COST EFFECTIVE ANALYSIS

INTRODUCTION

- Costs are measured in physical units and valued in monetary units.
- Effectiveness is measured in natural units of health improvement - clinical outcome measure, years of added life, prevention of event.
- Outcomes must be measured in the same units to compare interventions
- Results expressed as cost / effect
    - $100 per 1% reduction in Hem A_1C
    - $50 per 10 mg reduction in LDL
    - $5 per symptom-free day gained

INCREMENTAL COST EFFECTIVENESS (IECR)

- "The additional costs that one service or program imposes over another, compared with the additional effects, benefits, or utilities it delivers."

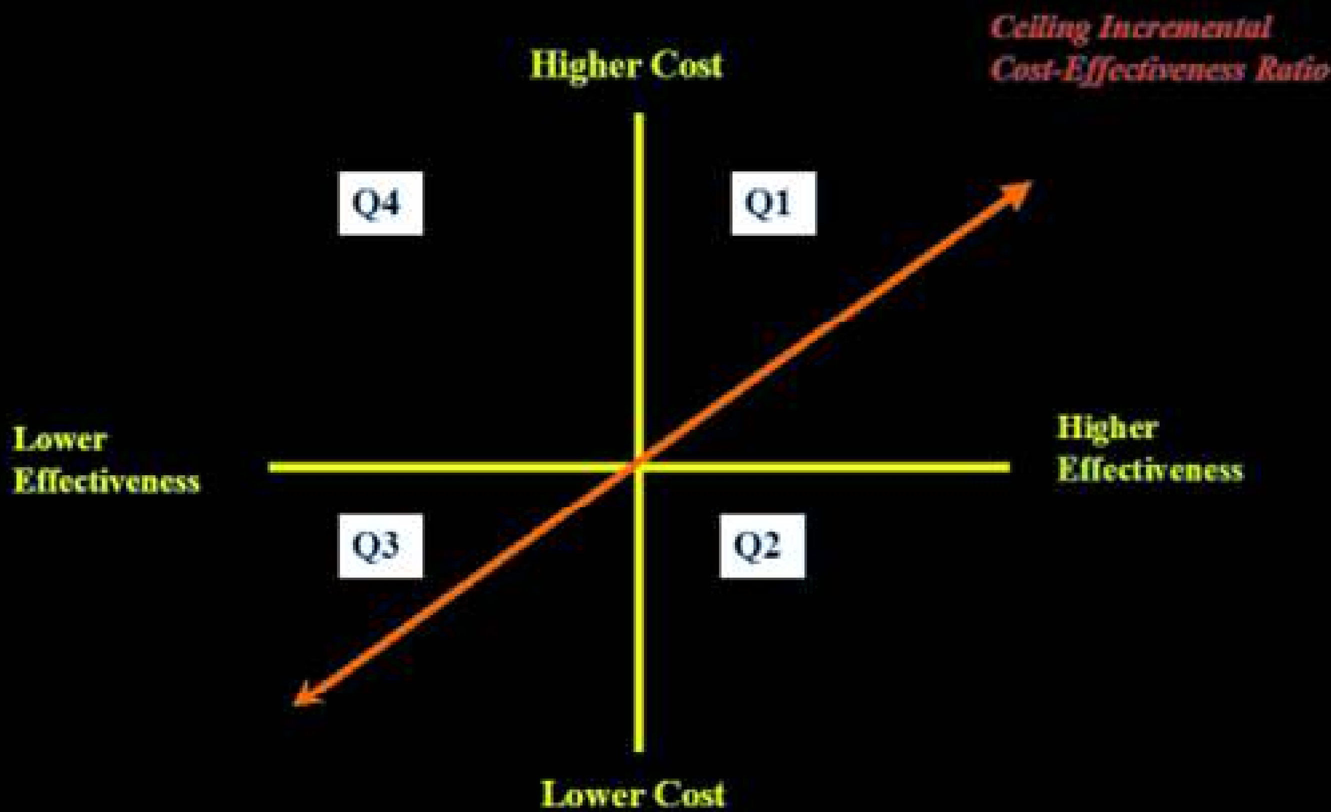
Incremental Cost Effectiveness

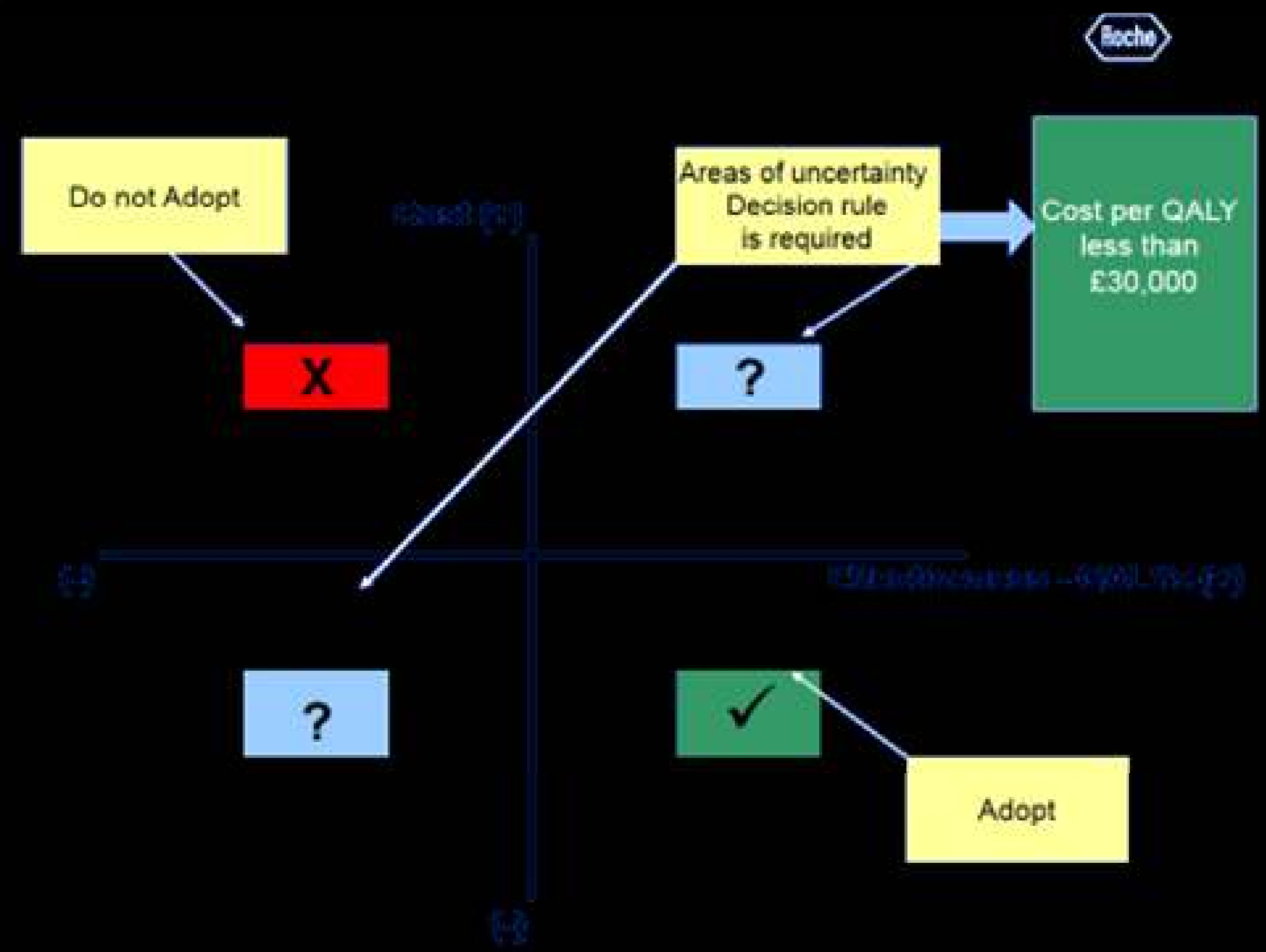
$$\frac{\text{Cost A} - \text{Cost B}}{\text{Effect A} - \text{Effect B}}$$

