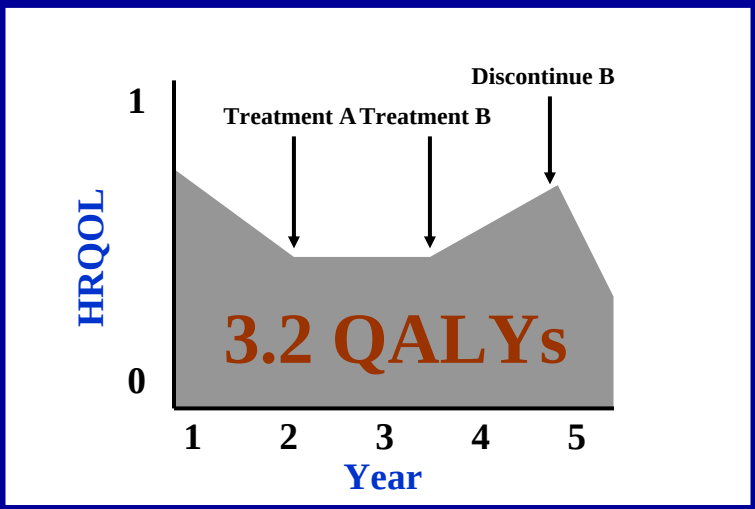
Quality-Adjusted Life-Years

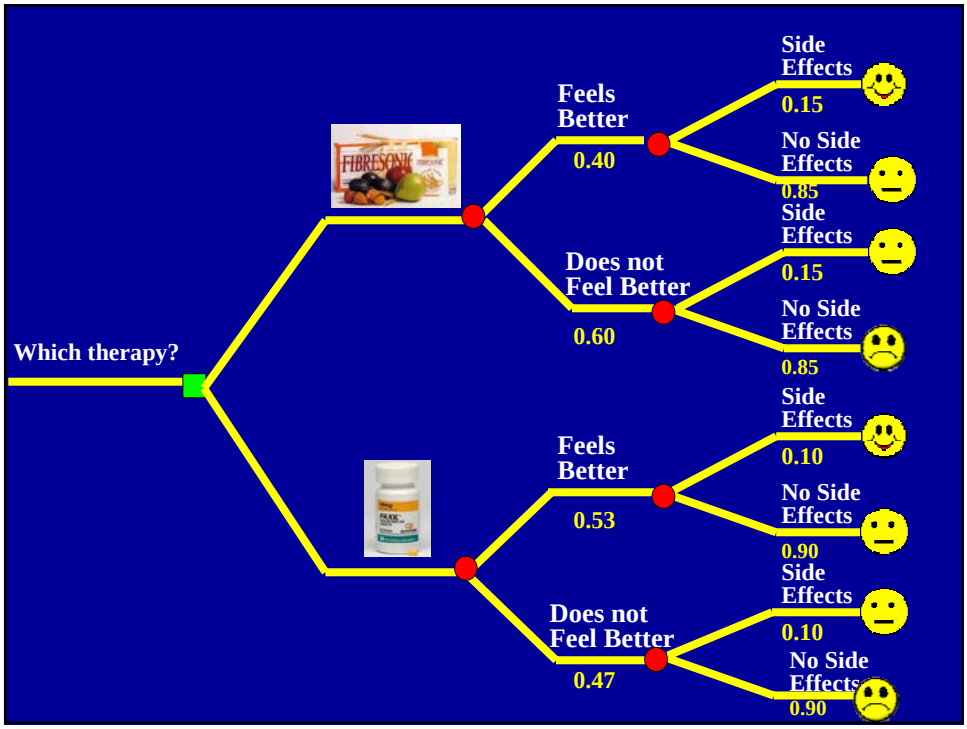
- QALY is a year of life, adjusted for the quality in which it is lived
- One year lived with utility of 0.87 = 87% of year lived in perfect health
- 87% of year lived in perfect health = 0.87 QALY

