Public Health Approaches to Cost-effectiveness analysis: Lecture 1: Introduction and cost valuation

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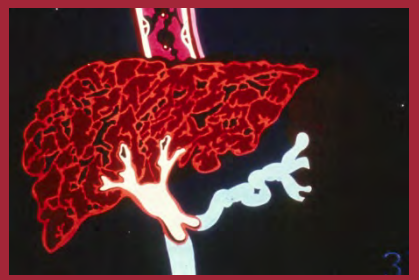


Part 1: Introduction

Important textbooks / guidelines

- Drummond MF et al. Methods for the economic evaluation of health care programmes. 3rd Ed. Oxford Univ Press 2005
- Drummond M and McGuire A. Economic evaluation in health Care. Oxford Univ Press 2001
- Pettiti DB. Meta-analysis, decision making and cost-effectiveness analysis. 2nd Ed. Oxford Univ Press 2000
- Gold MA et al. Cost-effectiveness in health and medicine. Oxford Univ Press 1996
- Tan-Torres Edejer et al. WHO guide to cost-effectiveness analysis. WHO 2003 (http://www.who.int/choice/publications/p_2003_generalised_cea.pdf)
- CADTH. Guidelines for the economical evaluation of health technologies: Canada. http://www.cadth.ca/media/pdf/186_EconomicGuidelines_e.pdf

Welfare Economics

- Individuals maximize utility
- Societal welfare
    - Aggregation of utility across all individuals
- When governments take a societal decision aimed at maximizing societal welfare
- Pareto optimality
  - Pareto improvement
    - Re-allocation of resources increases the utility of all individuals in the society
  - Pareto efficiency
    - Re-allocation results in at least one individual made better and no individual made worse

Purpose of economic analyses

- "Identify, measure, value and compare the costs and consequences of alternatives being considered."
  - Consequences can be different things, often health status
  - Consequences may combine several health outcomes / animal species / environmental impacts
  - The goal is to re-allocate resources to maximize costs vs consequences (ie costs relatively less or improve consequence relatively more)

Economic analyses help decision making

- How much does it cost?
  - What resources?
    - Physical
    - Personnel
  - Whose Budget?
    - National
    - State
    - Local
    - Clinic
    - Individuals
    - Health or agriculture or environment?
- What are the gains?
  - Resources / Capital
    - Personnel
    - Physical
  - Health (↓burden)
    - Mental, physical, social
  - Monetary

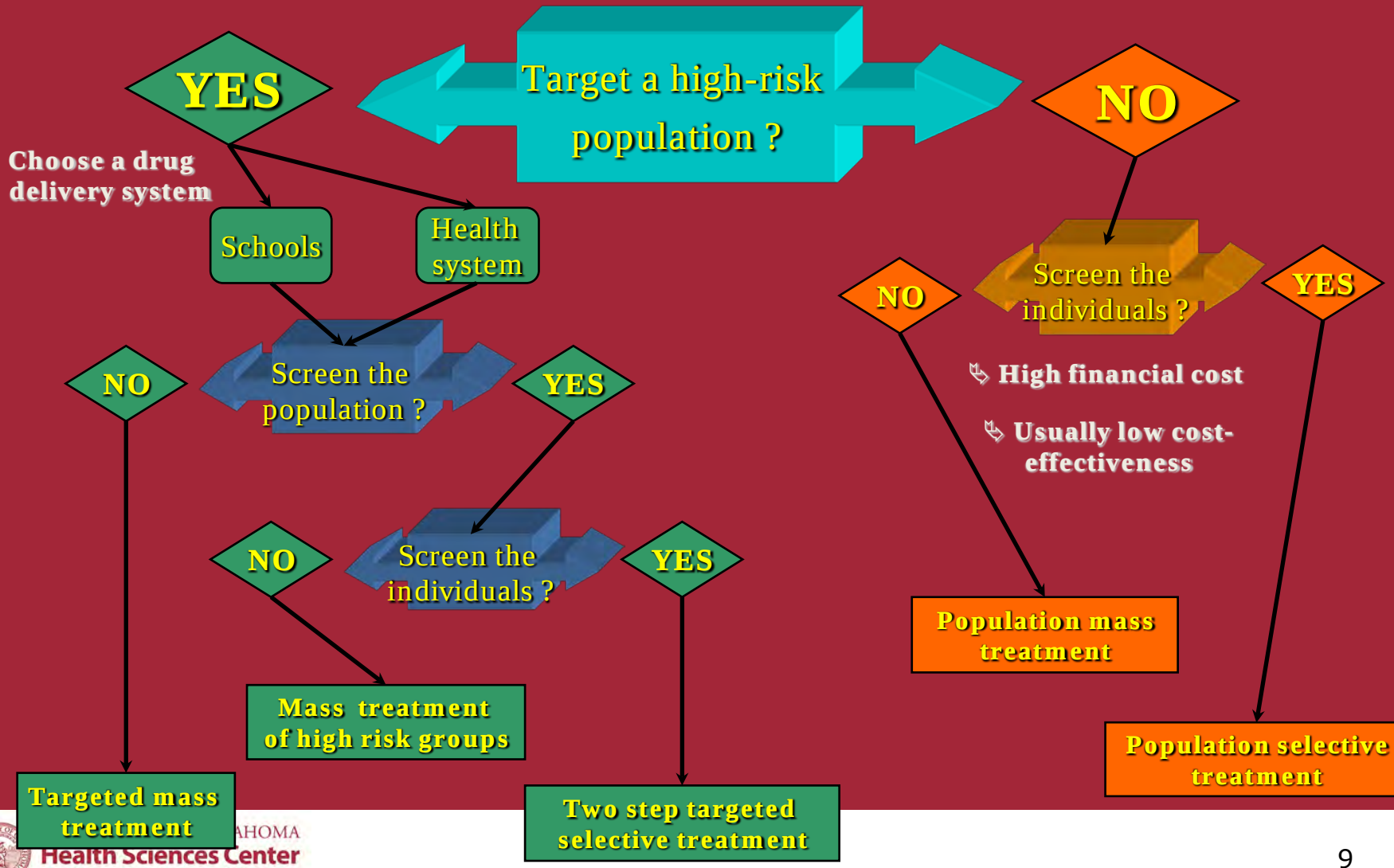
Why economic analysis?

- People who plan, offer, receive or pay for health case services are asking:
  - Who should do what to whom?
  - With what health resources?
  - In relation to what other health services (public or private)?
  - In relation to what other domain (agricultural, education, environment etc)?
- But…
  - This is only a one-dimensional aspect of decision making

Why economic analysis?

- Other dimensions to consider
  - Can it work?
    - Efficacy (procedure, drug, education)
  - Does it work?
    - Effectiveness (implementation)
  - Does it reach the people/population who need it the most?
    - Do they have access?
    - Should we target risks groups or not?
    - So WHOM do you want to reach?

Example: Choosing a strategy for schistosomiasis control



Why economic analysis?

- Scarce resources
- Systematic analyses are more reliable
- Quantitative analyses generally result in better decision making
- Quantify the needs in resources (costs) and the gains (consequences) to help in a educated decision making.

Other factors to consider

- Technical efficiency
  - A specific objective needs to be achieved for a specific disease
    - What intervention/treatment will cost the least?
  - A specific budget is available
    - Which intervention/treatment will result in the best outcome for a specific disease (consequences)?
- Allocative efficiency
  - How should resources be allocated across different projects / programmes?
    - Called Generalized CEA by WHO (WHO Guide to cost-effectiveness analysis)

What does economic evaluation mean?

- Inputs and outputs
  - Would you pay a price for a package with unknown content?
  - Would you buy something without knowing the price?
- Choices
  - Make choice criteria explicit
- *"the comparative analysis of alternative courses of action in terms of both their costs and consequences."* (Drummond et al., 2005)

Cautions or Caveats:

- Economic analysis involves mathematical modeling of the real world
  - All models require simplifying assumptions, therefore all models are wrong in some respects
  - Nevertheless, some models are useful for prediction in some settings
    - Ranking of more cost effective approaches usually correct, but absolute values rarely accurate
  - However, no model can be precise, realistic and generalizable for all settings

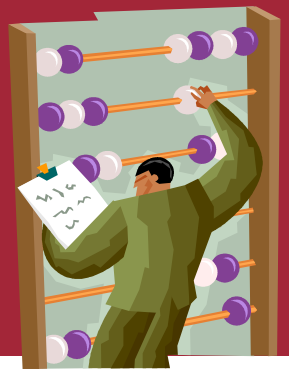
Setting and Perspective

- What goes into an economic analysis model as input depends on the system that is being modelled
  - Scope can vary
    - Hospital, District, Province, Nation, World
  - Perspective can vary
    - Employer, Insurer, Government, Society
  - Economic philosophy can determine perspective taken, and therefore the variables chosen for inclusion for economic analysis
    - Laissez-faire, Welfare economics, Marxist