or

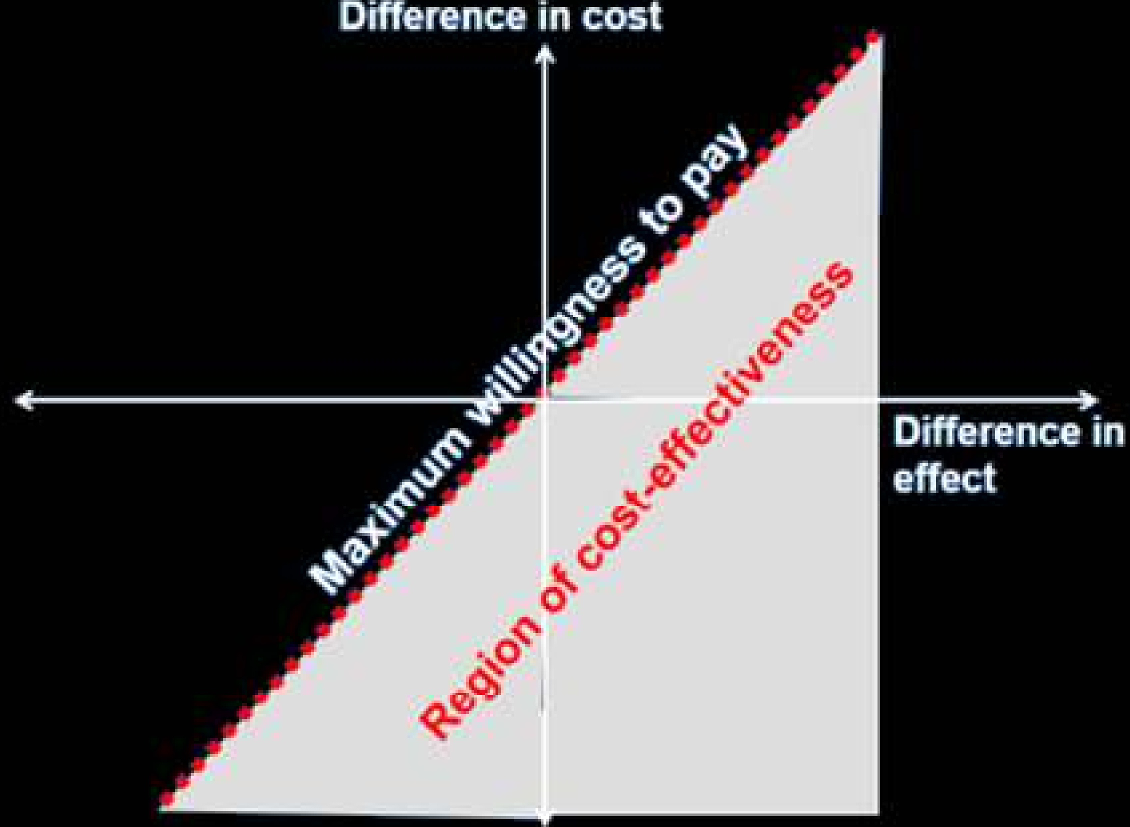
$$\frac{\Delta\ \text{Cost}}{\Delta\ \text{Effect}}$$

