# The Origin of HTA

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- *Technology:* an existing, new or emerging device, pharmaceutical, procedure or protocol.
- *Technology assessment:* the practical process of forming an advisory committee to determine effectiveness, outcome, risk and strategic planning
- T*echnology Planning:* the systematic method of determining the hospital's technology needs and setting short and long term priorities
- *Technology acquisition:* the process of determining which manufacturer provides the best equipment and support
- *Technology management:* the process of ensuring that the technology is well used and supported

# Technology Assessment

- Involve physicians
- Detailed financial analysis and other considerations
- Consider replacement proposals
  - Safety
  - Standard of care
  - Age
- Develop strategic plans

# Technology Planning

- Audit existing technology
  - Review
  - Condition, capability, history
  - Statistics
  - Incident reports
- Evaluate other hospitals' technology
- Review technology trends
- Develop a long term plan

# Technology Acquisition and Management

- Large purchases can be phased over several years
- Budget plans are submitted to cover training, spare parts, service, support and upgrades.
- Support costs, less expensive alternatives, insurance, in-house support or service contracts
- Cost savings of around 10-30%.

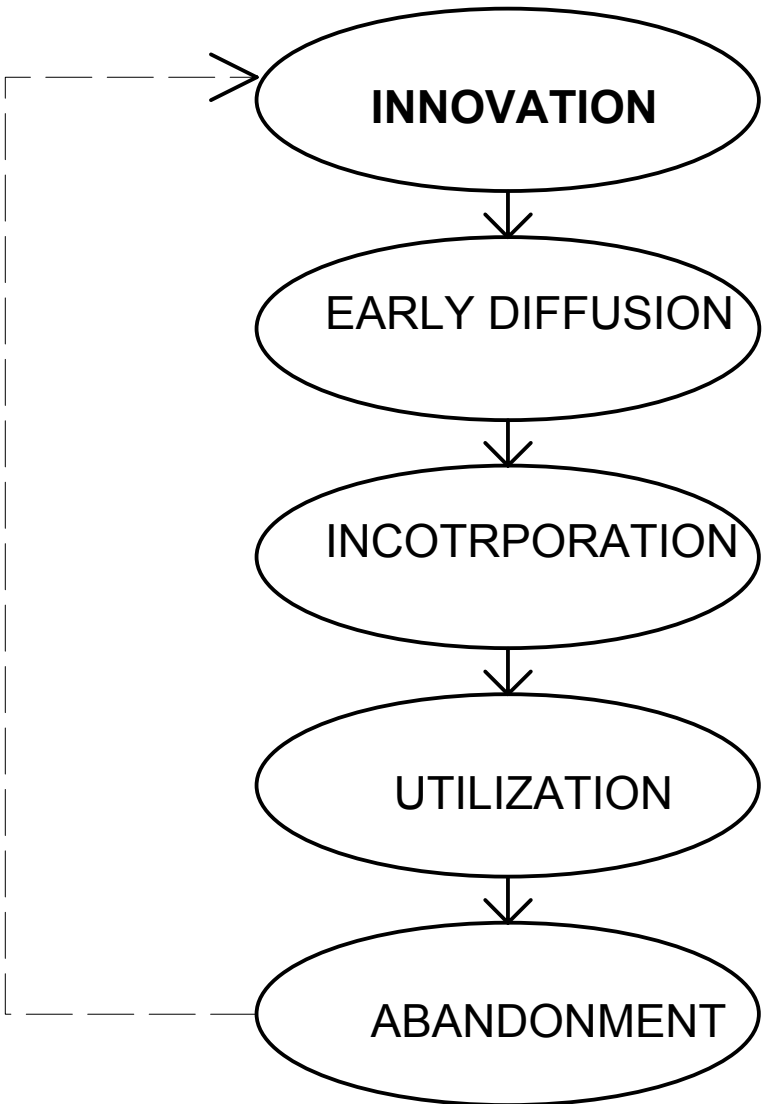
# Regional considerations

- Distribute technology more rationally
- Maximise patient convenience
- Enhance reputation of local hospitals

# Regional Considerations; Strategies

- Telemedicine systems
- Clinical practice guidelines
- Mobile services

# The life cycle of healthcare technology



# Cost-effectiveness (CE)

| | Benefit increase | Benefit decrease |
|---|---|---|
| Costs increase | CE analysis | do not adopt |
| Costs decrease | Adopt | CE analysis |

Utilities are measured in units such as QALY (quality-adjusted life years).

# Cost-effectiveness (CE) and cost-benefit (CB) analysis

$$\frac{\text{Added benefits}}{\text{Added cost}} \geq g \quad \text{or} \quad \frac{B_n - B_e}{C_n - C_e} \geq g$$

g: acceptable cut-off

- In CB analysis benefits as well as costs are measured in terms of monetary units
- Most clinicians feel uncomfortable or find it unethical to place a value on human life

# *Example*

A health district carries out smear tests on women between the ages (20 - 45) on 5 yearly basis. New evidence suggests that carrying out the tests on a 3-yearly basis increases benefit. Suppose the cost of a stool test per QALY is £500,000 whilst the same for a smear test is £20,000. The same district might decide to shift resources of £1m from the former to the latter thus gaining 48 QALYs. This can not be repeated indefinitely however due to the following factors:

- Carrying out smears in less susceptible population might increase its cost per QALY.
- Increasing the frequency of smears in the same population might increase its cost per QALY.
- At some point, stool tests will become as cost-effective as smear tests as its intensity of use falls.
- Changes in technology might reduce cost per QALY for either test.

# Cost Analysis Viewpoint

- Costs from a hospital viewpoint could be seen as benefits from a patient or society's viewpoint and vice versa e.g. patient travel costs, loss in earning due to sickness, etc.
- It might not always be easy to consider all costs especially costs which are not reflected in market prices such as volunteer time, patients leisure time, donated clinic space, etc.
- Sources of cost estimation can be collected from clinical trial forms, patient's notes, hospital records, patient diaries or questionnaires.