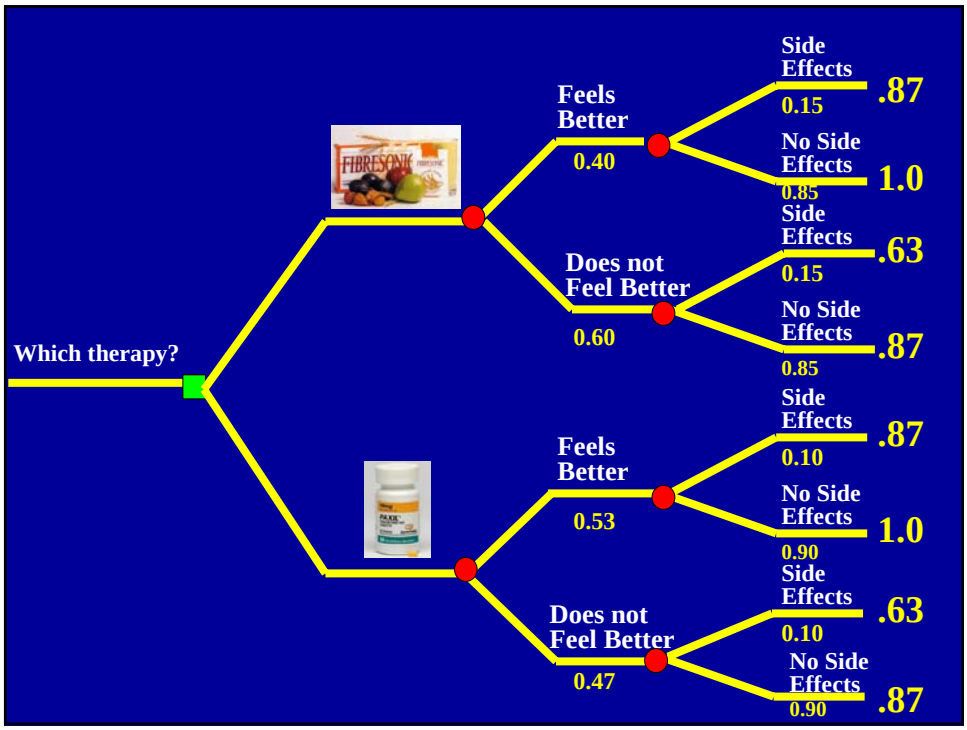
Quality-Adjusted Life-Years



Quality-Adjusted Life-Years



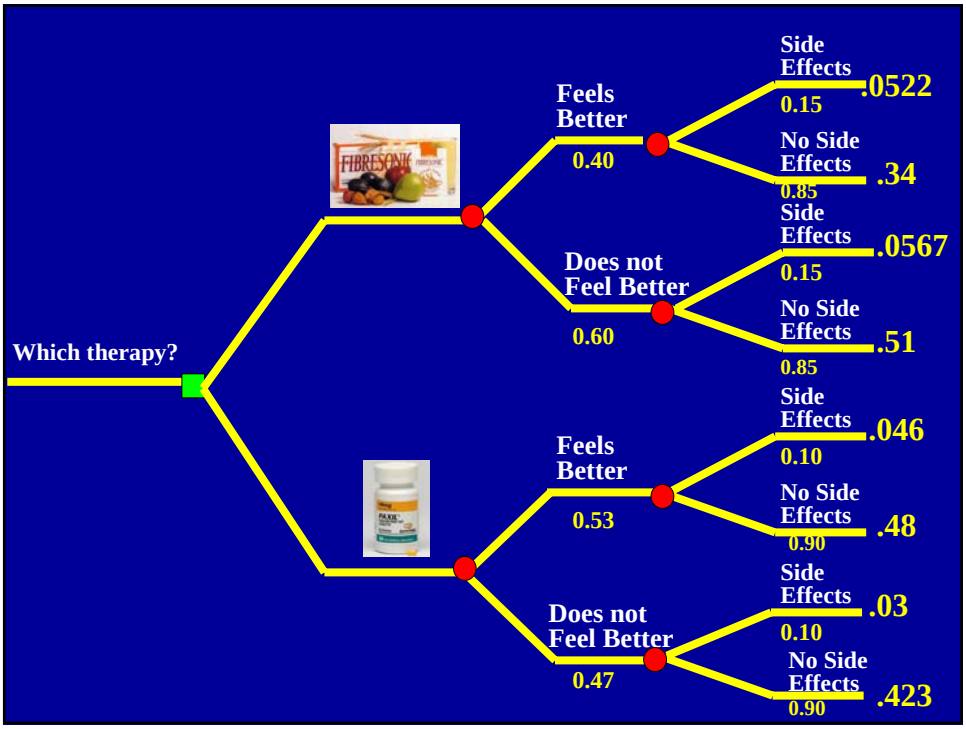

Which therapy?
Feels Better
0.40
Side Effects
0.15
No Side Effects
0.85
Does not Feel Better
0.60
Side Effects
0.15
No Side Effects
0.85
Feels Better
0.53
Side Effects
0.10
No Side Effects
0.90
Does not Feel Better
0.47
Side Effects
0.10
No Side Effects
0.90