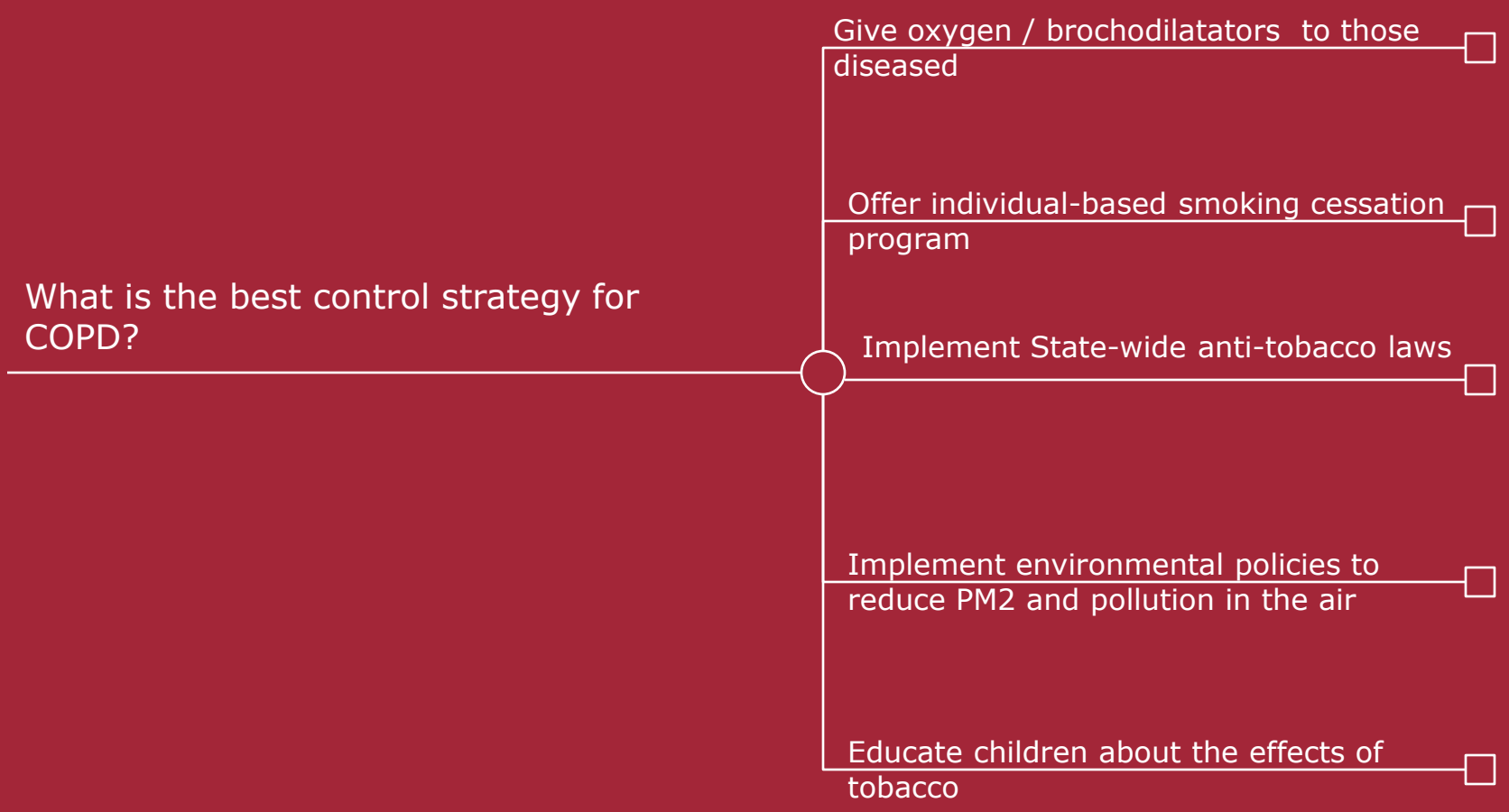
How can it be done?

- Identify
- Measure
- Value
- Compare

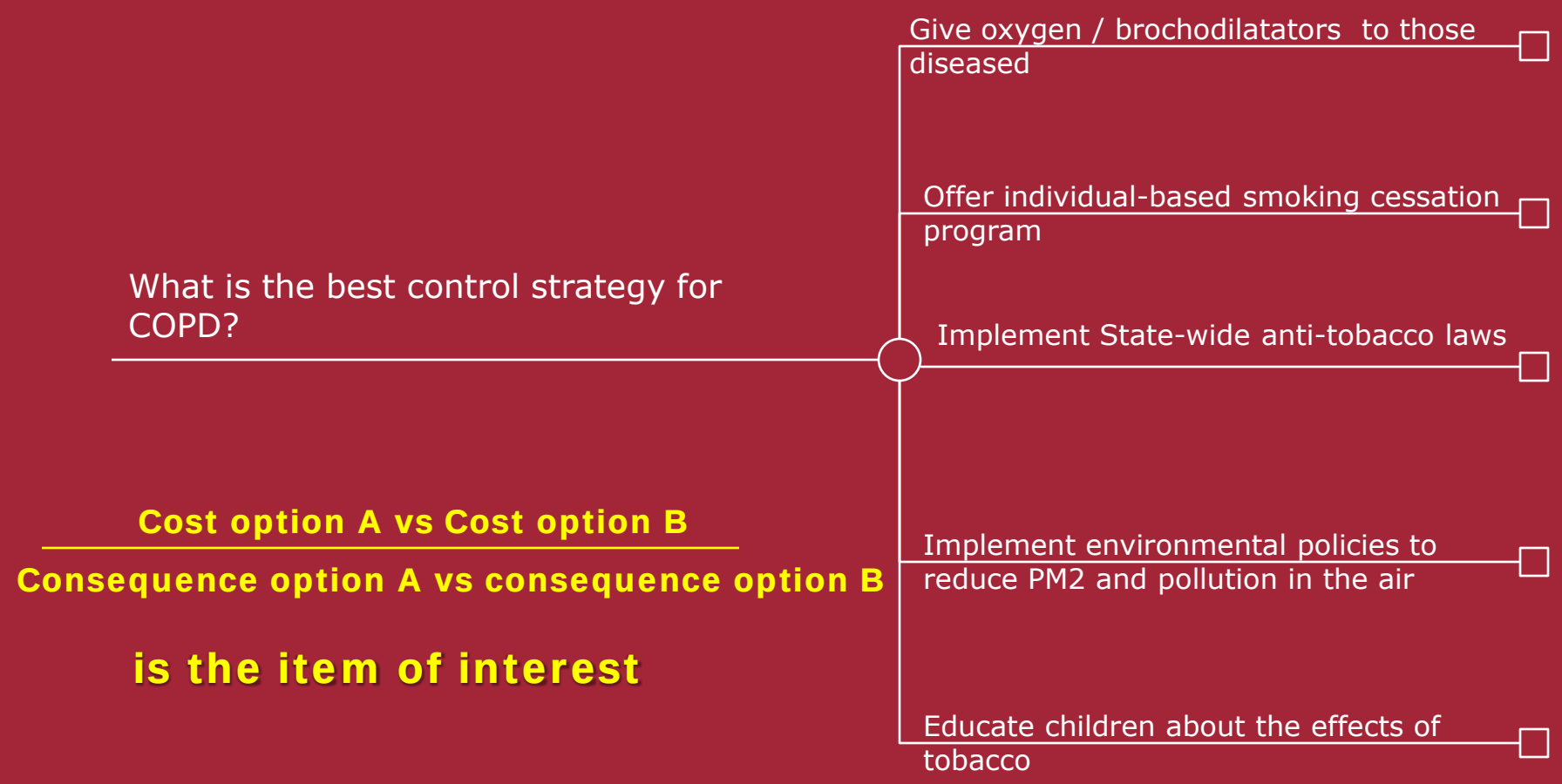
- Costs
- Consequences



Formal Decision Analysis



Formal Decision Analysis



Cost option A vs Cost option B

Consequence option A vs consequence option B

is the item of interest

Classification of economic evaluations of health care

Are both costs (inputs) and consequences (outputs) of the alternative examined?

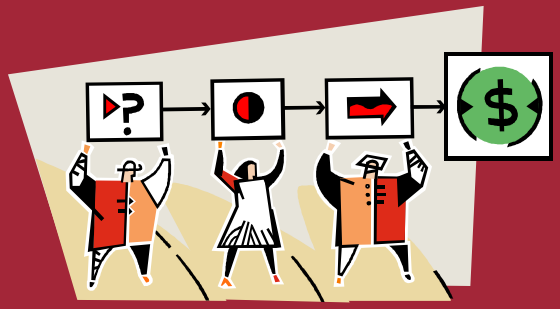
Is there comparison of two or more alternatives?

	NO		YES
	Only consequence	Only costs	
NO	Outcome description	Costs description	Cost - outcome description
YES	Efficacy or effectiveness evaluation	Cost analysis	Cost-minimization Cost-effectiveness Cost-utility Cost-benefit

Drummond et al., 1997

What could the consequences be?

- Mortality
  - Effectiveness (YLL)
- Morbidity
  - Effectiveness (morbidity, some argue QALYs)
- Utility
  - SG / PTO / TTO / QALYs / DALYs
- Monetary value
  - Willingness-to-pay
  - Human capital approach



Part 2 – defining a study question and its components

Design a decision-relevant, precise question

- Define
  - Population
  - Intervention
  - Comparator
- Relevance for
  - Target audience
- Specify
  - Perspective
  - Type of evaluation

Elements of the definitions

- Populations
  - Condition (e.g. severity, stage, or risk level)
  - Demographic characteristics (e.g. age, sex, race)
  - Setting (e.g. community, outpatient, inpatient)
  - Species (specific to zoonoses)
- Intervention and comparator(s)
  - Dose or treatment intensity
    - Could also be treatment strategies
  - Setting (e.g. primary care, health centre, home, community)
  - Co-interventions
  - Method of delivery (e.g. intravenous, oral, aerosol)

Target audience

- Question informs a specific decision
  - through targeting types of decision makers.
- Audience may comprise several jurisdictions (e.g. provinces).
- Data collected must reflect possible variation between jurisdictions or environment of the target audience.