# Time Period of Cost Analysis

- Angeoplasty v coronary artery bypass surgery costs
  - Short term study has shown that the latter costs more than twice the former.
  - A 24 month randomised control trial showed that the two procedures were almost identical in costs since more patients from the angeoplasty group may require additional treatment including bypass surgery.

# Related Costs

- The costs of treatment of a disease are closely linked with the costs of the screening programme.
- Capital costs, such as the purchase of equipment, building or land
- Opportunity cost
- Depreciation

$$E = K (1 + r)^{-n} - S$$

- 'annuity factor' $(1+r)^{-n}$

# Average v Marginal Costs

AC = TC/Q and

MC = d(TC)/dQ

- The extra cost of keeping a patient in hospital for another day at the end of their treatment might be less than the average daily cost for the whole stay.

# Overhead Costs

- Shared resources across many departments, e.g. general administration, laundry, cleaning, porters, power, etc.
- Marginal cost analysis are employed
- The quantities of service consumed by the patient (days of stay, number of laboratory tests, number of procedures, etc. ) are multiplied by the full cost (including overhead, capital, etc.) per unit and sum up the results.
- Alternatively, assume all patients cost the same amount in items related to 'hotel services'

# Cost Utility (CU) Analysis

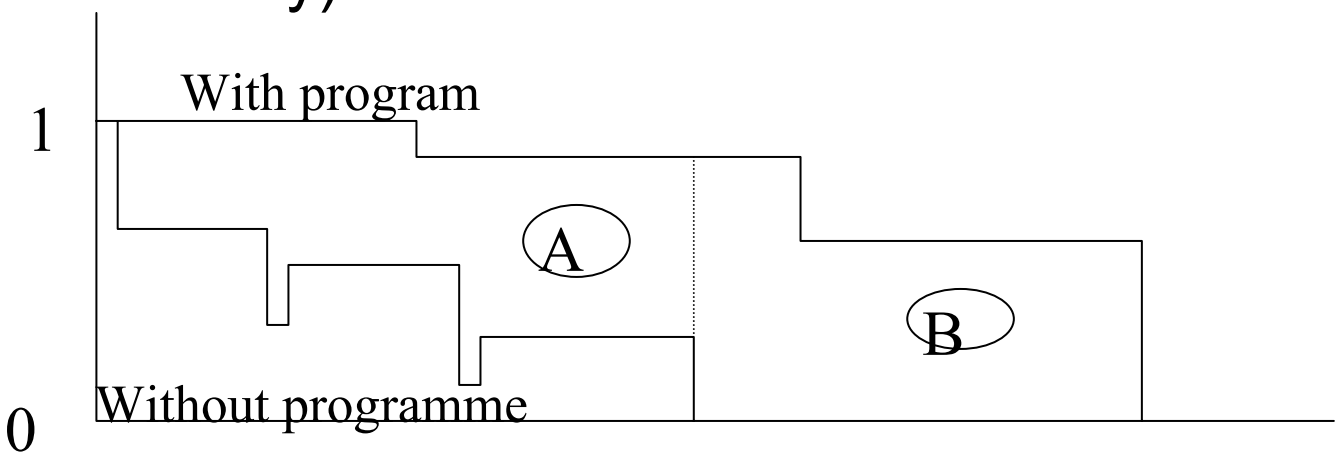
- When health related quality of life is *the* important outcome.
- When health related quality of life is an important outcome
- When the programme affects both morbidity and mortality and you wish to have a common unit of outcome.
- When comparing different programmes with different outcomes that are all applying for funding.
- When comparing a new programme to established ones

# Differences between CE and CB analysis

- **Reporting style**
  - CB calculates the net benefits
  - CE calculates the *price* of a QALY
- **Aggregation**
  - CE are on individual basis
  - CB applies to larger groups with the use of "weights”
- **Multiple dimensioned benefits**
  - CB combining benefits into one dimension (usually pounds)
  - CE use relative weights (a day in a hospital bed versus a healthy day)

# Quality Adjusted Life Years (QALY)

- The area between the 2 curves is the QALY gained by the intervention.
- Part A is the amount of QALY gained due to quality improvement (reduced morbidity) and part B is the same amount due to quantity improvement (reduced mortality).