Which therapy?
Feels Better
0.40
Side Effects
0.15
.87
No Side Effects
0.85
1.0
Does not Feel Better
0.60
Side Effects
0.15
.63
No Side Effects
0.85
.87
Feels Better
0.53
Side Effects
0.10
.87
No Side Effects
0.90
1.0
Does not Feel Better
0.47
Side Effects
0.10
.63
No Side Effects
0.90
.87

"Rolling Back" the Tree

Calculate the expected value of each arm

.60 x .15 x .63 = .0567



Summing the Arms

.0522 + .34 + .0567 + .51

.046 + .48 + .03+ .423

Summing the Arms

.95 < .98

Question

SSRI provides 0.03 more QALY vs. "usual care." That's 10.95 additional quality adjusted days per year.

So, "is the juice worth the squeeze?"

Juice = QALYs
Squeeze = $

Costs

- Cost estimates depends upon perspective
  - Third party payer perspective
    - Medicare reimbursement
    - Average wholesale drug prices
  - Patient perspective
    - Days lost from work
    - Transportation costs for doctor visits
  - Societal perspective
    - Includes all up-front, induced, and averted costs

Sequence of Costs

- **Initial:** Costs initially incurred upon initiation of a strategy
- **Induced:** Costs resulting from an intervention
- **Transition:** Costs associated with transitioning between health states
- **Averted:** Costs associated with events avoided by intervention
- **Terminal:** Costs of death

Some Issues with Costs

- **Cost** vs. **charges**
- **Comprehensiveness** of resources included in the model
- **Discounting** future costs
- Updating old costs using medical services component of **CPI**
- Problems with **AWP**

Example Cost Estimates

GI Resource	Cost
Cost per tablet of SSRI	$3.00
Cost per day of Metamucil	$0.50
GI office visit	$52
Colonoscopy	$624
Upper endoscopy	$624
Flexible sigmoidoscopy	$125
ERCP	$1213
Abdominal XR / Upper GI Series / BE	$541
Abdominal ultrasound	$541
Elective abdominal surgery	$13,531

Obtaining Cost Estimates

- Outpatient services
  - AMA CPT codes and costs (http://www.ama-assn.org/)
- Inpatient services
  - DRG codes and costs (http://www.ahrq.gov/data/hcup/)