Types of cost evaluations

- Cost-effectiveness analysis
- Cost-utility analysis
- Cost-minimization analysis
- Cost-benefit analysis
- Cost-consequence analysis
- Common element
  - Numerator
  - All CBA and CUA will need information on effectiveness on several outcomes

Types of cost evaluations

- Types of outcomes
  - Importance and relevance to the patient (human)
    - In order: duration of life, quality of life, disease-specific events, surrogates of clinical outcomes
      - Validated vs unvalidated surrogates
    - Problematic for studies of zoonoses where the intervention may affect more than 1 species
  - In PH, the outcome may be of a different type to achieve a set goal
    - These would be surrogates of “prevention” such as vaccination coverage, mass treatment coverage, bed net distributed etc…

Comparator

- Next best alternative to what is being evaluated
  - Usually “usual” care / intervention
    - May be nothing
    - May refer to the most prevalent care / intervention
  - There may be several alternative
    - Review carefully standard care / PH interventions
    - Choose by elimination
  - “Recommended” care / intervention
    - When the most frequent approach is not the recommended one

Part 3
Cost valuation (introduction to itemized cost menus)

Numerator of all heath economic evaluation = Costs of the programme

- Frequently based on empirical data
- Use itemized costs menus
- Can be divided into financial and opportunity costs
  - Somewhat outdated, all costs should be considered as opportunity costs
- Include health sector, other sectors (ie environmental / agricultural), patient/family and productivity losses/gains

First: Define your perspective

- **Societal perspective**: considers everyone affected by the intervention and counts all significant health outcomes and costs that flow from it, regardless of who experiences the outcomes or costs.
  - Follows Welfare economics concepts
  - Should be the goal
  - ex. Adding folic acid in cereal to make sure pregnant women will have enough
- **Other perspective** can omit some outcomes/costs:
  - Farmer's losses if pesticides are to be restricted (but less exposure)
  - Investment of the ministry of health in immunization campaign
  - Cost to insurance companies for their clients with a specific health problem etc…

First: Define YOUR perspective

- Use the SAME perspective for the COSTS and CONSEQUENCES
  - If cost of the programme for the insurance company and consequences with a society approach: ICER will look better than it is!
- Should aim at the society perspective whenever possible
  - Avoid transfer of fees between sectors of the government
  - Always with CBA

Second – do the programmes being compared have some costs in common?

- Costs common to programmes being compared need not be estimated
  - This can be VERY handy sometimes
- But, further comparison may be required in future analyses
  - If the data is available, better to collect it

Third – will some costs only confirm results from less data?

- For example, patients' costs may be negligible compared to operating costs
  - Is the extra work required to obtain patients' data worth it?
  - Requires strong justification

Fourth – what is the relative magnitude of the costs?

- If unit costs and the quantity of those items is small, consider excluding those
  - Justification again needed
  - Items should be identified in any case to make sure nothing has been forgotten.
    - Ex. drug data to treat NCC in Mexico – some drugs used by 1 patient once…

Fifth – what is the time spectrum?

- Goal
  - Avoid misleading decision maker / user
- Do not favour 1 alternative over the other by choosing time period
- Learning curves
  - Intervention may become more efficient / cheaper with time
  - Check if the cost at the start of implementation is the same as towards the end…

General approach

- Identify, measure (quantify) and value
  - Changes in resources due to the intervention
- Aim
  - Value the use of scarce resources to produce a certain effect (outcome)
- Level of refinement
  - Use “gross-costing” for global impression
    - For example, “cost per diagnosis”
    - More generalizable
  - Use “micro-costing” for full production function description
    - Detailed inventory
    - More specific to a particular situation

General approach

- Categories of changes in resource to include/use
  - Medical resources directly needed
  - Non-medical resources needed
    - Could be environmental / educational / agricultural sector
  - Productivity changes
    - Patients
    - Could be animals for zoonoses or crop for agricultural
  - Time of informal caregivers and other costs of informal care
  - Future medical costs as a consequence of the intervention
    - Ex. treating side effect of drugs..

Example from CADTH

Table 2: Perspectives of economic evaluations and their related costs

Perspective			Types of Cost	Examples
Societal perspective	Public payer	Publicly funded health care system	Direct costs to publicly funded services (other than health care)	Social services, such as home help, meals on wheels* Income transfer payments paid (e.g., disability benefits) Special education
			Direct costs to publicly funded health care system	Drugs, medical devices Equipment, space, facilities, and associated overhead costs Aids and appliances paid by government Health care providers and other staff Medical services, including procedures Hospital services Emergency visits Ambulance services Diagnostic, investigational, and screening services Rehabilitation in a facility or at home* Community-based services, such as home care, social support* Long-term care in nursing homes*
			Direct costs to patients and their families	Out-of-pocket payments (including co-payments) for drugs, dental treatment, walking aids Cost of travel for treatment, paid caregivers Premiums paid to, and benefits received from, private insurers† Income transfer payments received (e.g., disability benefits)
			Time costs to patients and their families‡	Patient's time spent for travel and receiving treatment Lost time at unpaid work (e.g., housework) by patient and family caring for the patient
			Productivity costs	Lost productivity due to reduced working capacity, or short-term or long-term absence from work (during friction period) Costs to employer to hire and train replacement worker for patient

Sources of data

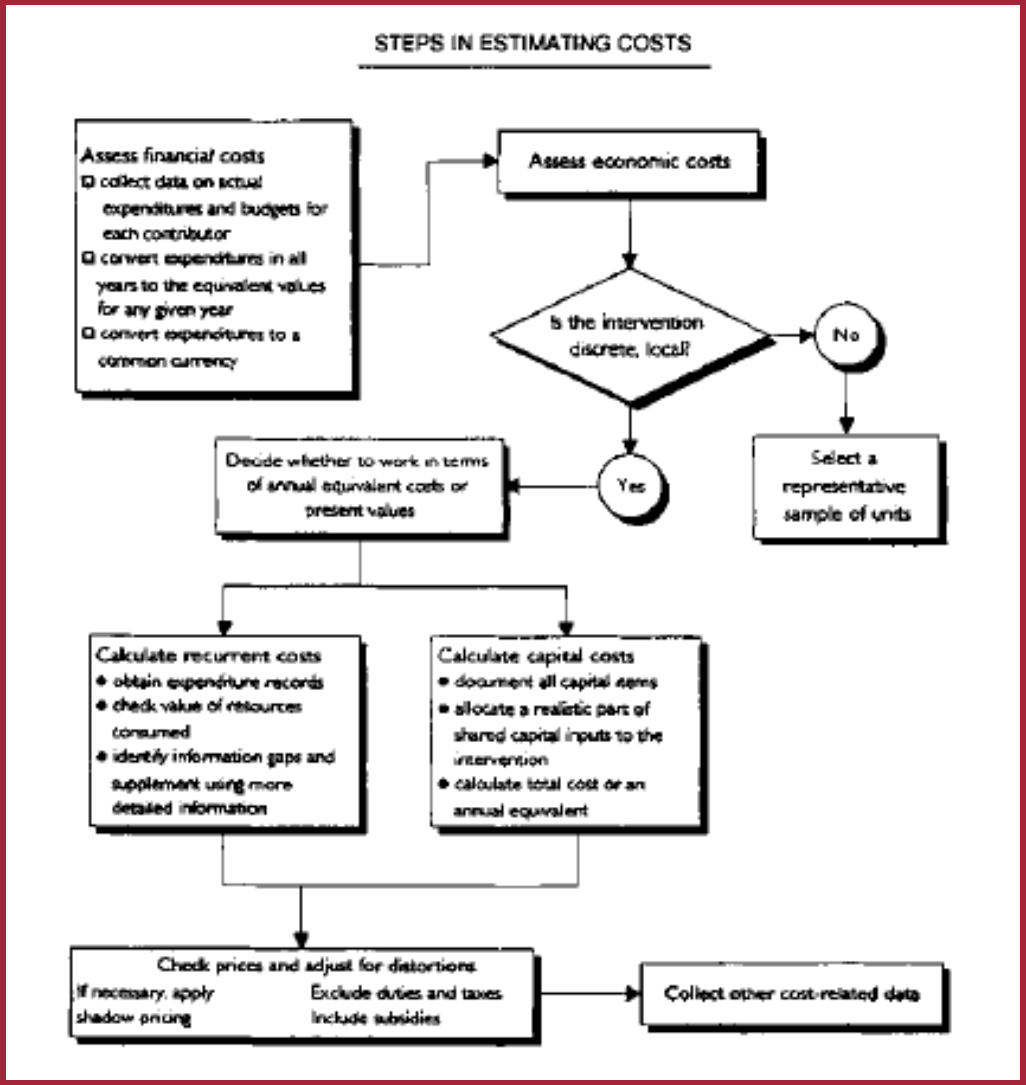
- Quantity (frequency) data
  - Patients' charts
  - Questionnaire/diary
  - National registries
  - Others
- Cost/price data
  - Aim at market prices
  - Ideally – use opportunity costs
    - Value of resources in their best alternative use
    - Reflect true societal value of the sacrificed resources
    - Often uses market prices too…

Frequent issue

- Volunteer/leisure/ ”unemployed” time
  - Volunteer – wage of unskilled worker
  - Leisure – varies from none to overtime
    - Conduct sensitivity analyses
  - Officially unemployed
    - Often encountered in developing countries (small farmer, housewives, no official job in statistics)
    - From 0 to salary of equivalent skilled worker
    - Some have estimated time spent on different chores and attributed time
    - For “housewives”, use daycare center salaries etc..
    - SENSITIVITY analyses are important (uncertainty)

Double counting

- The categories to be valued for the change in resources must not be double counted
- This can be difficult to determine
  - Ex. if the consequence under study are QALYs (utilities), the change in productivity losses due to intervention may also be captured in an improvement in the QALYs. So this costs change should not be included in the numerator



Taken from: Philipps et al. Guidelines for cost-effectiveness analysis of vector control. WHO/FAO/UNEP/UNCHIS 1993.

Building an itemised cost menu: Identify the items

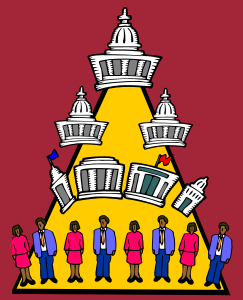
Divide your items into capital and recurrent elements

- **Capital Costs**
  - Will be used for MORE than 1 year
    - Vehicles
    - Equipment
    - Buildings
    - Training
    - Land
- **Recurrent Costs**
  - Will have to be purchased or replaced within 1 year
    - Personnel
    - Supplies
    - Operating costs of:
      - Vehicle
      - Equipment
      - Buildings
    - Other operating expenditures

Building an itemised cost menu: Identify the items

- **More details**….
  - Capital costs:
    - Vehicle, buildings, equipment etc..
  - Recurrent annual costs:
    - Personnel per hour or per day (includes part and full-time staff assigned, overtime, per diem, bonuses etc.)
      - GROSS income (pre-tax)
    - Consultants (short-term experts, advisers and others)
    - Material and supplies (consumable commodities, education material, office supplies)
    - Operating and maintenance of vehicle (gas, repairs, insurance, registration)
    - Operating & maintenance of buildings (electricity, heating)
    - Communications (cell phones, internet, mail)
    - Office miscellaneous costs (printing, photocopying)

Building an itemised cost menu: Identify sub-groupings



- For each YEAR of the intervention, the itemised costs (capital and recurrent) can be divided in different ways
  - Activities or functions
    - Training, screening, treatment, monitoring, etc.
  - Level
    - Central, national, regional, hospital, etc.
  - Source
    - Ministry of health, donors, insurance companies
  - Currency
    - Foreign, domestic

Example 1 – comparing control strategies for tobacco cessation programs (self help manual vs manual + phone calls + video)

Table 1. Summary of costs per subject, Northwest Smokeless Tobacco Study (2000 dollars).