The Cost-Effectiveness Plane

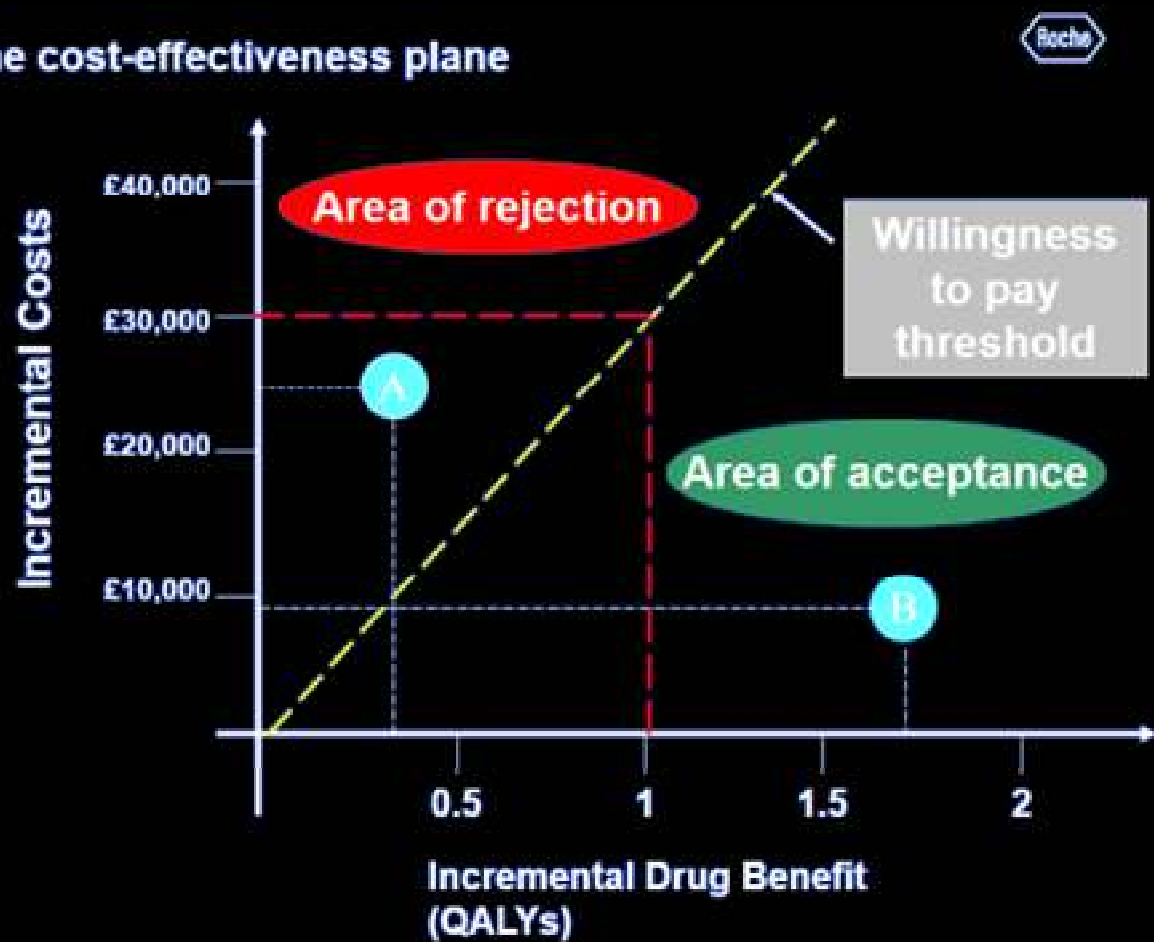



Do not Adopt
X
Areas of uncertainty
Decision rule
is required
Cost per QALY
less than
£30,000
?
?
Adopt

COST-EFFECTIVENESS PLANE



The cost-effectiveness plane



CEA EXAMPLE: PREVENTION OF STROKE

- Drug A
  - Total cost for 100 patients = $10,000
  - Effectiveness = 10 strokes prevented

- Drug B
  - Total cost for 100 patients = $60,000
  - Effectiveness = 50 strokes prevented

STROKE PREVENTION EXAMPLE: AVERAGE CE

Agent	Total Cost for 100 pts	Strokes Prevented	Cost/ Stroke Prevented
Drug A	$10,000	10	$1000
Drug B	$60,000	50	$1200

INCREMENTAL COST-EFFECTIVENESS ANALYSIS

$$= \frac{\$60,000 - \$10,000}{50-10}$$

$$= \frac{\$50,000}{40}$$

= $1250 per additional stroke prevented

Grid Representing of Cost to Effect Between Two Competing Alternatives

		Cost of alternative A relative to alternative B		
		Lower	Equal	Higher
Effectiveness alternative A relative to alternative B	Lower	+/- Trade off	-	- Dominated
	Equal	+	Arbitrary	-
	Higher	+ Dominant	+	+/- Trade-off

WILLINGNESS-TO-PAY (WTP)

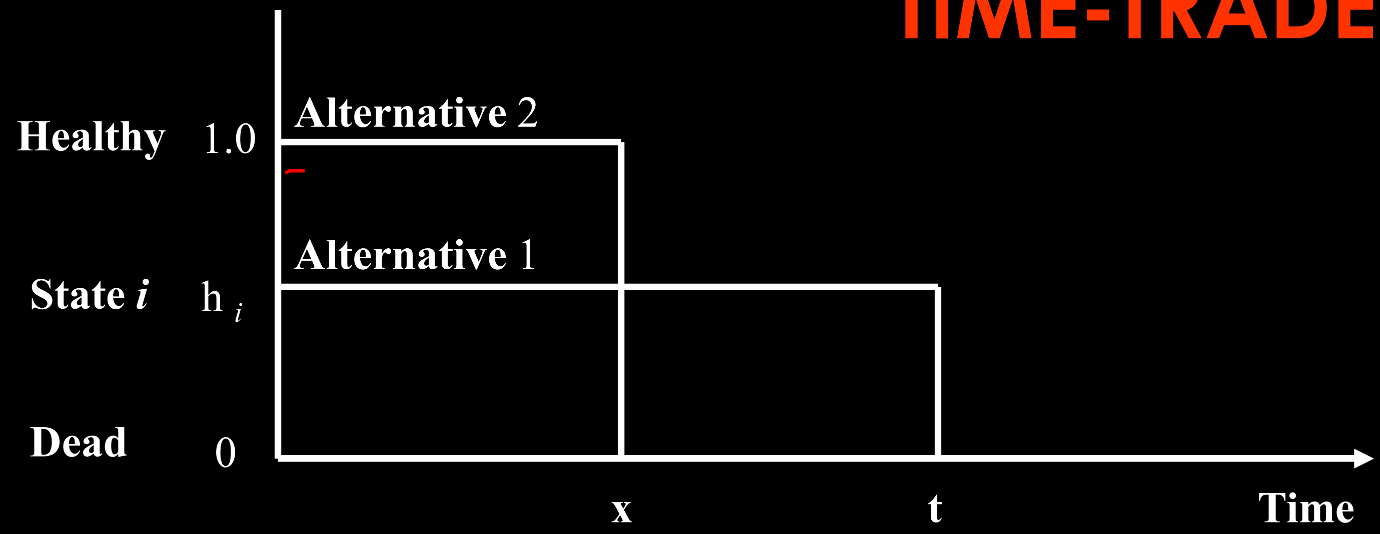
- Evaluation method used to determine the maximum amount of money an individual is willing to pay for a particular outcome or benefit (e.g. to receive a health care service).
- This method is often used in cost-benefit analysis to quantify outcome in monetary terms.

- WTP was measured using a contingent valuation method that involved asking respondents about their maximum WTP for pharmacists' services using a self-administered questionnaire.
- Respondents' WTP through (out of pocket) and (insurance premium) methods were measured using three hypothetical scenarios illustrating reductions in the risk of medication-related problems.
- Logistic regression and semi log regression were performed to evaluate the responses to the survey.