Cost-Effectiveness

→ $850 / year

→ $1350 / year

Cost-Effectiveness

→ $\frac{\$850}{.95}$

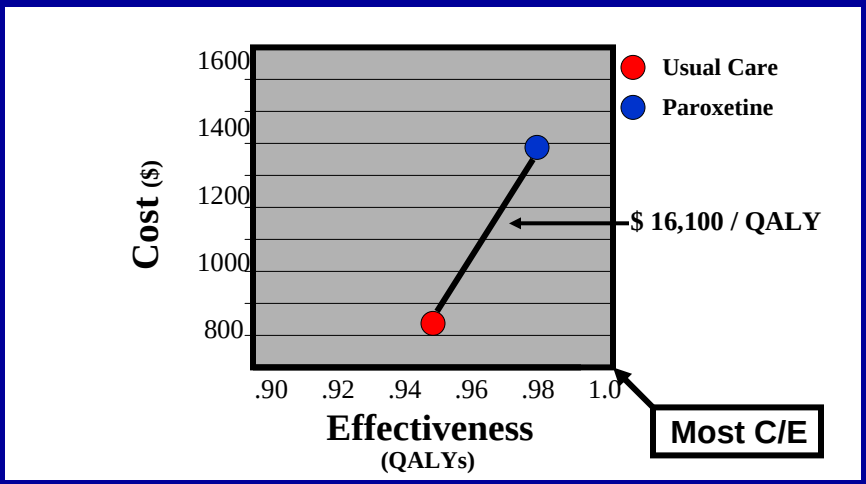
→ $\frac{\$1350}{.98}$

Cost-Effectiveness

→ $895/QALY

→ $1378/QALY

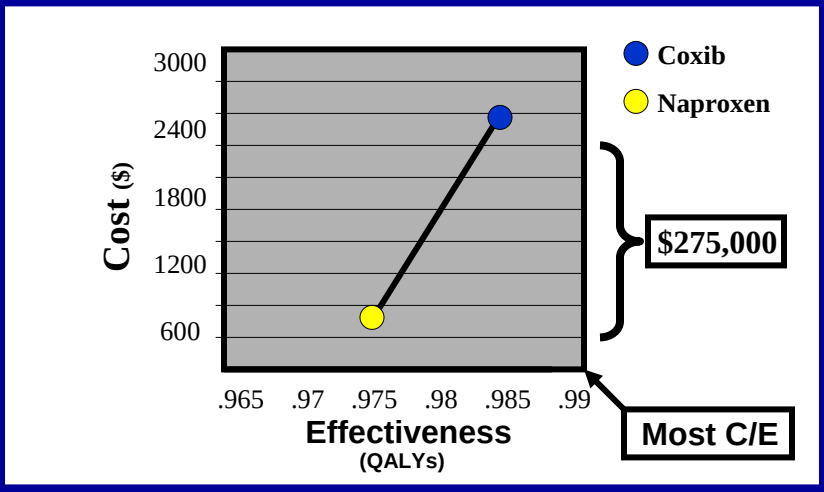
Cost-Utility Results



Incremental Cost Effectiveness

$$\text{ICER} = \frac{\Delta \text{ Cost}}{\Delta \text{ Effect}}$$

Another Example



Spiegel et al. *Ann Int Med* 2004

Question

How do you know if $275,000 per QALY is "too much"?

Anyone who tells you there is an easy answer to this is mistaken!

Question

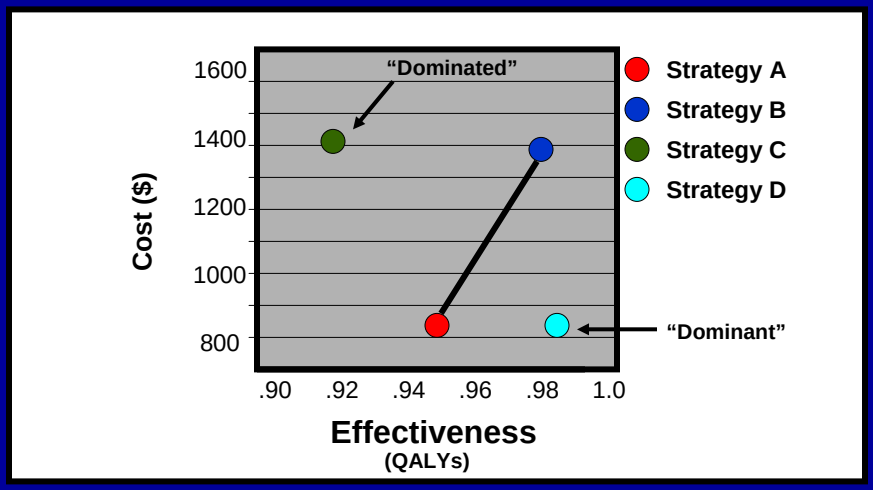
Why are we using QALYs, anyway?

"League Table"

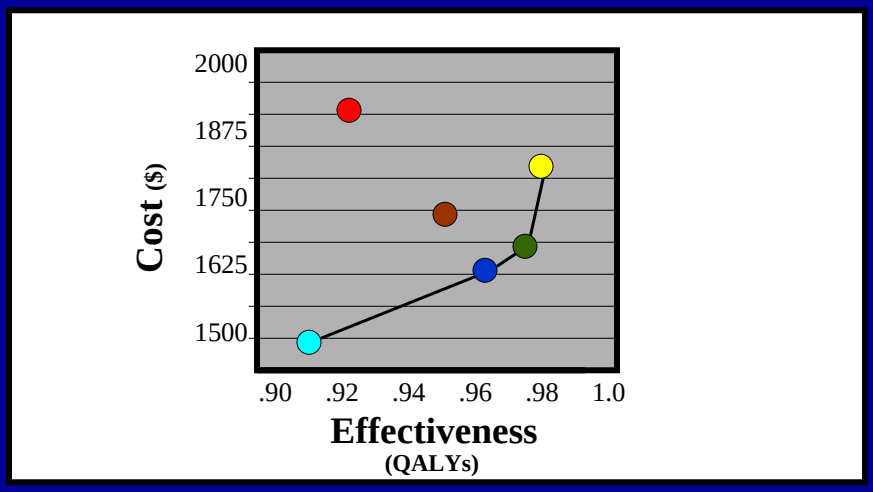
COST DESCRIPTION	$ / OUTCOME
"PPI Test" in acid reflux	$10,160
Screening for Barrett's esophagus	$10,440
Screening for celiac sprue in IBS	$11,000
Angioplasty in acute MI	$13,100
CMV prophylaxis in AIDS	$22,000
Screening for varices in cirrhosis	$175,833
Celebrex for chronic arthritis	*$275,000*
Intravenous PPI therapy for ulcer bleed	$708,735