# Quality Adjusted Life Years (QALY)

QALY = 1.06(b1 x b2 x b3 x b4 x b5 x b6 x b7) - 0.06

$$Q \times (1 + r)^{-n}$$

year n - discount r

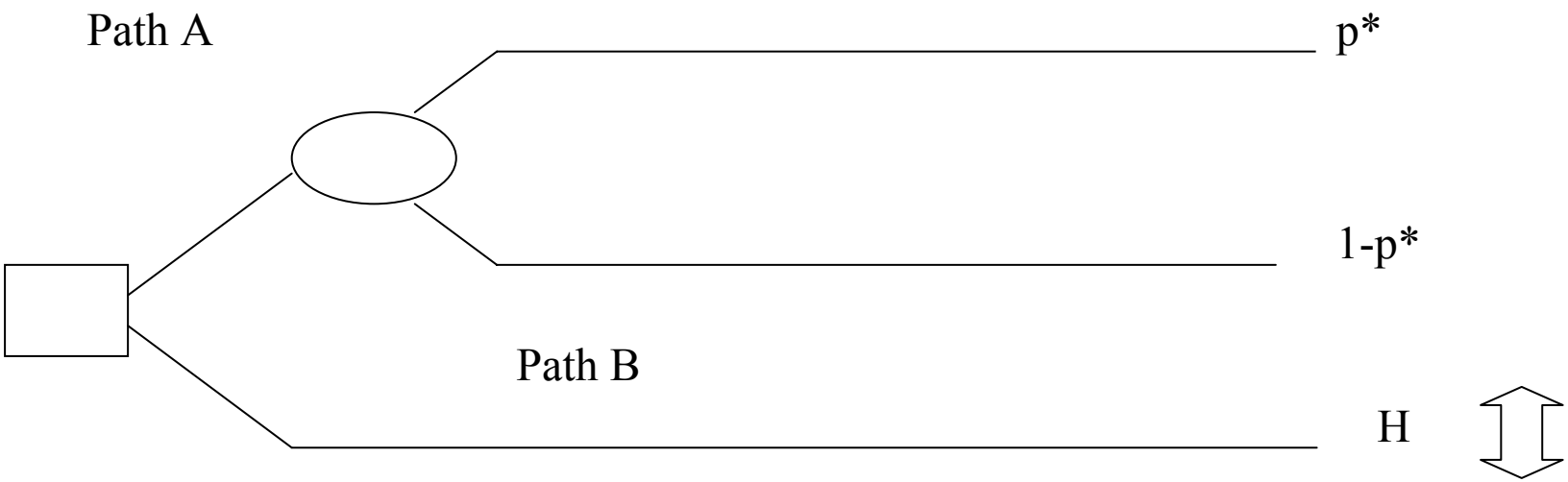
Total amount of QALYs gained is:

$$Q \times \sum_{x=0}^{n-1} (1 + r)^{-x}$$

# Healthy Years Equivalent (HYE) - Stage 1


- Path B: living with a condition (x) for (n) years.
- Path A: perfect health for (n) years with probability p, immediate death with probability (1-p).
- Vary (p) until path B is the preferred option. Fix (p) as (p*)

# Healthy Years Equivalent (HYE) - Stage 2

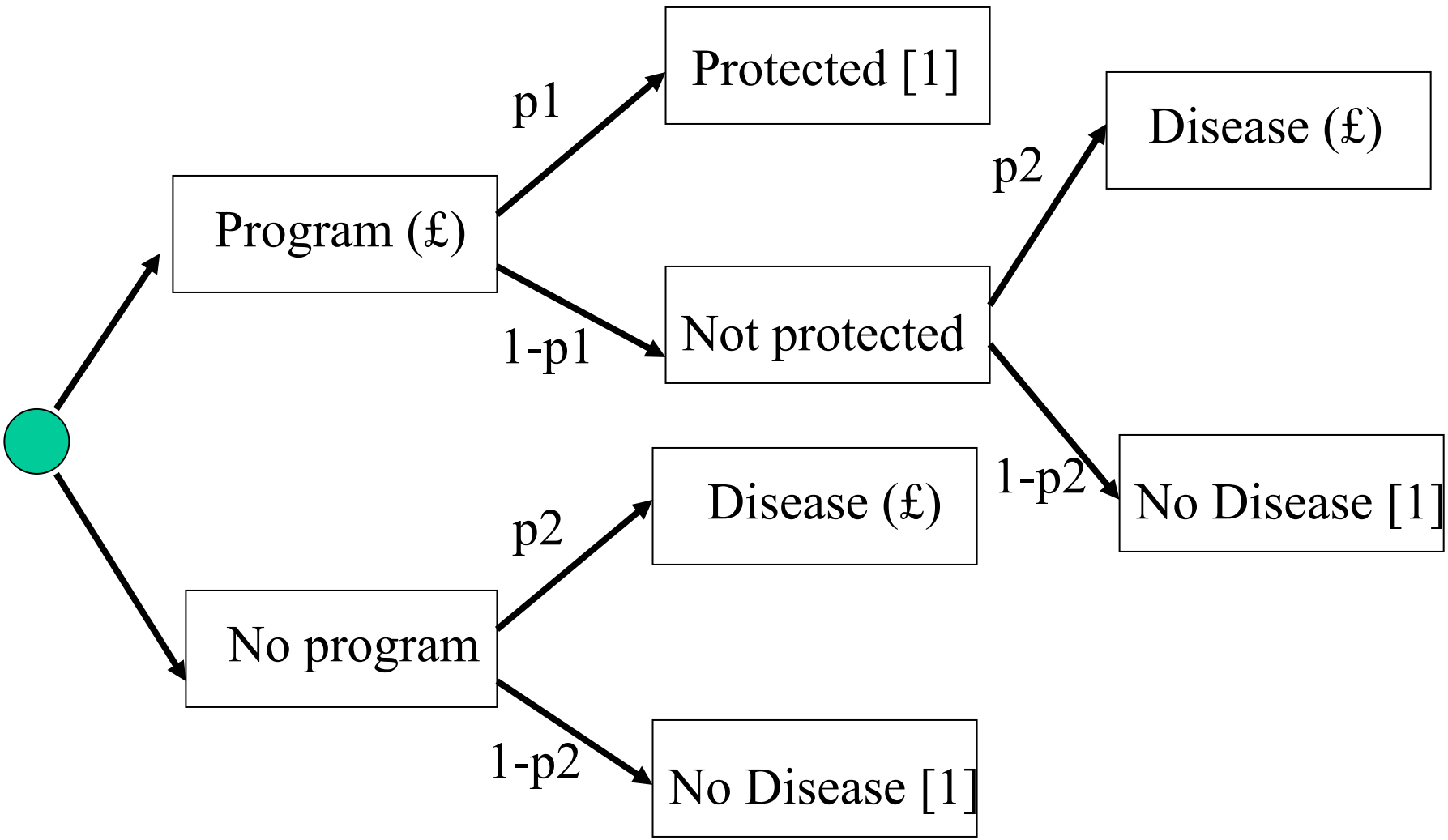



- Path B: perfect health for (H) years
- Vary (H) until path B is the preferred option.
- (H) is the HYE for condition (x)