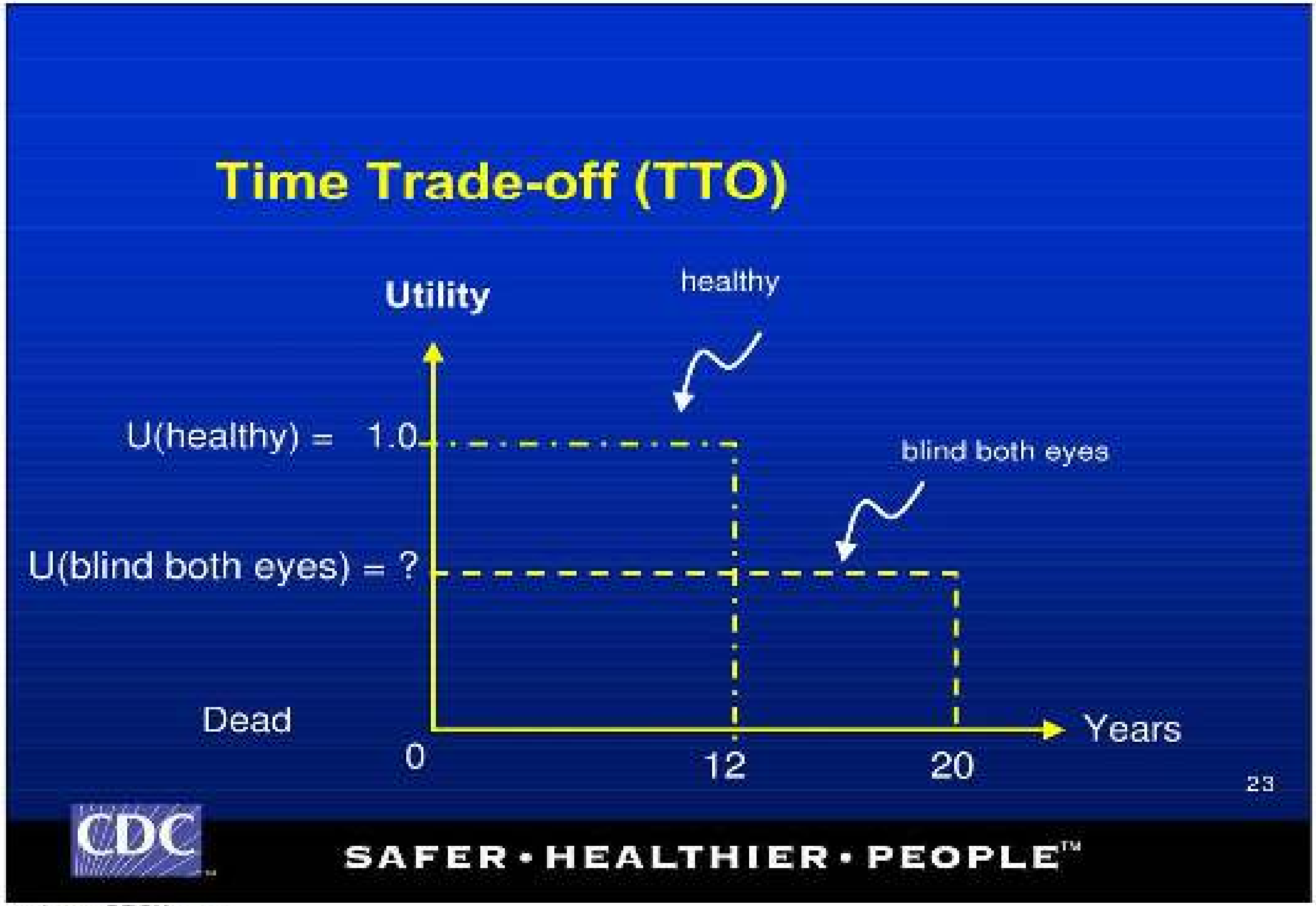
TIME-TRADE OFF (TTO)

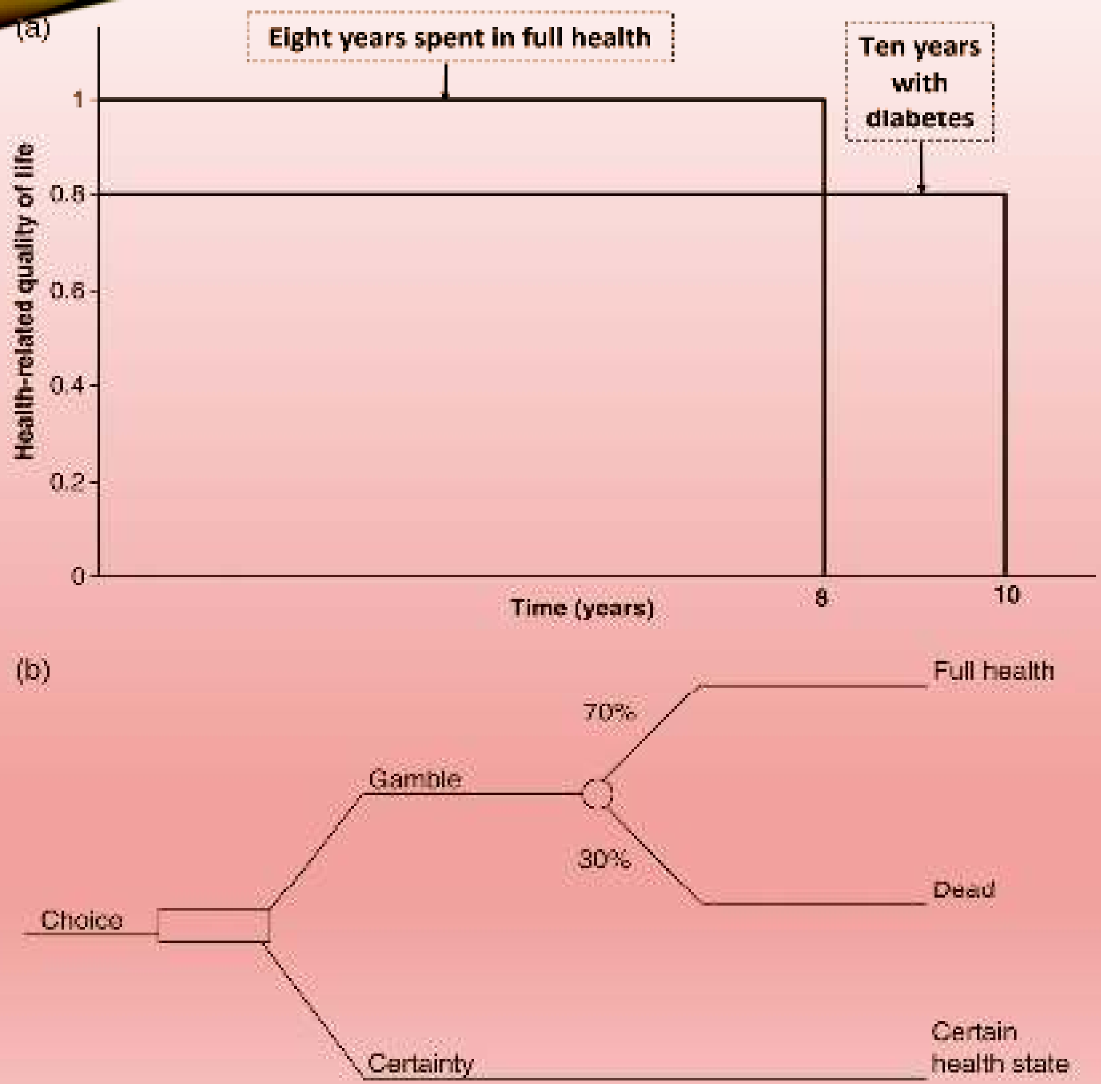
- Utility measure developed specifically for health care
- Involves respondents selecting between known choices (no uncertainty)
- Scale is anchored by death and perfect health
- (TTO) is a tool used in health economics to help determine the quality of life of a patient or group. The individual will be presented with a set of directions such as: Imagine that you are told that you have 10 years left to live

TIME-TRADE OFF



- Time trade-off for a chronic health state. $h_i = x/t$, where h_i = preference value for state *i*; state *i* = chronic health state; t = life expectancy for an individual with chronic health state *i*; and x = time at which respondent is indifferent between alternatives 1 and 2.