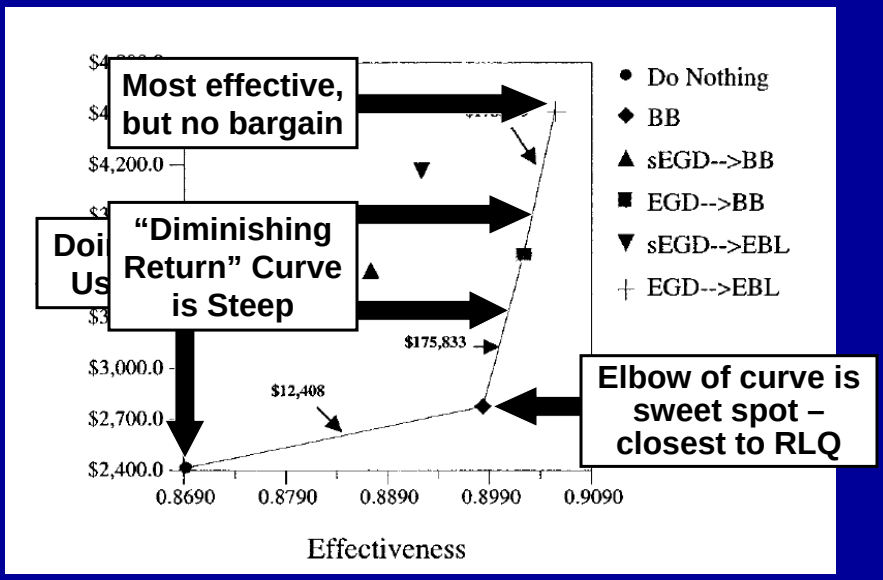
PPI Test: Ofman et al. *APT* 2002
Barrett's: Inadomi et al. *Ann Int Med* 2003
Sprue: Spiegel et al. *Gastroenterol* 2004
Angioplasty: Lieu et al. *JACC* 1997
CVM: Moore et al. *J AIDS Hum Retro* 1997
Varices: Spiegel et al. *Hepatology* 2004
Celebrex: Spiegel et al. *Ann Int Med* 2004
IV PPI: Spiegel et al. *Clin Gastro Hep* 2006

Another Example



Another Competing Choice Example

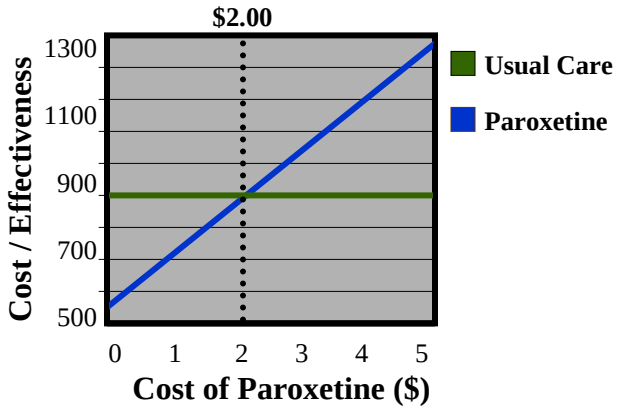




Handling Uncertainty

- Precise probability estimates may not be valid
- Cost estimates may vary between different settings
- Solution: Sensitivity Analysis

One-Way Sensitivity Analysis: Cost of Paroxetine



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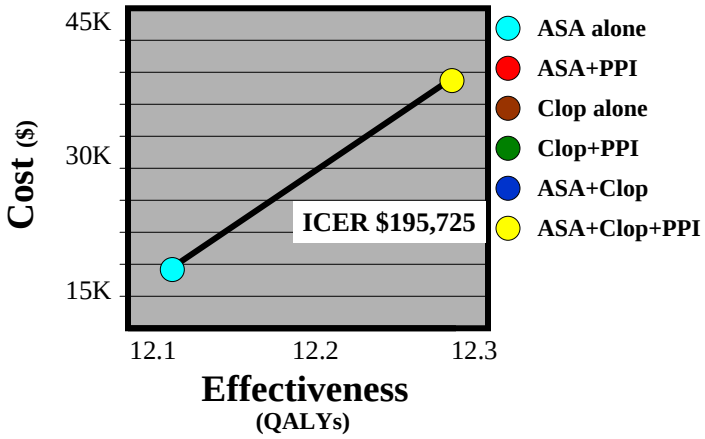