# Willingness to Pay (WTP)

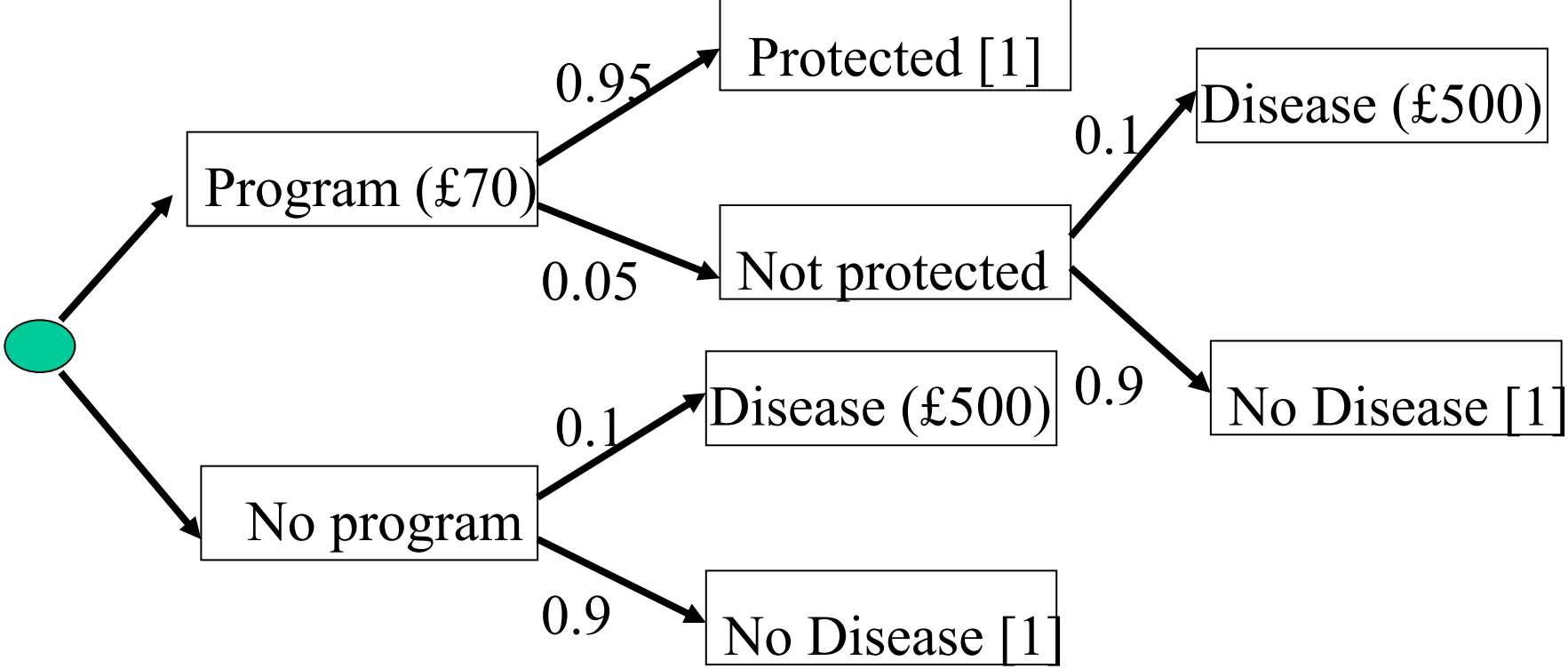
- Valuing a certain health outcome.
- Valuing a treatment with uncertain outcome.
- Valuing access to a treatment programme.

# Decision Trees



# Decision Trees

- $U_E = \Sigma P_i.U_i$
- $C_E = \Sigma P_i.C_i$
- Cost effectiveness = $U_E / C_E$




$U_E$(No Program) = 0.9

$U_E$(Program) = 0.95 + {0.9*0.05} = 0.995 (0.095 gain)_

$C_E$(No Program) = 500*0.1 = £50

$C_E$(Program) = 70 + {500*(0.1*0.05)} = £72.5 (£22.5 loss)

# Bayes' Rule

$$p(d \mid s) = \frac{p(d).p(s \mid d)}{p(s)}$$

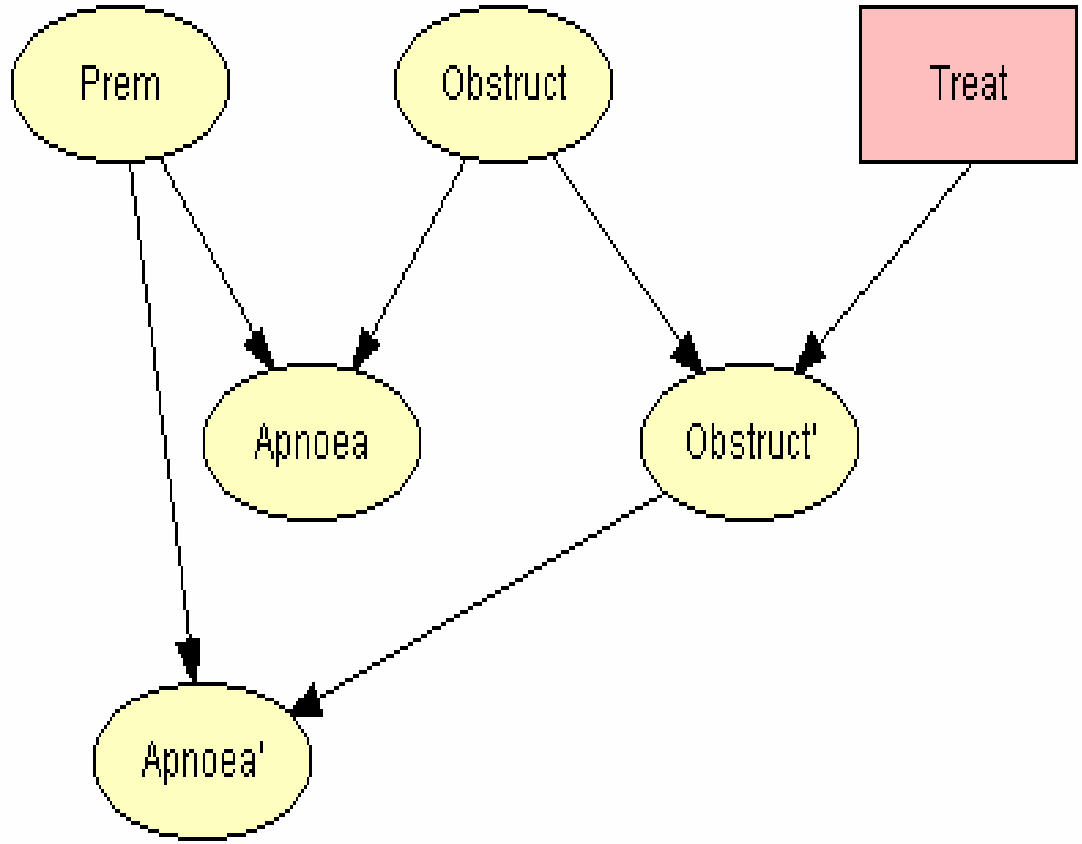
p(d|s): Probability of disease given symptom
p(d): Probability of disease
p(s|d): Probability of symptom given disease
p(s): Probability of Symptom