	Societal perspective	Provider perspective
Manual-only condition		
Office staff time	1.98	1.98
Intervention materials and mailing them	5.68	5.68
Subject use of materials	9.63	—
Support activities	2.75	—
Total	20.04	7.66
Assisted self-help condition		
Office staff time	2.20	2.20
Intervention materials and mailing them	11.46	11.46
Subject use of materials	11.35	—
Support activities	4.01	—
Counseling coordination	3.30	3.30
First counseling call	11.95	10.75
Second counseling call	9.87	8.97
Ongoing counselor training	2.10	2.10
Total	56.24	38.78

Note. A fully itemized cost inventory is available upon request from the authors. All materials costs reflect large-volume purchases and do not represent retail prices.

Taken from Akers et al. Nicotine Tob Res 2007; 9: 907-14

Example 2 – comparing control strategies for Herpes Simplex Virus infection at delivery in CA

Table A3. Itemised cost menu for P3 (Programme 3 entails aciclovir therapy for partners of women at risk for HSV infection).

Items	Units	Unit cost (US$) Training	Screening	Treatment	Surveillance
C1 Health care sector					
Personnel[β]					
Counselling & Testing Trainer's salary	Per day	599			
Obstetrician's Training Allowance	Per day	200			
Follow-up visit nurse to hospitals x2 nurses	per week	1 628			
Obstetrician Salary: Counselling & Testing	per couple per pregnancy		19	12	
Nurses/Midwifes - salary	per couple per pregnancy		5	3	
Admin clerk (partner admission)	per couple per pregnancy		2	0.83	
Pharmacy dispensing and education	per couple per pregnancy			3	
Epidemiologist	Per day				593
Data entry clerk (for epidemiologist)	Per day				79
Transport[γ]					
Nurse travel allowance	per mile	0.39			
Procedure cost[α]					
No. of C/S for genital lesions*	per C/S			11 084	
Neonatal care after C/S*	per C/S			884	
Capital and building costs					
Building costs	per couple per pregnancy			N/A**	
Training facility rent	per day			N/A**	
Training facility overheads	per day			N/A**	
Car (Annualised)[δ]	per day	3 440			
Supplies and consumables					
Diagnostic Kit[θ]	per couple per pregnancy		70		
Drugs[κ]	per couple per pregnancy			37	
Transport Costs of Diagnostic Kit and Drugs	per couple per pregnancy			N/A**	
Overhead costs	per couple per pregnancy				
Fuel, oil, tyres and car maintainence[γ]	per mile	0.12			
C2 Patient and family[ε]					
Partner time (work)	per hour		11	11	
Transport expense	per couple per pregnancy			N/A**	
Maternal Mortality (C/S)***	per case			443 858	
Earnings of father for C/S	per hour			11	
Domestic help (mother hospitalised)	per day			58	
Publicity[η]					
Pamphlets for the antenatal clinic	Per 5000 brochures	865.00			

Taken from Barnabas, Carabin, Garnett. STI 2003; 78; 425-9

Building itemised cost menu financial vs opportunity costs

- Financial and opportunity costs
  - Financial
    - **EXTRA-cash investments** associated with a strategy.
      - The investments that would not be spent otherwise,

      such as vehicle, buildings, equipment, training, drugs etc..
  - Opportunity
    - Resources valued at their best alternative use
    - Usually represented by one's wage when time is valued
    - Important not to forget any time where "voluntary" work has been involved

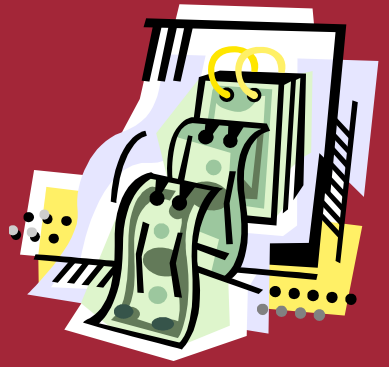
Time preference

- Positive rate of time preference
  - Better to have a benefit today than later
- Reasons
  - Short-term view of life
  - Future is uncertain
  - People expect to be more wealthy in the future
    - $100 now vs $100 in 10 years?
  - Expect positive return of investment
- Two types
  - Discounting multi-year interventions
  - Annualization of capital expenditures

Discounting

- When an intervention lasts for more than 1 year
  - Calculate the cost each year
  - Estimate the PRESENT VALUE for expenses in future years (value for a common year) using
    - Health Consumer Price Index
    - Consumer Price Index
    - Discount rate
  - Usually a good idea to run a sensitivity analysis with varying the discount rate

Discounting:



- Costs occurring in the future
  - Get present values

$$P_{y=1} = \sum_{y=1}^{Y} \frac{C_y}{(1+r)^y}$$

- Example (Drummond) with 5% annual discount rate:

Year	Programme A	Programme B
1	5000	15000
2	10000	10000
3	15000	4000
SUM	30000	29000

Programme A = (5000 / 1.05) + (10000 / 1.05^2) + (15000 / 1.05^3) = 26790

Programme B = (15000 / 1.05) + (10000 / 1.05^2) + (4000 / 1.05^3) = 26810

Discounting

- Previous example assumes all costs occur at the END of year 1
- If we assume they occur at the START of year 1 we would use

$$P_{y=0} = \sum_{y=0}^{Y} \frac{C_y}{(1+r)^y}$$

- So that the first year's costs are not discounted

Discounting: Using cost data from the past

- Adjusting costs that have occurred in the past

$$P_Y = \sum_{y=0}^{Y} C_{y=0}(1+r_y) = C_{y=0} \times \left(\frac{CPI_Y}{CPI_{y=0}} \right)$$

  - Ex. Cost of 1 day hospitalised in a ICU in the US in 2010
    - US$ 9700
    - Health CPI index (% yearly change) – these can be found at www.bls.gov/cpi

1982	2010	2014
100	391.9	429.6

  - 2014 price in US$:
    US$ 9,700 * (429.6/391.9) = US$ 10,633
  - When you want to report in another currency
    - Use the exchange rate at year Y
    - 2014 price in euro: US$ 1 = Euro 0.8191 in 2014 (oanda.com historical exchange rates)
    - US$ 10,633 * 0.8191 = Euro 8,709

Capital costs

- Sometimes the itemized cost menu is well described year-to-year, but the programme spans more than 1 year
- Annualization
  - Often, large equipment bought at the beginning of a programme at price C_0
  - Not fair to attribute all the money on the year of purchase, if used throughout the project
  - Want to know the YEARLY cost (a(r,n)) of an item that will be USED n years when the interest rate is r

$$a(r,n) = \frac{\left[r(r+1)^n\right]}{\left[(1+r)^n - 1\right]} \times C_0$$

What interest rate to use?

- Discount rate
  - Societal value judgment about intergenerational equity
    - To what extent should we, as a society, postpone our own gratification for the sake of future generations.
- Recommendations
  - Conduct sensitivity analyses with rates of
    - 0% (base case)
    - 3% (US recommendations)
    - 5% (most literature)
    - Other recommended value by jurisdiction
- If inflation
  - Use smaller discount rate

Itemised cost menu: Shared costs

- Sometimes, an item will not strictly be used for the programme of interest
- Identify the unit in which each item is measured (used), e.g.,
  - Time of use (minutes, hours, days)
  - Distance (km)
  - Space (office in a building)
  - Weight / volume (storage)
- Allocate a % of the annual cost of that item attributable to your programme
- A capital cost can also be a shared cost

Itemised cost menu

- Attribute a quantity (q) and cost per unit (c) of all the elements identified previously and for each YEAR of the programme
- Make sure that the market values are measured in equivalent
  - Currency
  - Time (year)
    - If not: adjust for the INFLATION and potential interest rates (discounting rate) using health CPI when it is a health element

PRACTICUM 1: COST-MINIMIZATION OF STRATEGIES TO TREAT SCHISTOSOMIASIS IN BURUNDI

Cost-minimization analyses (Basic)

- When is it used?
  - The effectiveness of the alternative strategies compared has been shown to be the same
- How is it done?
  - Because the denominator is the same, a comparison of the costs is sufficient
  - Estimates incremental costs

Ex. Control of schistosomiasis in Burundi

17 PHCCs → Rusizi Plain Burundi

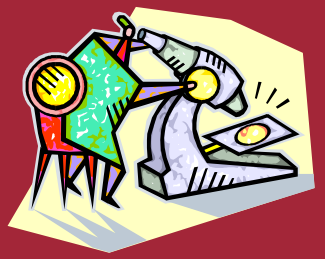
41,051 symptomatic* patients seen in 1990 → Used for the cost-effectiveness analysis

21,397 symptomatic* patients with complete data → Used to estimate epidemiological parameters

* Symptomatic patients had one of the following symptoms:

1) vague chronic symptoms or non-intestinal symptoms
2) mild but persistent intestinal symptoms
3) severe intestinal symptoms (e.g. blood in stool)
4) hepato-splenic symptoms

Ex. Control of schistosomiasis in Burundi



- **ALTERNATIVE TREATMENT STRATEGIES**
- **Screening with Kato-Katz** All symptomatic patients screened with a single 25-mg Kato smear
  - All positives treated with praziquantel (40 mg/kg - 3 tablets average)
  - Includes costs of training, refresher course, diagnosis, treatment
- **Screening with** All symptomatic patients treated with praziquantel (40 mg/kg - 3 tablets average)
  - Includes costs of treatment

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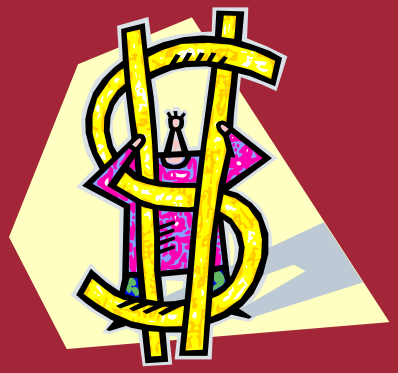
Overview of types of economic analyses and measuring burden

H Carabin DVM PhD, CH King



The UNIVERSITY of OKLAHOMA
Health Sciences Center
College of Public Health

Part 1
Overview of the types of economic evaluations of health

Classification of economic evaluations of health care

Are both costs (inputs) and consequences (outputs) of the alternative examined?