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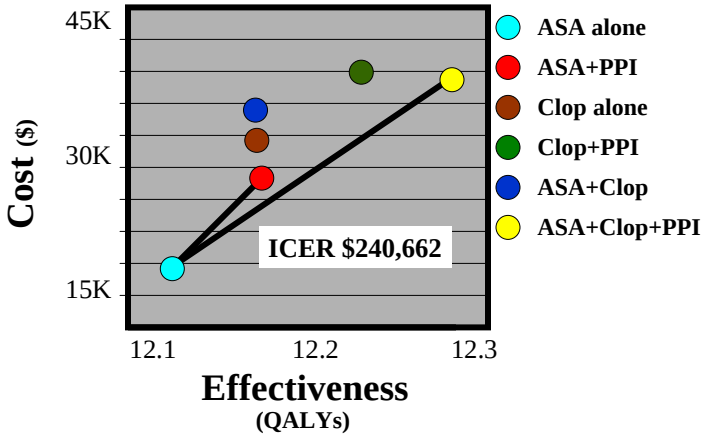
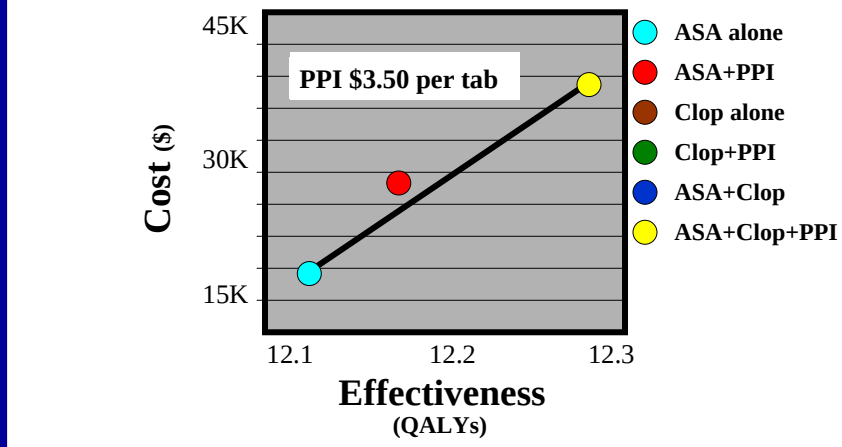


Sensitivity analysis on PPI cost



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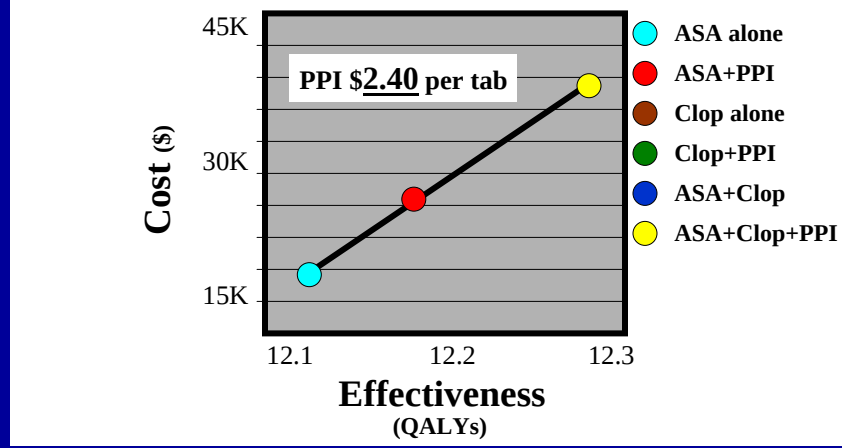
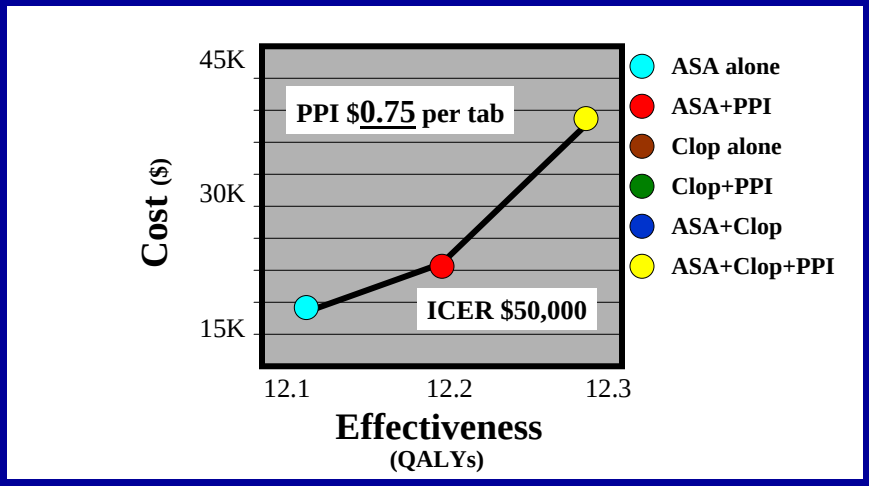
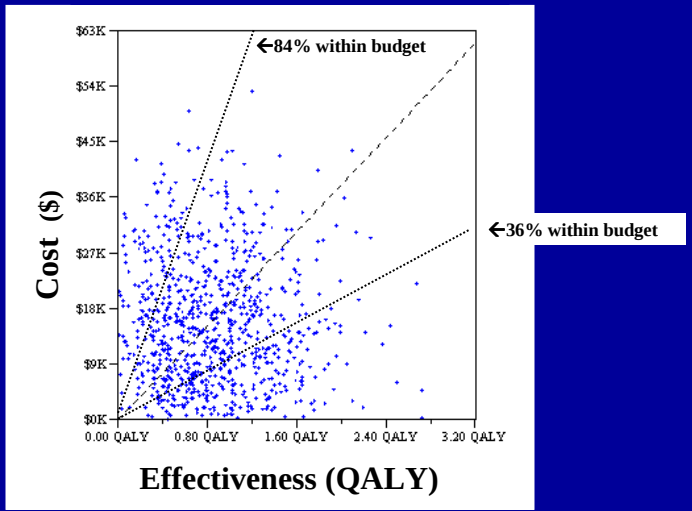