Time Trade-off (TTO)
Utility
healthy
U(healthy) = 1.0
blind both eyes
U(blind both eyes) = ?
Dead
0
12
20
Years
23
CDC
SAFER • HEALTHIER • PEOPLE™


(a)
Eight years spent in full health
Ten years with diabetes
Health-related quality of life
1
0.8
0.6
0.4
0.2
0
Time (years)
8
10
(b)
Full health
70%
Gamble
30%
Dead
Choice
Certainty
Certain health state

DECISION ANALYTIC MODELING

- A technique used to evaluate competing decisions
- Can focus on cost, outcomes or both
- Uses a "decision tree" to help determine the best selection

ELEMENTS OF A DECISION TREE

- Event branches
- Nodes
  - Decision □
  - Chance (event) ○
  - Terminal ◄
- Probabilities
- Rollback values

DECISION TREE BRANCHES

- Represent alternative paths and events (either chosen or based on probabilities) that may occur

DECISION TREE NODES

- Decision – represents a point where a choice of alternatives can be made
- Chance – represents a point where potential events can occur (based on probabilities)
- Terminal – represents a point where the end results (payoffs) of a particular pathway are calculated

BUILDING A DECISION TREE MODEL

- Identify the problem
- Structure the tree
- Gather data to populate the tree
- Analyze the tree
- Conduct sensitivity analysis

IDENTIFY THE PROBLEM

- What is the question you are trying to answer?
  - Which long-acting insulin is most cost-effective?
- What decision must be made?
  - Treat with NPH or Insulin glargine
- What events follow the decision?
  - Glucose control
  - Adverse events
  - Adjust or change drug

CLINICAL SCENARIO

- Type 1 Diabetes Mellitus
  - New diagnosis
    - Begin basal insulin therapy
- Type 2 Diabetes Mellitus
  - Pt is not well-controlled on oral antidiabetic agents.
    - Option 1: Stop oral meds and begin insulin
    - Option 2: Cont oral meds and begin insulin

LONG ACTING INSULIN ALTERNATIVES

- NPH (neutral protamine Hagedorn)
  - Novolin*
  - Humulin
- Mixed NPH and regular/short acting
- Glargine (Lantus)

NPH INSULIN

- Advantages
  - Least expensive
  - Pre-filled devices available
- Disadvantages
  - Greater frequency of nocturnal hypoglycemia
  - Increased immunogenicity
  - More weight gain
  - Lower glycemic control
  - Reduced patient satisfaction
  - Duration of action 18-24 hours

GLARGINE INSULIN

- Advantages
  - Duration of action 24 hours, so no peak effect
  - Once daily dosing
  - Reduced frequency of nocturnal hypoglycemia
  - Type I
    - Greater reduction in fasting blood or plasma glucose levels
    - Improved patient satisfaction
  - Type 2
    - Improved HgA1c values
- Disadvantages
  - Most expensive

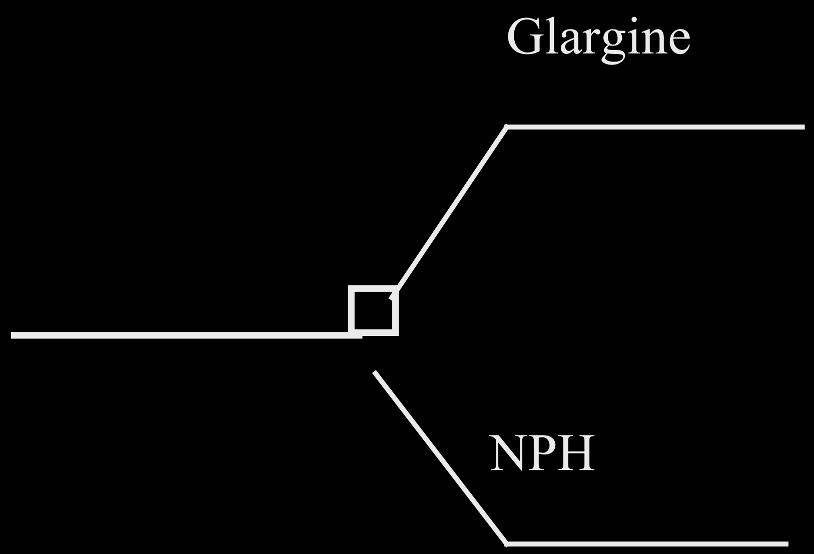
AVG COST (10ML VIAL) IN DOD
ASSUME: DEC 03 – NOV 04

- NPH (neutral protamine Hagedorn)
  - Novolin $4.50
  - Humulin
- Mixed NPH and regular/short acting
  - Approximately $15.00
- Glargine (Lantus)
  - $26.11