Is there comparison of two or more alternatives?

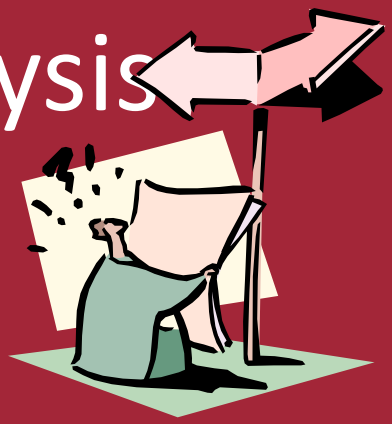
	NO		YES
	Only consequence	Only costs	
NO	Outcome description	Costs description	Cost - outcome description
YES	Efficacy or effectiveness evaluation	Cost analysis	Cost-minimization Cost-effectiveness Cost-utility Cost-benefit

Taken from Drummond et al., 1997

Cost-minimization analyses (Basic)

- When is it used?
  - The effectiveness of the alternative strategies compared has been shown to be the same
- How is it done?
  - Because the denominator is the same, a comparison of the costs is sufficient
  - Estimates incremental costs
- You know all about this now!

Cost-effectiveness analysis



- When is it used?
  - Effectiveness value is NOT the same
  - Cost of alternative strategies vary
  - The outcome of interest is the same and “sufficient” for all individuals
    - Unit
    - Impact
    - Ex YLL, cases averted, reduction in calories intake
- Challenge
  - Valid estimation of both costs & effectiveness
- CER vs ICER

Incremental cost-effectiveness ratio

$$ICER = \frac{Cost_A - Cost_B}{Cases_A - Cases_B}$$

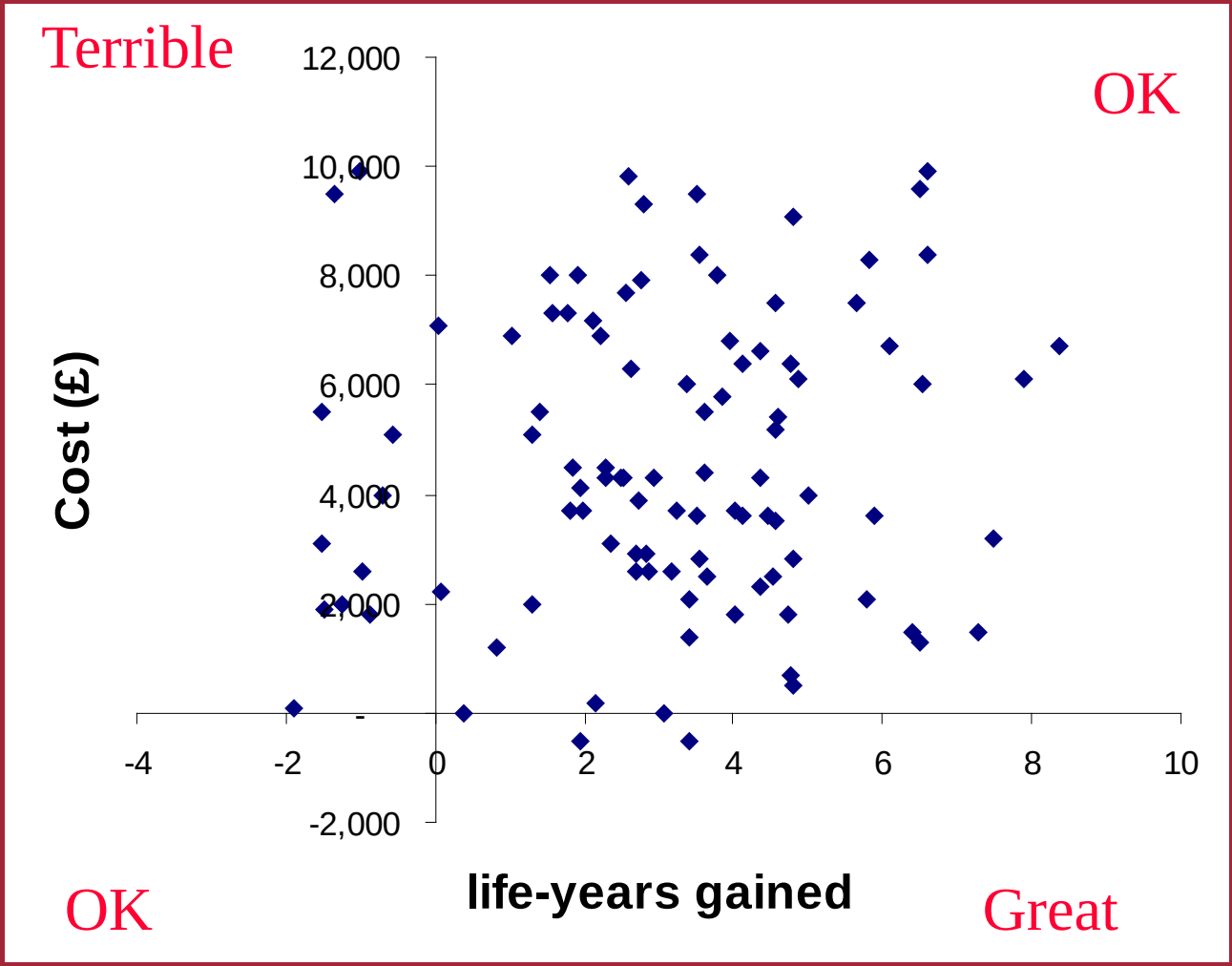
- Obtains the additional costs per case averted

Cost-effectiveness analysis

- What does it do?
  - Shows the tradeoffs involved in choosing among interventions or variant of an intervention.
  - Helps to define and illuminate the "opportunity cost" of each alternative:
    - the health benefits lost because the next-best alternative was NOT selected.
- The lowest the incremental cost-effectiveness ratio, the better.

From Gold et al., 1998

The cost-effectiveness plane



From John Edmunds PhD lecture to Imperial College, 2003

What do ICER results say?

Costs	Effectiveness: More	Effectiveness: Same	Effectiveness: Less
More	No dominance Is added effect worth added cost?	**Weak dominance** **Reject treatment**	**Strong dominance** **Reject treatment**
Same	**Weak dominance** **Accept treatment**	No dominance Neutral on cost & effect. Other reasons to adopt one alternative?	**Weak dominance** **Reject treatment**
Less	**Strong dominance** **Accept treatment**	**Weak dominance** **Accept treatment**	No dominance Is reduced effect acceptable given reduced cost?

From Drummond

Other aspects than ICER to consider for PH interventions

- The treatment/prevention is offered to a majority of individuals that are **NOT sick**
- There is a large amount of **uncertainty** when it comes to deciding if one wants to follow the PH recommendations
  - Preventive drugs and the risk of side effects vs disease (eg aspirin and arthritis, vaccines and AEFIs)
  - Tobacco and preventing lung cancer.. Most smoker will not develop cancer anyways…
- Some large-scale PH interventions can have a **negative effect** on some groups of individuals
  - Iron supplementation and malaria
  - Diet control and anorexia
  - Moderate alcohol intake vs addiction…

Ex. ICER of weight loss programs (in-person vs internet) on years of life saved

Table 4 Internet, in-person, and incremental cost-effectiveness results

	Internet	Internet CI's	In-person	In-person CI's	Incremental	Incremental CI's
Cost	$373		$706		$333	
LYG (YLL undiscounted obesity)	0.469	(0.343, 0.596)	0.580	(0.449, 0.710)	0.126	(0.015, 0.296)
LYG (YLL discounted 3% obesity)	0.173	(0.126, 0.219)	0.214	(0.165, 0.261)	0.046	(0.006, 0.109)
C-E ratio: $/undiscounted LYG obesity	$795	($1,087, $626)	$1,217	($1,572, $994)	$2,643	($22,200, $1,125)
C-E ratio: $/discounted LYG obesity	$2,160	($2,953, $1,700)	$3,306	($4,270, $2,701)	$7,177	($60,291,$3,055)

Confidence interval for lower limit based on 80% because the 95% interval crosses zero (at which point the cost-effectiveness ratio does not exist).
C-E, cost-effectiveness; CI, confidence interval; LYG, life years gained; YLL, years of life lost.