Sensitivity analysis on PPI cost



Monte Carlo Analysis: Paroxetine *vs* Usual Care

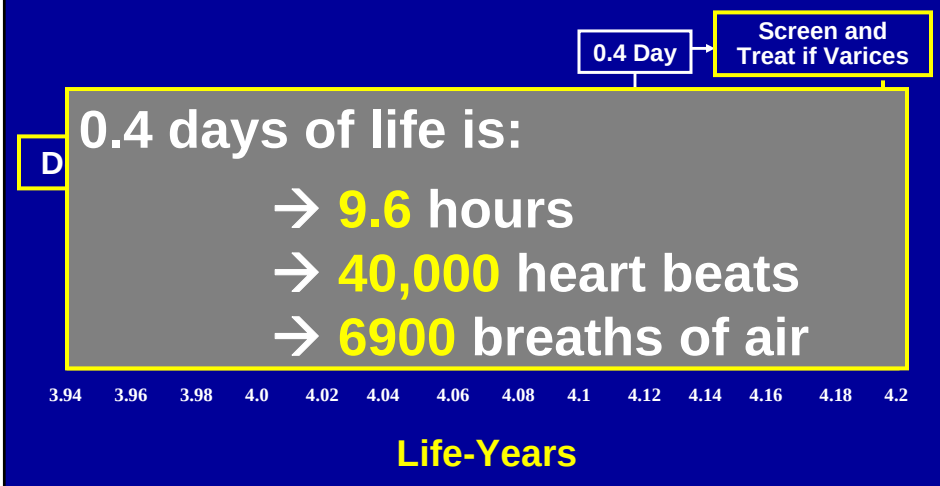


CEAs Don't Tell the Whole Story

Limitations of CEAs:

- Difficult to interpret ICERs – sometimes more academic than practical
- Does not account for underlying prevalence of disease
- Less useful when effectiveness is similar in competing strategies
- Does not address budget impact

Focusing on Effectiveness: Screening for Varices in Cirrhosis



Importance of Considering Budget Impact

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1 Endoscopy

30 Bicycle Helmets for Kids

Importance of Considering Budget Impact

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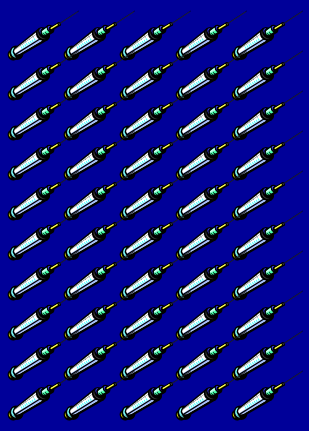

1 Endoscopy

100 Flu Vaccinations

Importance of Considering Budget Impact

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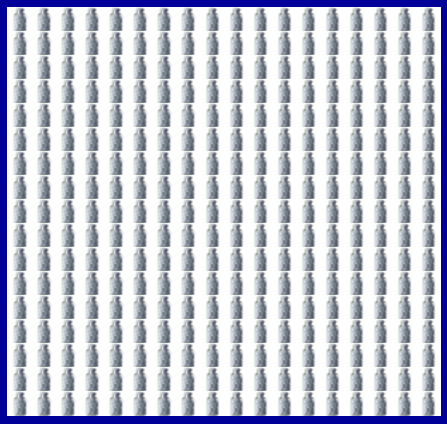


1 Endoscopy

300 Bottles of Aspirin

Budget Impact Question:

In a managed care population, what is the per-member per-month (PMPM) cost of paying for endoscopic screening with EGD *versus* using empiric medical therapy alone?