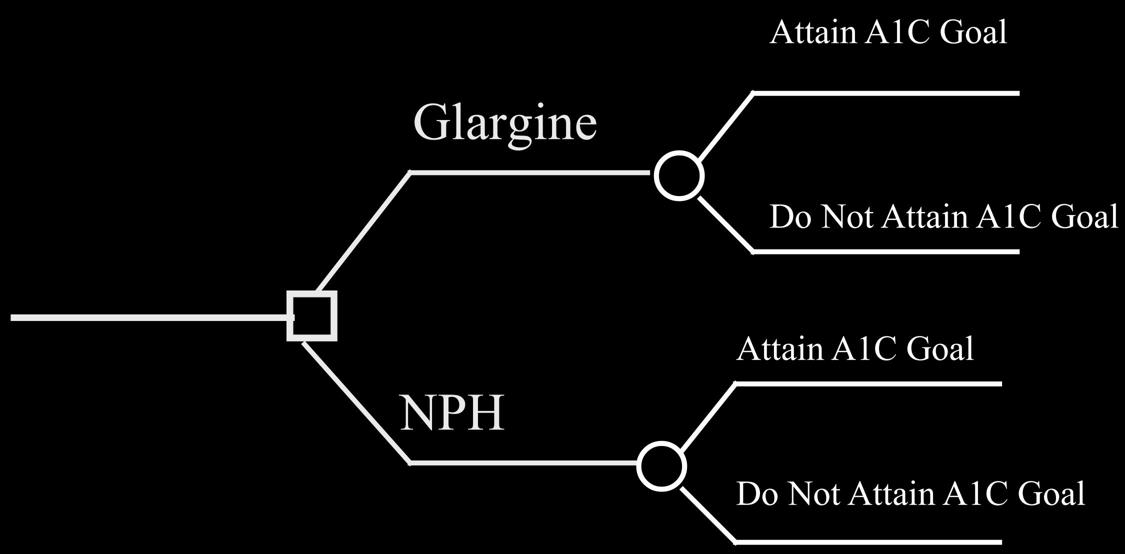
STRUCTURE THE DECISION TREE

- Depicts the components of the problem graphically
- Build tree left to right
  - Nodes and branches