# Bayes' Decision Theory

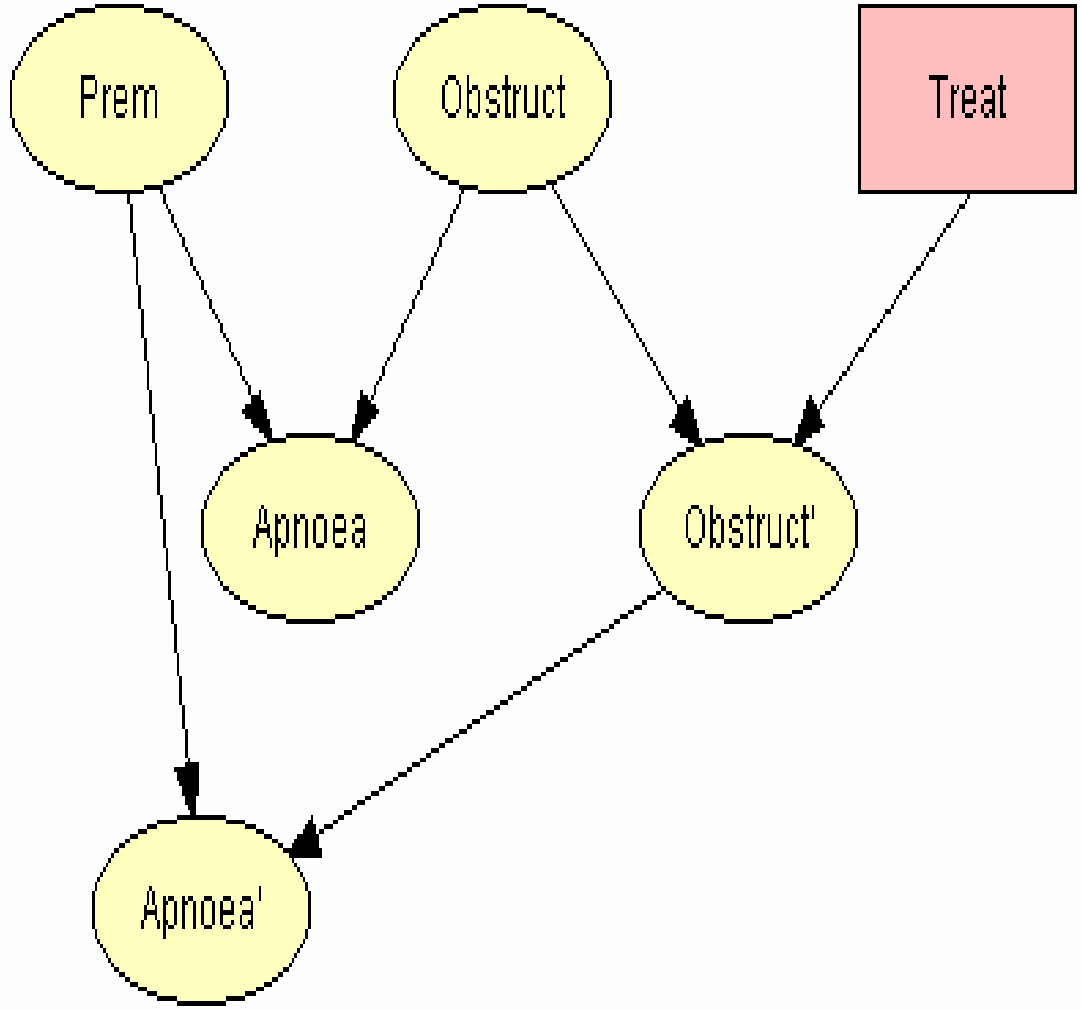
- P(error | s) = p(d | s) if we decide $\bar{d}$
  = p($\bar{d}$ | s) if we decide d

- decide d if p(d | s) > p($\bar{d}$ | s) and *vice versa*

Apnoea (Apnoea)
0.1832 Yes
0.8168 No
Apnoea' (Newap)
0.099682 Yes
0.900318 No
Obstruct (Obstruct)
0.1 Yes
0.9 No
Obstruct' (newobs)
0.102 Yes
0.898 No
Prem (Prem)
0.1 Yes
0.9 No
Treat (Treat)
0 Yes
0 No