Budget Impact Results

Strategy	1-Year Cost per Cirrhotic	PMPM	IPMPM
No Screening	$3,824	$1.59	--
Screening	$4,432	$1.85	$0.26

* Assuming 0.5% prevalence of cirrhosis in MCO of 1,000,000 covered lives

Spiegel et al. *Gastrointest Endo* 2007

PMPM League Table

Intervention	PMPM
Tegaserod for irritable bowel syndrome	$0.01
Sildenafil for erectile dysfunction	$0.18
Screening for varices in cirrhosis	$0.26
Intravenous PPI therapy for ulcer bleeding	$2.68
Rifaximin for hepatic encephalopathy	$3.41

Bloom et al. *Am J Man Care* 2005;11:S27
Cook et al. *J Man Care Pharm* 2005;11:674
Huang et al. *Aliment Pharm Ther* 2007;27:1147
Spiegel et al. *Clin Gastro Hep* 2006;4:988

IBS Example (Again)

→ $850 / year

→ $1350 / year

BIM Calculations

If we assume that a hypothetical MCO has 1,000,000 covered lives, and that the prevalence of IBS is 10%, then:

$$PMPM_{SSRI} = \frac{(\$1350 / 12 \text{ months}) \times (1{,}000{,}000 \times 0.1)}{1{,}000{,}000} = \$11.25$$

$$PMPM_{Usual} = \frac{(\$850 / 12 \text{ months}) \times (1{,}000{,}000 \times 0.1)}{1{,}000{,}000} = \$7.08$$

IPMPM = $11.25 - $7.08 = $4.17

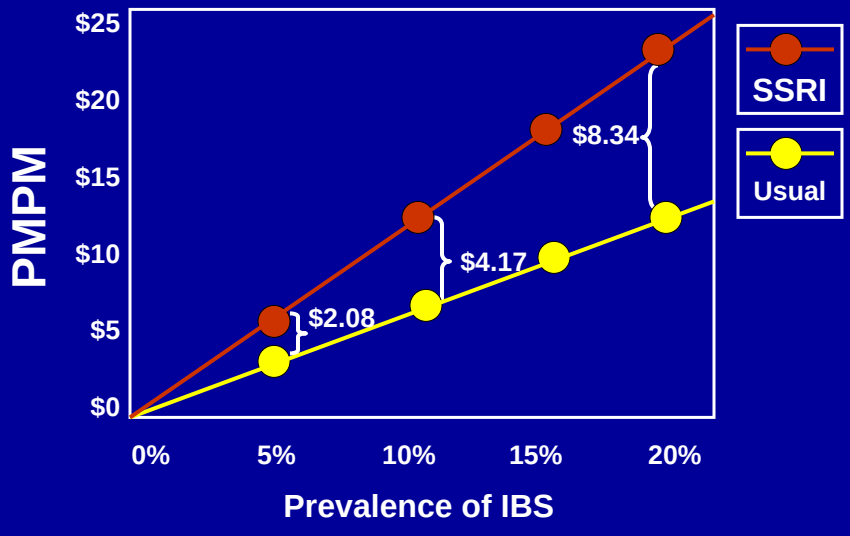
BIM Spreadsheet

IBS Budget Impact Model

	1-Yr Cost (per patient)	PPPM	IPPPM	PMPM	IPMPM SSRI vs. Usual
Usual Care	$850	$70.83	--	$7.08	.
SSRI	$1,350	$112.50	$41.67	$11.25	**$4.17**

>> KEY VARIABLES CONTROL PANEL <<	
Covered Lives in MCO (dropdown menu)	**1,000,000**
Percent with IBS (dropdown menu)	**10.00%**
Total IBS (total lives x prop with HE)	**100,000**

Changing IBS Prevalence



Take Home Points

- Most health economic analyses are based on underlying decision model
- Good models must be comprehensive in competitors and scope
- We use QALYs as an “exchange currency” to compare strategies across medicine
- Interpret ICERs with league table
- CEAs don’t account for prevalance, but BIMs do