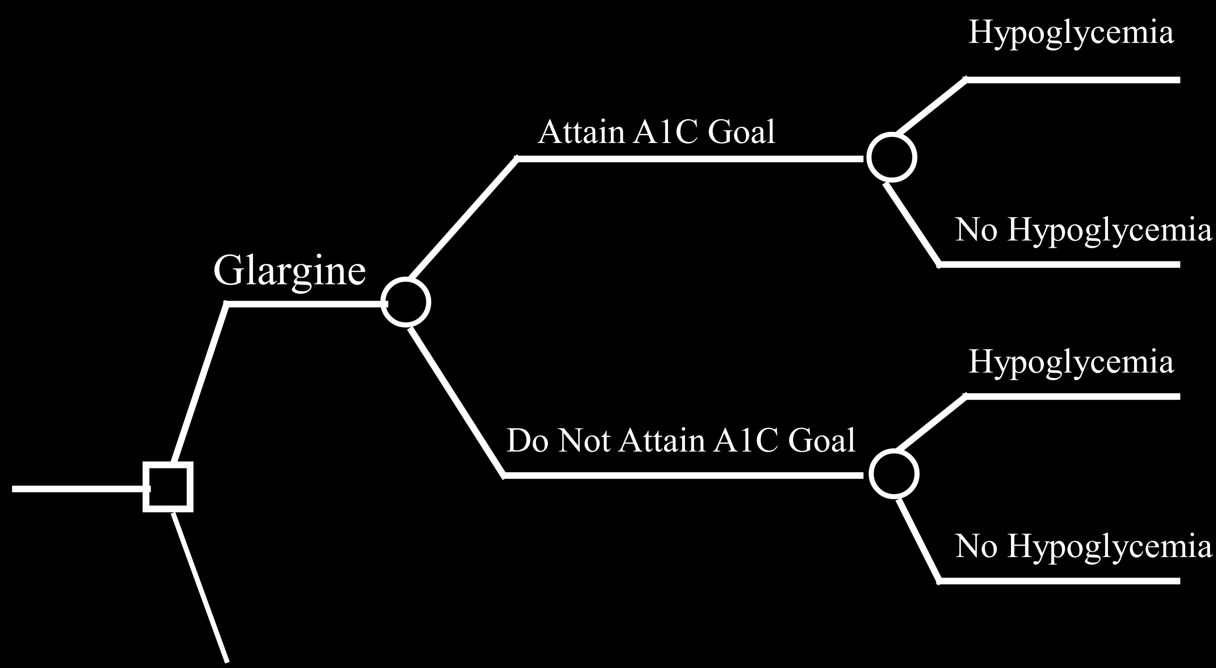
WHAT ARE OUR CHOICES



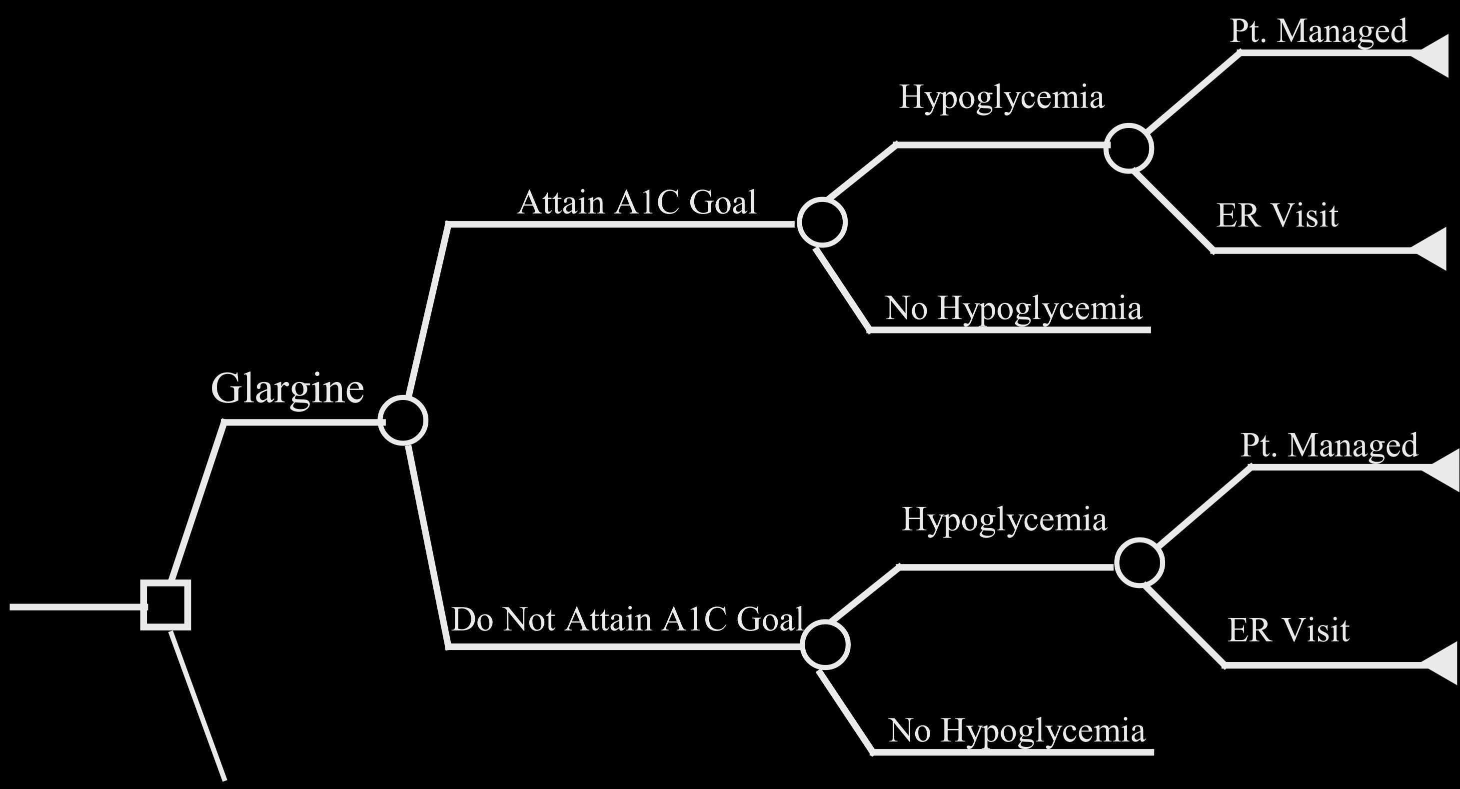
What Events Will Follow Our Choices



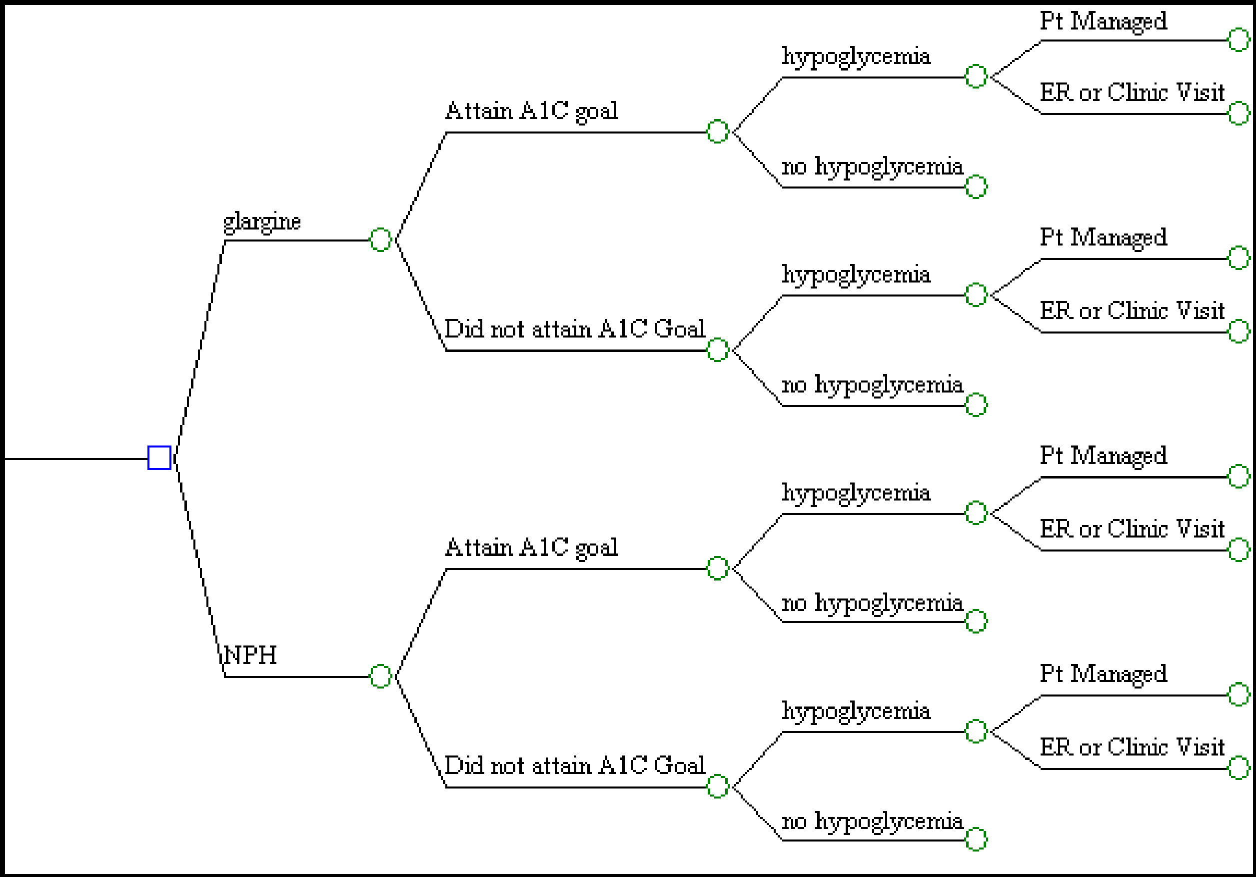
WHAT EVENTS WILL FOLLOW OUR CHOICES



What Events Will Follow Our Choices



The Complete Decision Tree



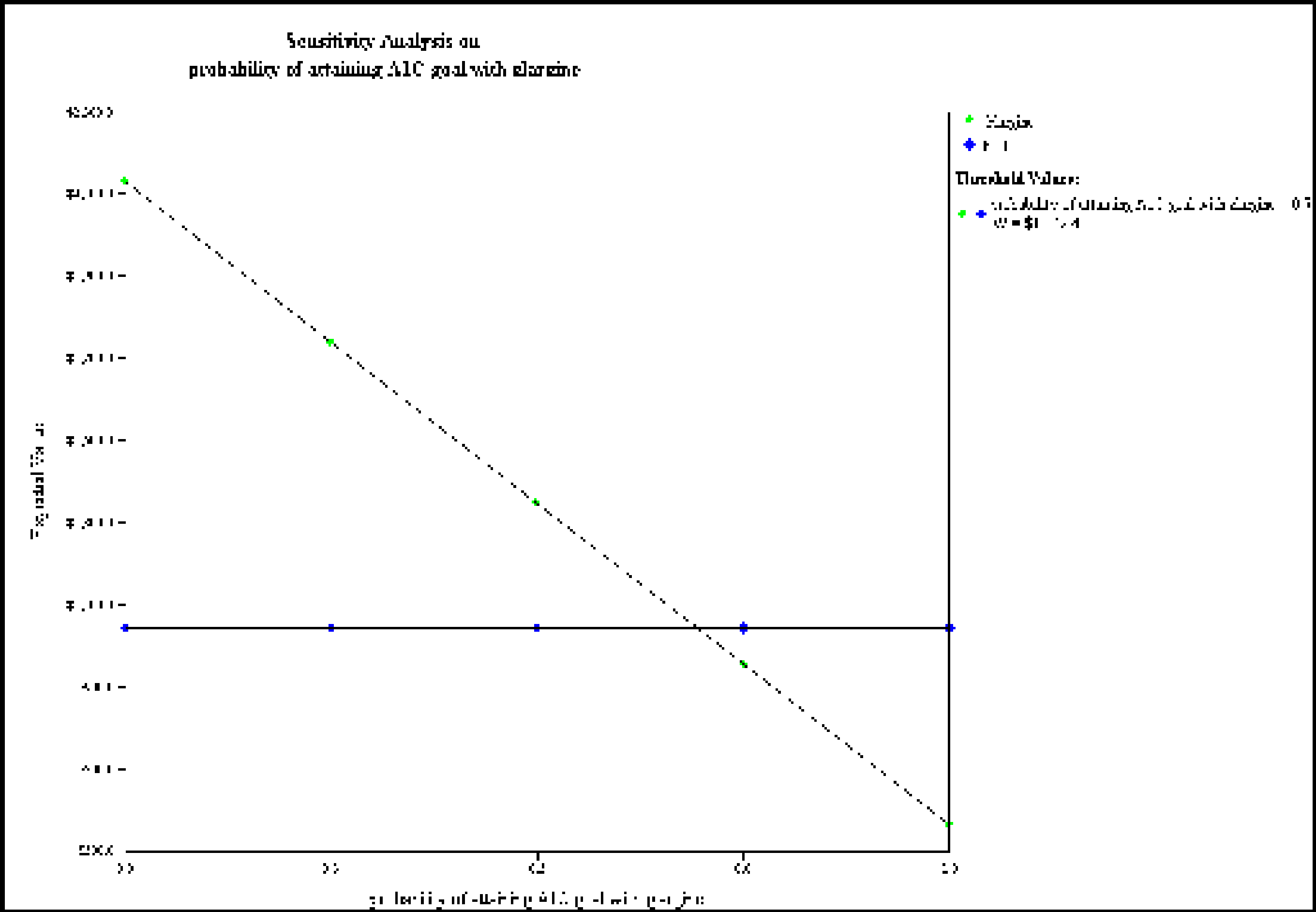
Conduct Sensitivity Analysis

- Done to "debug" the tree
- Done to check whether changes in parameters influence model's results

Sensitivity Analysis

- Perform one-way sensitivity analyses on all parameters to debug tree
- Vary probabilities from 0 to 1; response to changes should be logical
- Set all cost/outcomes equal to zero; strategies should have same expected value

Sensitivity Analysis: Varying the probability of attaining A1C Goal with Glargine



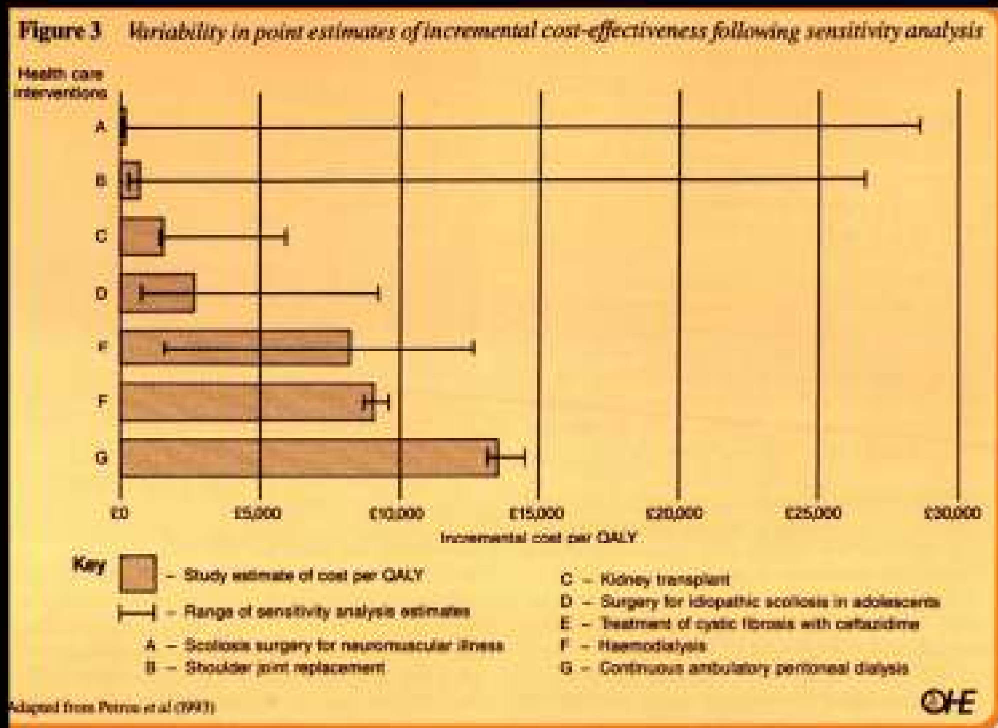


Figure 3 Variability in point estimates of incremental cost-effectiveness following sensitivity analysis
Health care interventions
A
B
C
D
E
F
G
£0
£5,000
£10,000
£15,000
£20,000
£25,000
£30,000
Incremental cost per QALY
Key
– Study estimate of cost per QALY
– Range of sensitivity analysis estimates
A – Scoliosis surgery for neuromuscular illness
B – Shoulder joint replacement
C – Kidney transplant
D – Surgery for idiopathic scoliosis in adolescents
E – Treatment of cystic fibrosis with ceftazidime
F – Haemodialysis
G – Continuous ambulatory peritoneal dialysis