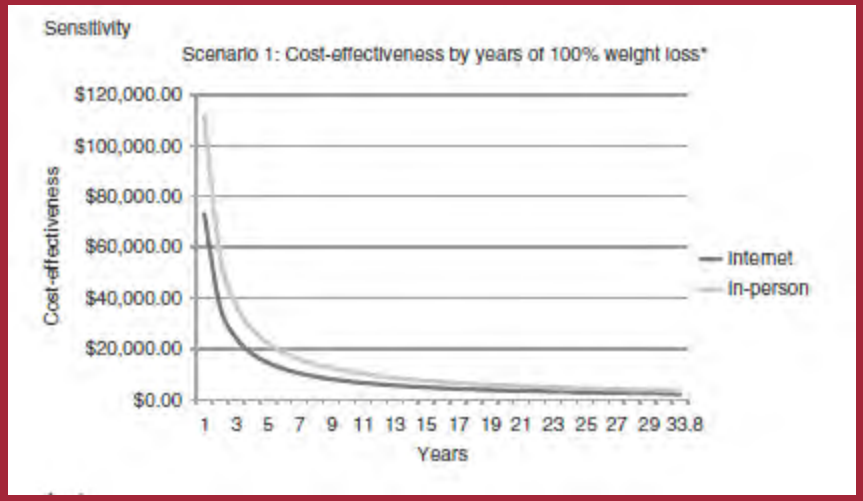


Figure 1 Sensitivity analyses. *Employs the methods and assumptions of Gustafson and colleagues (12) applied to study data, including 1 year of benefit of full weight loss. **Employs the methods of Gustafson *et al.*

From Krukowski et al. Obesity 2011; 19: 1629-35

Ex. ICER of control programmes for *Schistosoma japonicum*

- Mass treatment programme (humans):
  - Cost: RMB yuan 13,380
  - Effectiveness: 83 human cases averted per year
- Screening programme:
  - Cost: RMB yuan 11,211
  - Effectiveness: 59 human cases averted per year
- ICER: (13380-11211) / (83-59) =

RMB yuan 90 per extra case averted

From Yu D et al., Southeast Asian J Trop Med Public Health 2002; 33: 441-57.

Ex. Challenges when the outcome is not the same

- Human-oriented programme (mass):
  - Cost: RMB yuan 13,380
  - Effectiveness: 83 human cases averted per year
- Animal-oriented programme (theoretical):
  - Cost: RMB yuan 6,350
  - Effectiveness: 112 cattle cases averted per year
- ICER: (13380-6350) / (83-112) = RMB yuan 242 gained per ???
- Can we value a cow case as a human case?

Cost-utility analyses

- When is it used?
  - The control strategies do not have 1 single effect of interest (ex cases averted)
  - It is believed that people with and without the condition of interest do not have the same quality of life…
- What is used
  - QALY, DALY etc..

Cost-utility analyses

- How does it work?
  - Weighs life expectancy with a measure of quality of life, which in some cases may be called utility
  - Comes from economic principles
  - Individuals affected by certain health problems are asked to "weigh" their current health state with
    - Standard gamble
    - Time trade off
    - Rating scales linked to utility values
  - QALYs: 0 death, 1 excellent
  - DALYs: 1 excellent, 0 death

Example – ICER with DALYs for preventing childhood depression

TABLE 2 Results of Reference Case Analysis for the Psychological Intervention

	Median Point Estimate[a] (95% Uncertainty Interval)
DALYs averted	5600 (1000–11 000)
Cost of the intervention	Government: $43M ($27M–$69M)
	Private: $4M ($2M–$8M)
Cost offsets	$16M ($3M–$33M)
Total costs	$31M ($13M–$58M)
ICER (with cost offsets)	$5400 ($1400–$32 000) (US$4000 [$1000–$24 000])
ICER (without cost offsets)	$8200 ($4200–$35 000) (US$6100 [$3100–$26 000])

M, million.

[a] Amounts are in Australian dollars. The ICER results are also presented in US dollars by using the purchasing power parities index (for gross domestic product) published by the Organisation for Economic Co-operation and Development to convert from Australian dollars to US dollars (http://stats.oecd.org/Index.aspx?datasetcode=SNA_TABLE4).

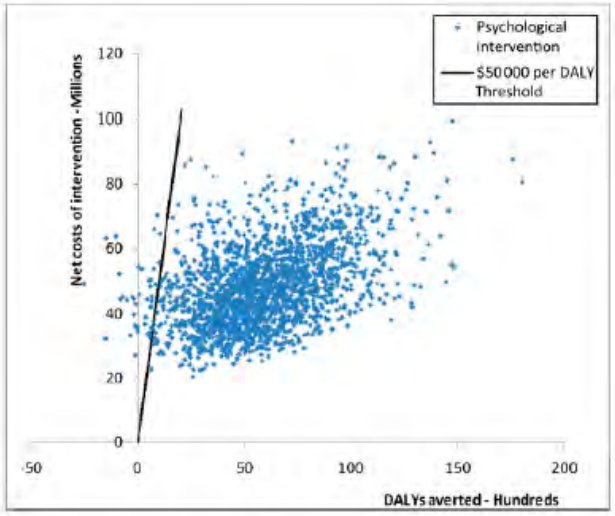


FIGURE 1
Scatter plot of the psychological intervention for the prevention of depression in children and adolescents.

From Mihalopoulos et al. Pediatrics 2012; 129: e723-30

Example – ICER using QALYs

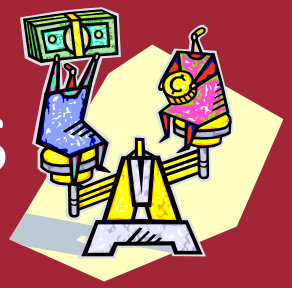
Table 3—*Differences in total costs and QALYs and incremental cost-effectiveness ratios* for lifestyle and metformin versus placebo and lifestyle versus metformin over 10 years from three alternative perspectives*

	Lifestyle vs.placebo	Metformin vs. placebo	Lifestyle vs. metformin	DPP group lifestyle vs. placebo†
Differences in total costs (Δcost)				
Health system perspective[1]				
Undiscounted	$1,656	−$251	$1,908	$81
Discounted[2]	$1,748	−$105	$1,853	$201
Modified societal perspective[3]				
Undiscounted	$3,224	−$573	$3,797	$1,649
Discounted[2]	$3,202	−$362	$3,564	$1,655
Societal perspective[4]				
Undiscounted	$2,571	−$3,644	$6,215	$996
Discounted[2]	$2,688	−$3,021	$5,709	$1,141
Differences in total QALYs (ΔQALY)				
Undiscounted	0.15	0.01	0.14	0.15
Discounted[2]	0.14	0.01	0.12	0.14
Incremental cost-effectiveness ratios (Δcost/ΔQALY)				
Health system perspective[1]				
Undiscounted	$10,759	Cost-saving	$13,469	$528
Discounted[2]	$12,878	Cost-saving	$14,885	$1,478
Modified societal perspective[3]				
Undiscounted	$20,942	Cost-saving	$26,812	$10,712
Discounted[2]	$23,597	Cost-saving	$28,634	$12,197
Societal perspective[4]				
Undiscounted	$16,699	Cost-saving	$43,881	$6,468
Discounted[2]	$19,812	Cost-saving	$45,867	$8,412

*Differences in total costs and QALYs and incremental cost-effectiveness ratios are adjusted for survival. †Sensitivity analysis. Assumes that the core curriculum and follow-up visits were conducted as group sessions with 10 participants during the 3 years of DPP. [1]Includes total direct medical costs. [2]Both costs and QALYs discounted at 3%. [3]Includes direct medical costs and direct nonmedical costs excluding participant time. [4]Includes direct medical costs and direct nonmedical costs including participant time.

From: The Diabetes Prevention program. Diabetes Care 2012; 35: 723-30

Cost-benefit analyses



- When is it used?
  - Cannot use utility values (ex zoonoses)
  - Knowing the cost per QALY or per case averted is not sufficient to make a decision
  - Would like to know what are the monetary gains for a monetary input
- How does it work?
  - A monetary value is attributed to the consequences.
  - Eg a cost would be attributed to a human schisto case and to a cow schisto case
  - The number of cases averted with each programme is multiplied by the monetary value of an average case

Cost-benefit analyses

- Methods to attribute a monetary value to the consequences
  - Itemised cost menu
  - «Willingness-to-pay»
- What does it mean?
  - Net Present Value
    - Cost of the consequences – cost of the programme

Ex Vaccination against measles

- Routine 2 doses of MMR (2nd dose at 18 months)
  - Cost of the programme: CND$ 53,385,395
  - Benefits of the programme:
    - 195,340 measles cases saved x CND$ 929 per case = CND$ 181,470,860
  - NPV = 53,385,395 – 181,470,860
    = CND$ 128,085,465
  - Therefore, the implementation of a 2nd dose of MMR results in cost-saving: should be implemented

From Pelletier et al., 1998

Example 2

- Educational programme on pig pen building in Mbulu district, Tanzania, to control cysticercosis (pig aspects only)
  - US$3507 gained for each farmer
  - Ngowi et al. http://www.cipav.org.co/lrrd/lrrd19/5/ngow19062.htm
- Dog treatment + sheep vaccination to control
  - Benefits of about US$300,000 per year for Shiqu country, Tibetan plateau, China
  - Budke et al Am J Trop Med Hyg 2005

Part 2
Concept of disease burden

What IS disease burden?

Google news search (May 10)

Google news search

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Part Two: Racial Disparities Continue In Burden of Death, Illness

07 May 2015 | Health

By Rosaland Tyler

Associate Editor

New Journal and Guide

Blacks disproportionately experience death and illness, according to numerous reports.

Typically every reason fits in one category: the lack of ongoing care. But two local companies are working to reduce death and suffering among minorities. The first one is Hampton Roads Community Health Center. It operates offices in Norfolk and Portsmouth and recently received a $40,000 colorectal screening grant from Walgreens and the American Cancer Society. The second center is Newport News Health Clinic. It provides free and low-cost health care.

"I think the disparity is due to (a lack of) preventive health care," said Dr. Catherine Christie, chief medical officer at the Hampton Roads Community Health Center, which operates

Google news search

Google news search

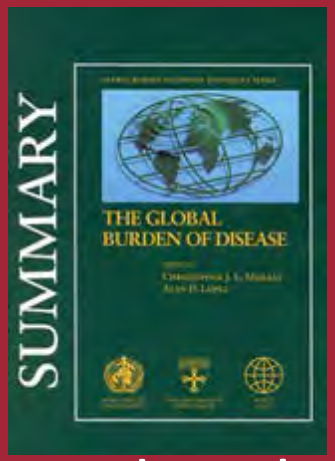
Google news search

What IS disease burden?