Apnoea (Apnoea)
1 Yes
- No
Apnoea' (Newap)
0.255116 Yes
0.744884 No
Obstruct (Obstruct)
Obstruct' (newobs)
Prem (Prem)
1 Yes
- No
Treat (Treat)
0 Yes
*0 No



Apnoea (Apnoea)

1 Yes

- No

Apnoea' (Newap)

0.86 Yes

0.14 No

Obstruct (Obstruct)

1 Yes

- No

Obstruct' (newobs)

Prem (Prem)

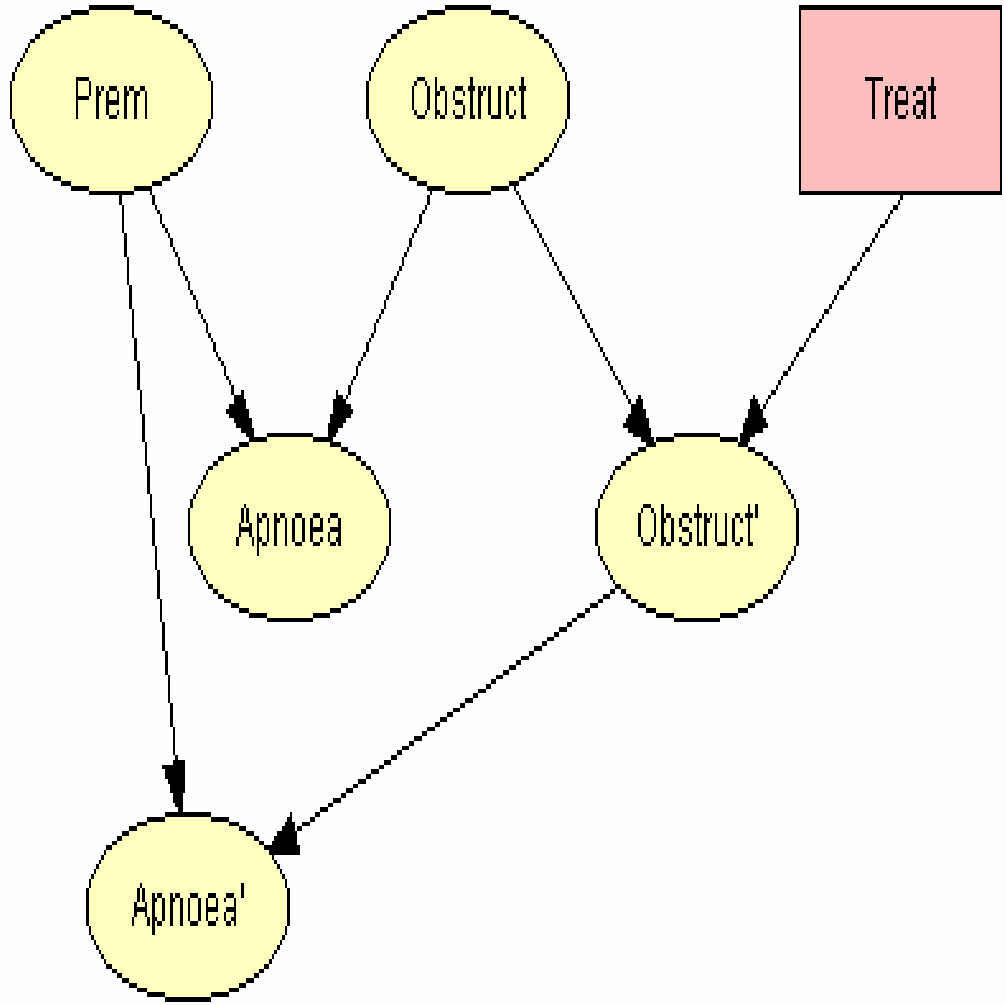
1 Yes

- No

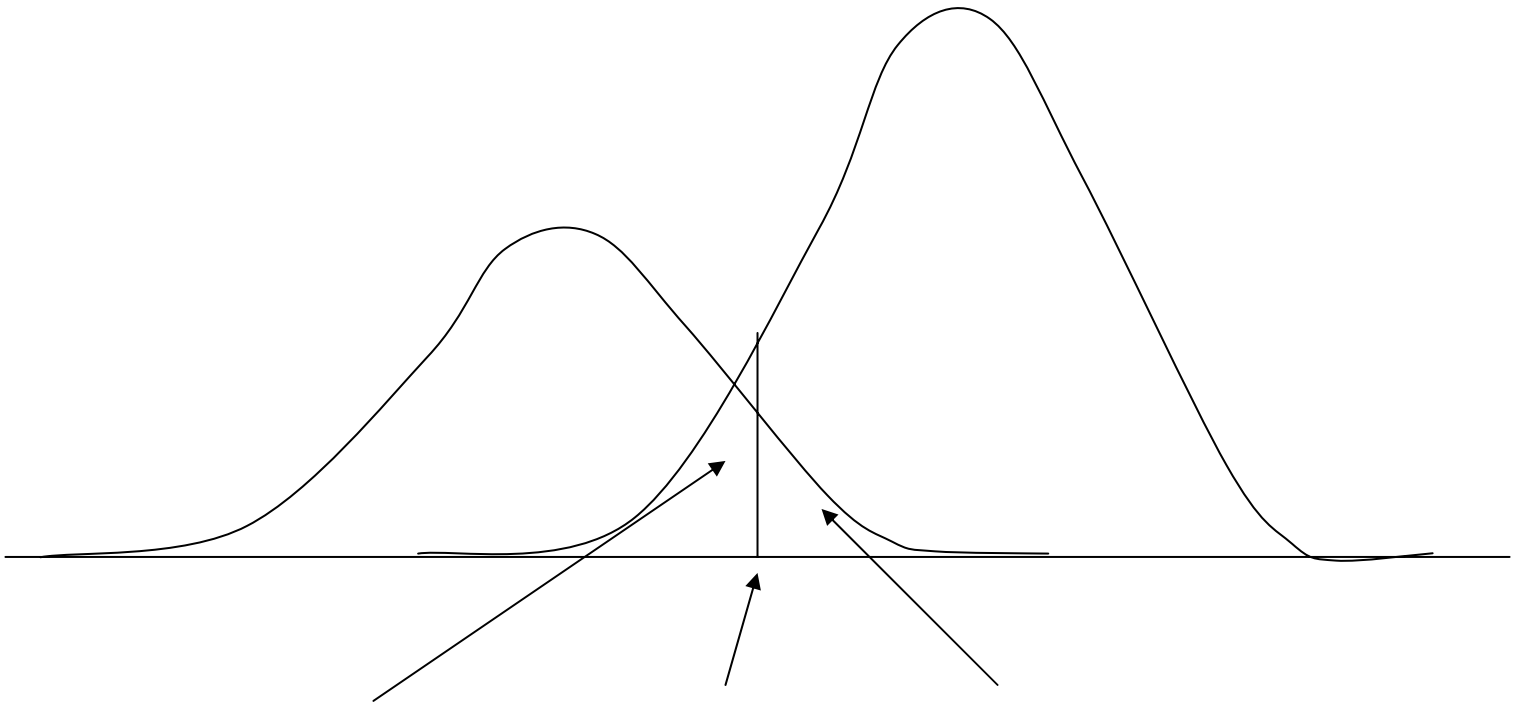
Treat (Treat)