Adapted from Petrou et al (1993)
OHE

GATHER DATA TO POPULATE THE TREE

- Literature review
  - Estimates from clinical trials (e.g. efficacy, adverse events)
- Expert Opinion
  - Good where no clinical trial data exists or for specifics like system costs
- Database studies
  - Good for “real-world” event probabilities, cost identification

DATA NEEDED FOR THIS MODEL

- Probabilities
  - Probability of attaining A1C target
  - Probability of having hypoglycemic event
  - Probability that patient manages hypoglycemia
  - Probability that hypoglycemia requires medical intervention
- Payoffs
  - Cost of treatment with NPH
  - Cost of treatment with glargine
  - Cost of complications if A1C goal not reached
  - Cost of medical intervention if hypoglycemia severe

Data Estimates for Model

Variable	Point Estimates	
	NPH	Glargine
Probability of attaining A1C goal*	0.439	0.579
Probability of hypoglycemia*	0.382	0.165
Probability hypoglycemia managed by patient†	0.95	0.95
Cost of 3 years insulin treatment	$162	$564
Cost of complications if A1C goal not attained §	$1565	$1565
Cost of medical intervention if hypoglycemic requiring treatment †	$125	$125

Analyze the Tree

- Done by "rolling back" the tree to get "expected values"
- Start at terminal node and multiply probabilities as you trace tree to origin to get probability of outcome
- Sum weighted outcomes for each potential path

Rolled-Back Decision Tree