- Size of a health problem in an area, measured by cost, mortality, morbidity, or other indicators. (Public Health Agency of Canada)

What IS disease burden?

- The buzz started here



  - The burden of disease can be viewed as the gap between current health status and an ideal situation in which everyone lives into old age free of disease and disability.
    - Causes of the gap are premature mortality, disability and exposure to certain risk factors that contribute to illness. (GBD group)

Part 3
The four measures of disease burden

What can be used to measure human disease burden?

- Mortality
- Morbidity
- Utility
  - DALYs
  - QALYs
- Monetary value
  - Human capital
  - Revealed preference
  - Willingness to pay/accept

Mortality (deaths) to measure disease burden?

Mortality to measure human disease burden?

- Indicators
  - Total / infant / neonatal / under 5
  - Life expectancy
  - Cause-specific death rates
    - What is of interest for Dz burden assessment
- Sources of information
  - Vital registries (partial or complete)
    - WHO (http://apps.who.int/ghodata/)

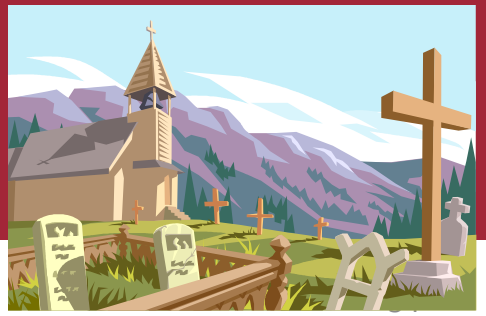
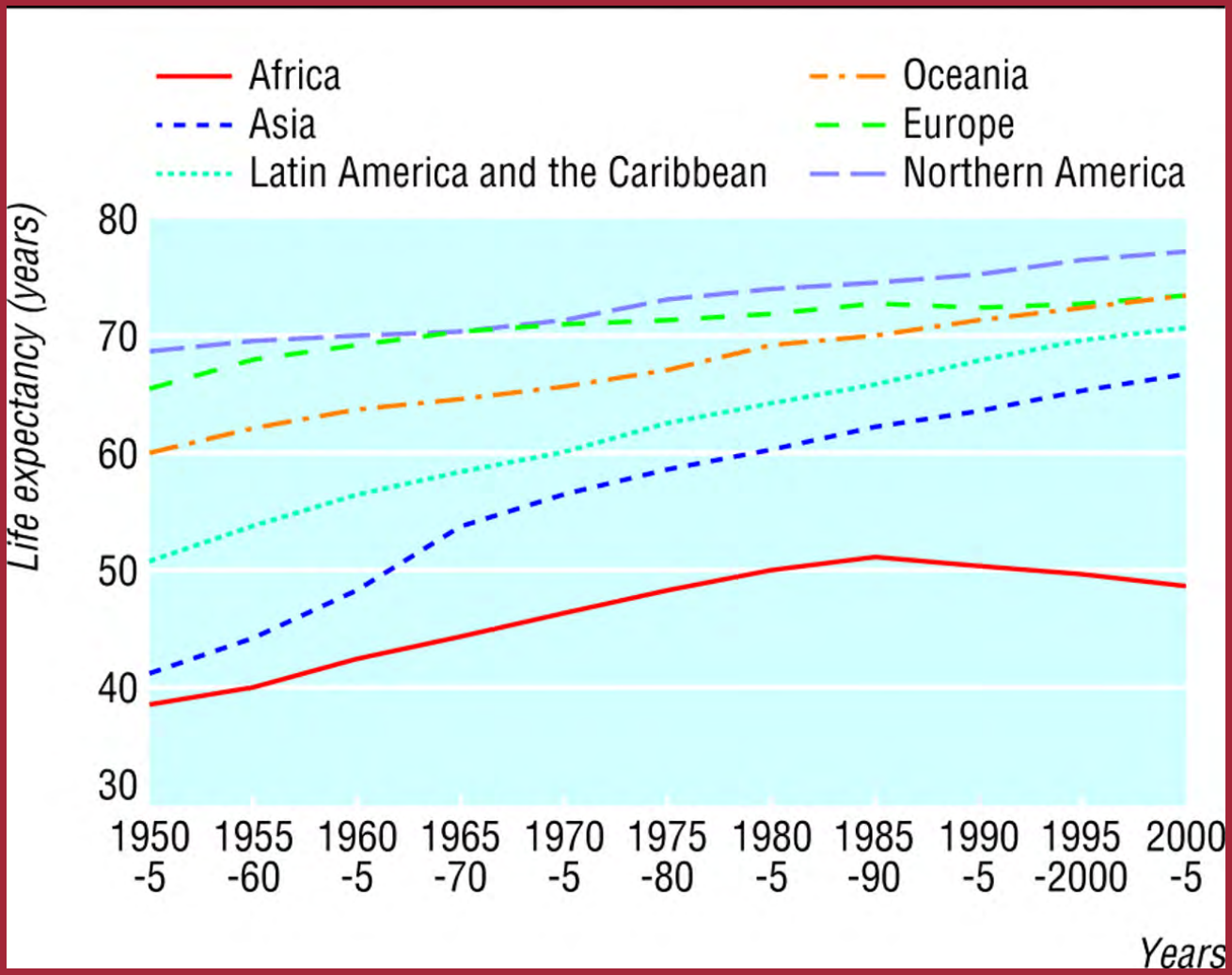


Fig 2 Life expectancy (in years)



Dorling, D. et al. BMJ 2006;332:662-664

Mortality to measure human disease burden internationally?

- Challenges
  - Vital statistics available from 40% countries and 25% of its population (Lopez et al. WHO. 2002)
  - Causes of death recording by country (Mathers et al. GDB v2. WHO; 2002)
    - 12% high quality
    - 17% medium
    - 5% poor
    - 66% NO DATA
- Sources of information
  - Death certificates

Additional challenges of international comparison of causes of death

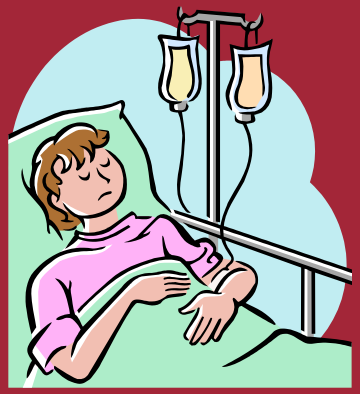
- "Garbage codes"
  - "*Allocation of a substantial fraction of deaths to causes of death that are not underlying causes of death*" (Foreman et al. BMC Pop Health Metrics 2012; 10:1)
- Poor completeness of deaths in some vital registry systems
- Change in ICD coding through time

Mortality to measure human disease burden?

- Pros
  - Availability
  - All new cases
  - Relatively easy

- Cons
  - "note the dead and ignore the living" (Kaplan, 1990)
  - Misclassification
  - Remote areas / Stigmatisation

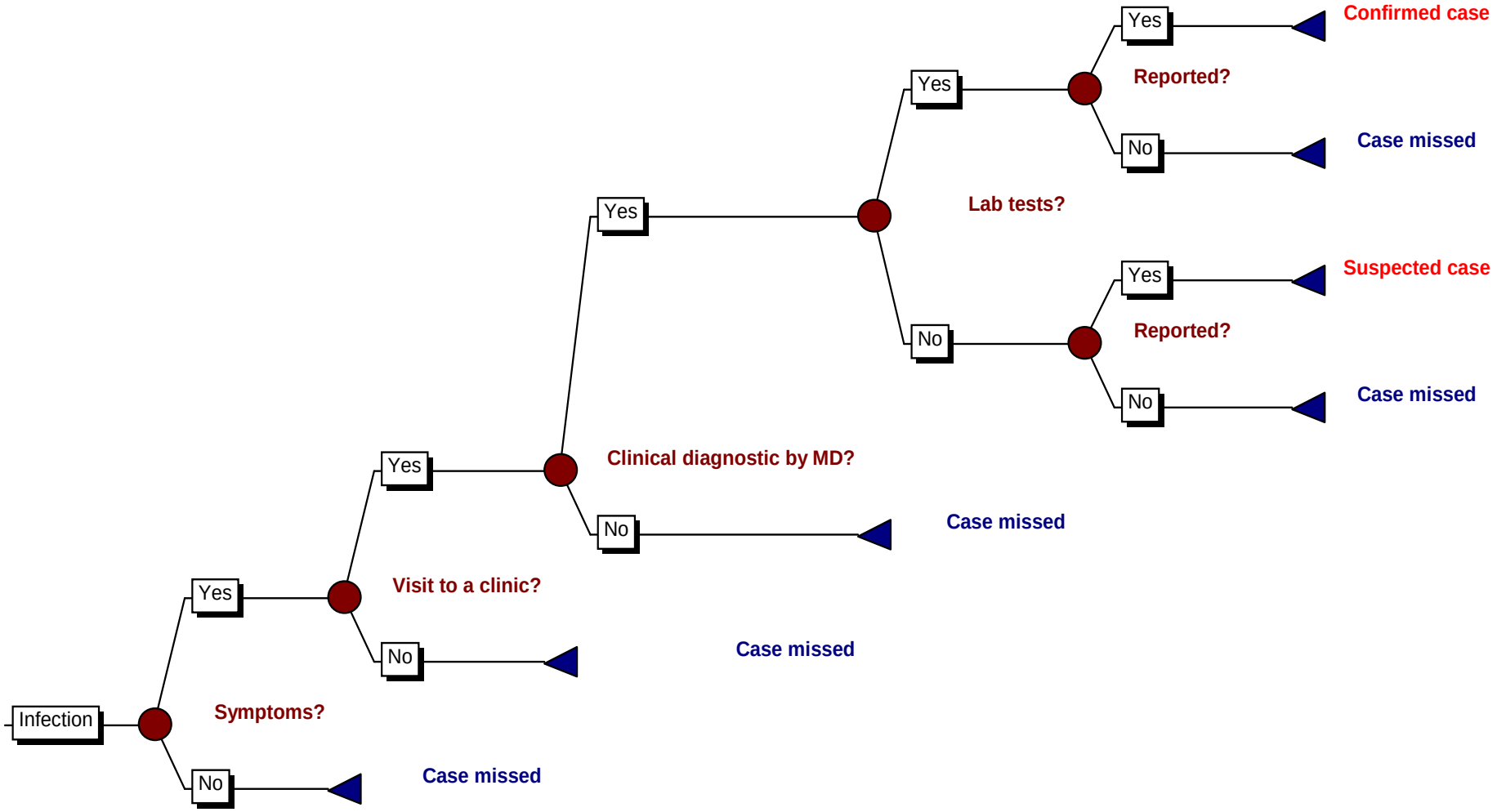
Morbidity (disease symptoms) to measure disease burden?