0 Yes

*0 No



# Risk Analysis

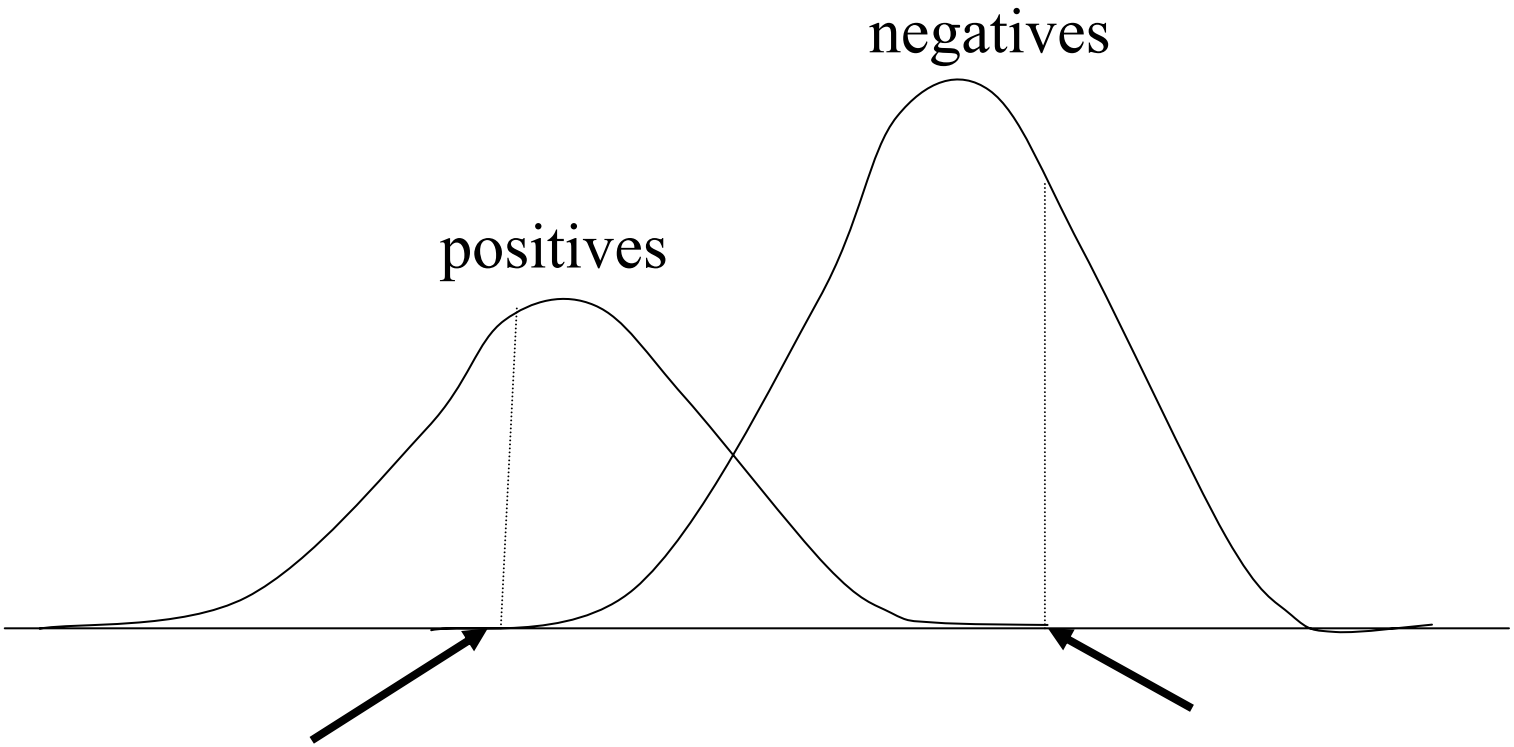


Decision line D

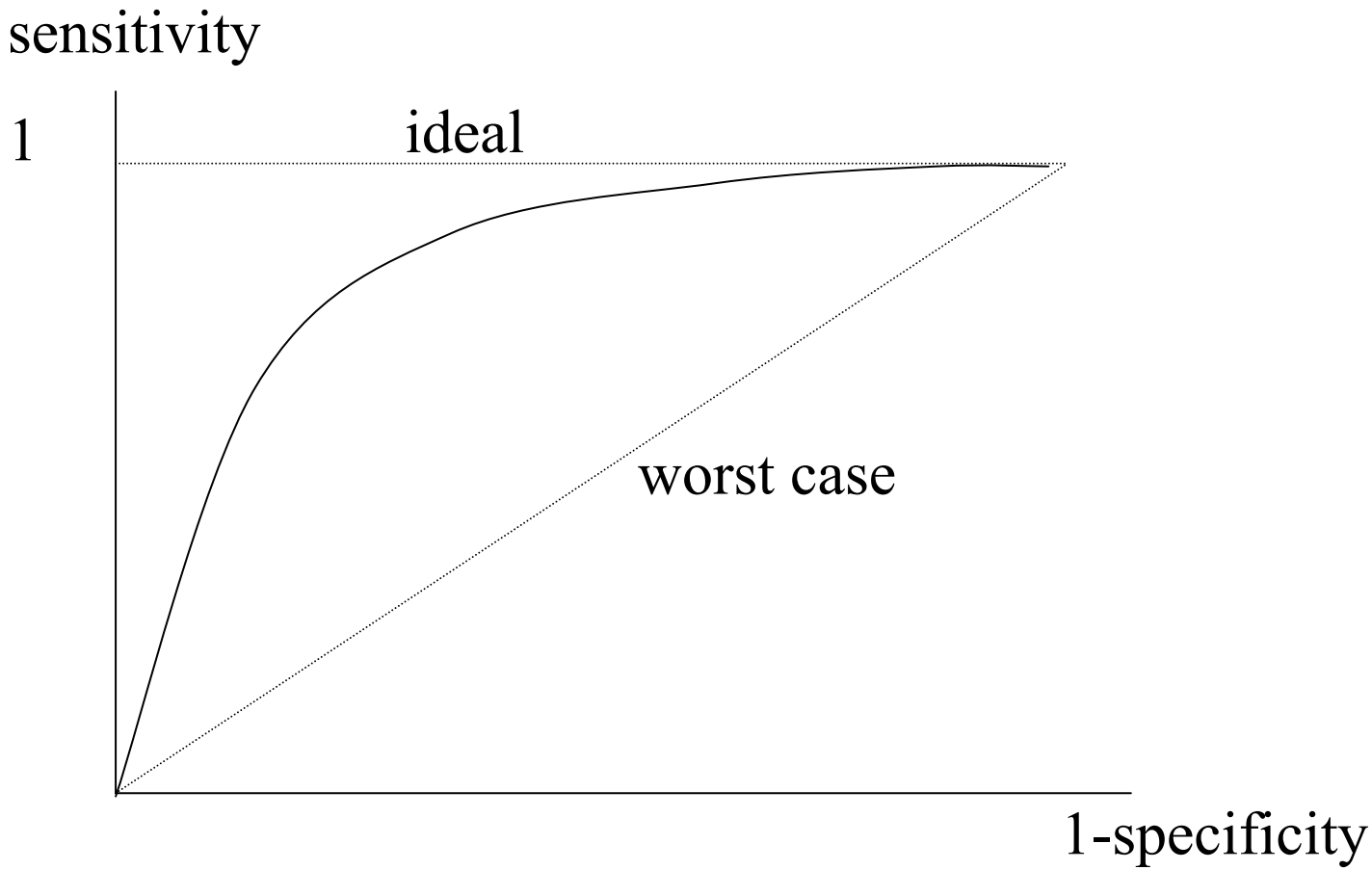
$$\int_{-\infty}^{D} p(s \mid \bar{d}).p(\bar{d})$$

$$\int_{D}^{\infty} p(s \mid d).p(d)$$

$$Sensitivity = \frac{TP}{TP + FN} \qquad Specificity = \frac{TN}{TN + FP}$$



# ROC Analysis



# Assessment of Antenatal Screening

# Glossary

- Cut-off Level: Value of screening variable distinguishing positives from negatives.
- DR: Detection Rate (sensitivity).
- FPR: False-Positive Rate (specificity).
- MoM: Multiple of Median:

Serum marker concentration for a woman / median concentration for unaffected pregnancies with same GA

- Risk: Expressed in two ways:
  - 1:3 One affected for every 3 unaffected
  - 1:4 One affected in every 4 pregnancies.

# Background

- Extra chromosome 21 (1959)
- Cut-off age between 35-37 years
- Amniocentesis carried out at weeks 16-18 of pregnancy
- Amniocentesis offered to oldest 5% gives DR of 30% (1968)
- Low AFP: maternal serum $\alpha$-fetoprotein (1983)
- Combining maternal age and AFP yielded DR of 35% and FPR of 5%
- Human chorionic gonadotrophin (hCG) and unconjugated oestriol (uE3) (1987)
- Performed between weeks 15-22 it could identify DR of about 60% of with a 5% FPR
- Ultrasound screening (1992)

# Factors affecting serum marker levels

- Gestation age
- Weight
- Insulin-dependent diabetes
- Twin pregnancies
- Ethnic origin
- Smoking
- Previous pregnancies
- Recurrence risk
- Repeat testing
- Screen positives from previous pregnancies
- Assisted reproduction

# Two-step screening: rescreen positives

- Women above 30 - serum test
- Overall DR of 46%
- FPR: 2.7% for two step vs 1% for 1 step equivalent

# Problems with current screening practice in the UK

- Inconsistency
- Lack of access
- Stepwise screening
- Problems with ultrasound
- Staff training
- Organisation

# Recommendations

- Organisation
  - Screening centres
  - National network
  - Budget
  - Agreed criteria
- Equal access
- Avoidance of multistep screening
- Screening policy
- Education and training
- Further research

# Assignment

Assess the use of one of these technologies:

- Dialysis therapy
- Mammography
- Bone density measurement

1000-word essay

- Usefulness
- CE analysis
- CB analysis
- Clinical audit data
- Statistical analysis
- Alternative technologies in the third world