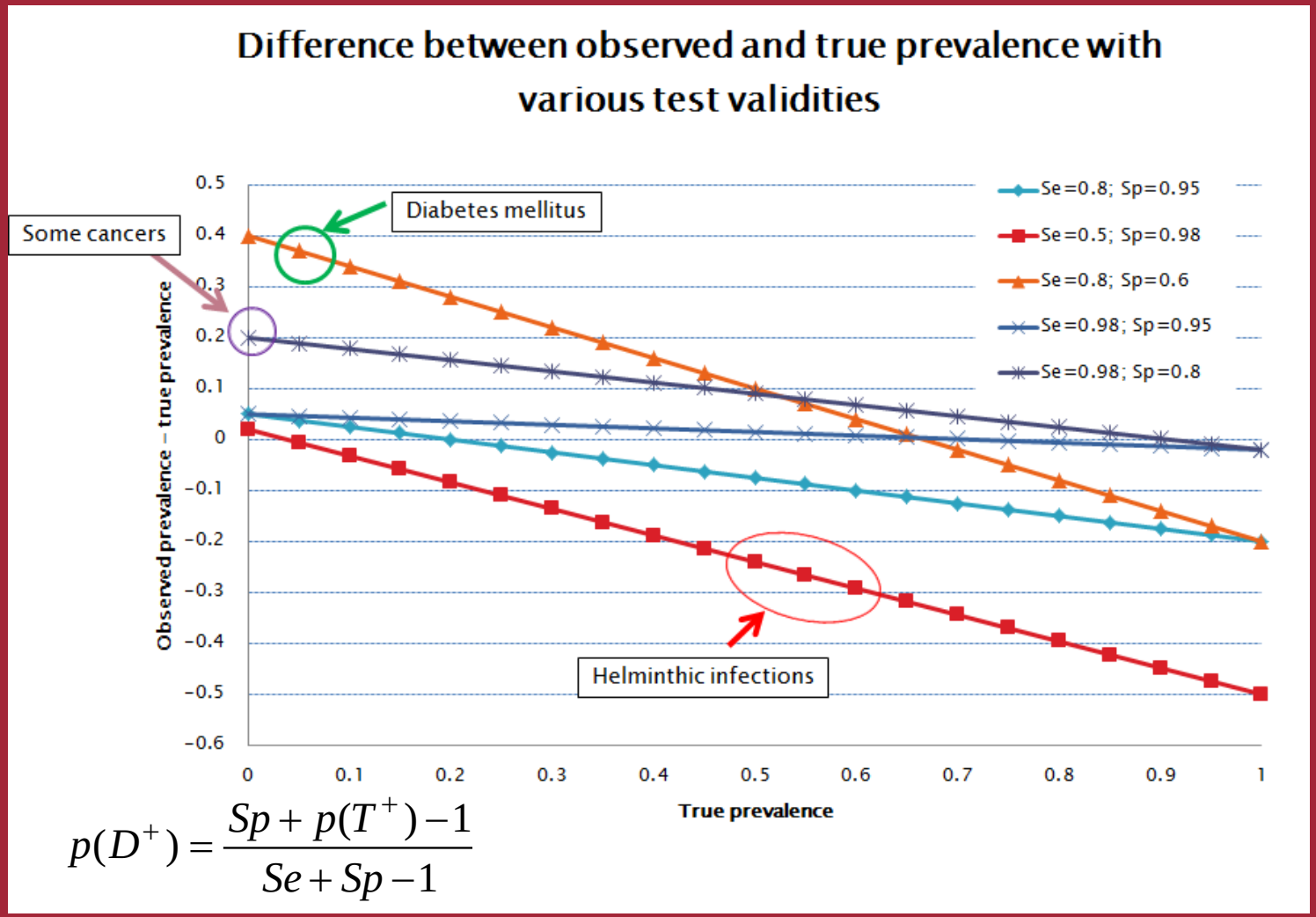
Morbidity to measure human disease burden?

- Sources
  - Hospital inpatient discharge records
    - Available where public system in place
    - Available where records are kept!
  - Outpatient registers
    - Usually prescription information available where public system in place (for reimbursement purposes)
      - Most industrialized countries
  - Surveillance systems when available
    - Will most often underestimate the true incidence / prevalence of infections
      - Reporting
      - Recognition

Challenges to measuring morbidity – Surveillance data



Another problem with surveillance data, esp. for neglected diseases



$$p(D^+) = \frac{Sp + p(T^+) - 1}{Se + Sp - 1}$$

Morbidity to measure human disease burden?

- Pros
  - Not all diseases will kill you
  - Easy where surveillance in place

- Cons
  - Availability
  - Misclassification
  - Old (prevalent) cases vs new (incident) cases
  - Burden of epilepsy vs common cold
  - Some diseases have more than 1 symptom

Utility (quality of life) to measure disease burden?

Utility theory

- How people make decisions under conditions of uncertainty. Utility is the preference that people have for health outcomes along a continuum.
- Derived from Jeremy Bentham's 'Utilitarian Philosophy' (1789), as subsequently adopted for many kinds of economic analyses.
- Paretian welfare economics requires to accept that each individual is the best judge of his/her own welfare.

Utility to measure human disease burden?

- Utility
  - Can combine several symptoms into 1 measure
  - QALYs (see later)
    - Require specific studies
    - Issues with cultural perceptions of health
    - Are not generalizable
    - Accuracy determination can be an issue
    - Very much liked by physicians
  - DALYs (see later)
    - Uses measures of morbidity and mortality

Utility to measure human disease burden?

- Pros
  - Get the feeling from the patient – subjective perception
- Cons
  - Perception of people with or without the problem
  - New vs old cases
  - Availability
  - Feasibility

Monetary value to measure disease burden?

Monetary value to measure disease burden?

- Needs
  - Information on the prevalence or incidence of each infection
  - Distribution of symptoms associated with that infection with the incubation periods
    - Preferably stratified by age and sex
  - Information on frequency of each type of treatment given for each symptom and productivity losses estimates
  - Information on cost of each treatment and productivity losses

Ex. Cystic echinococcosis in Tunisia

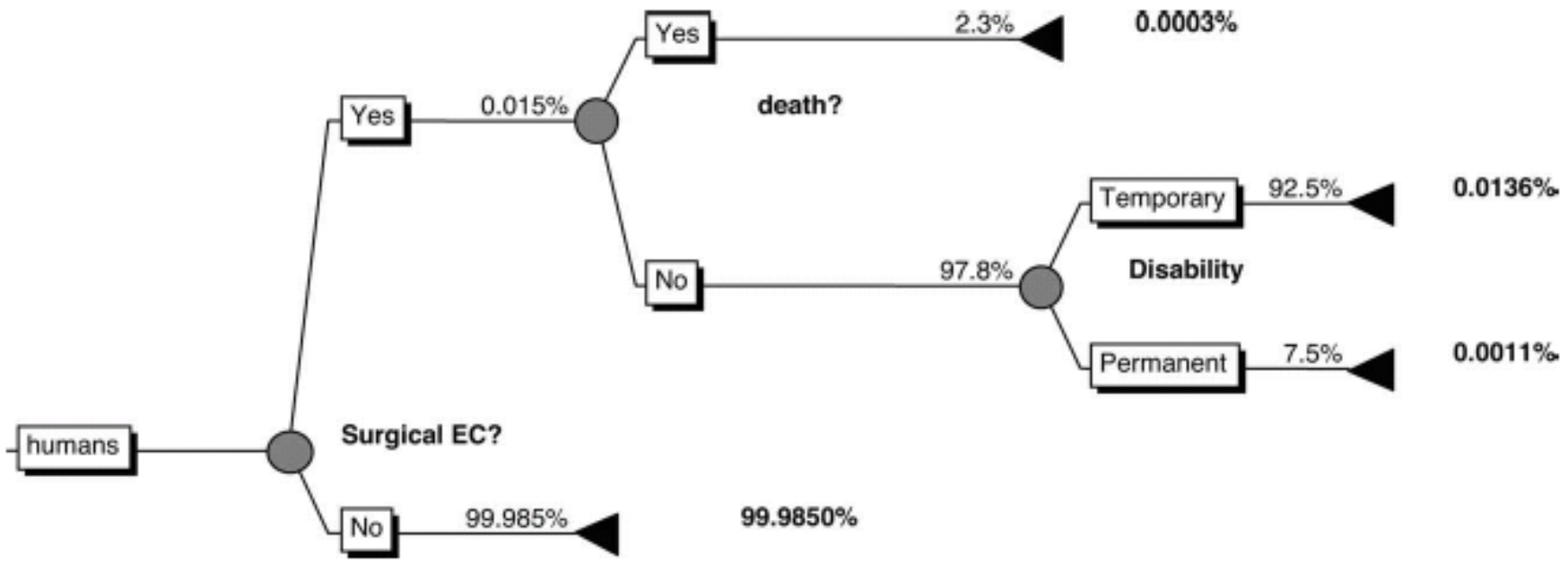
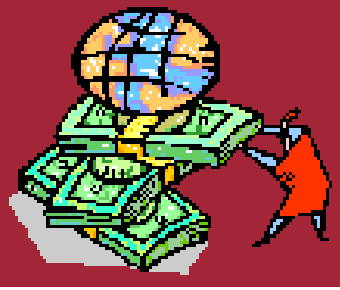


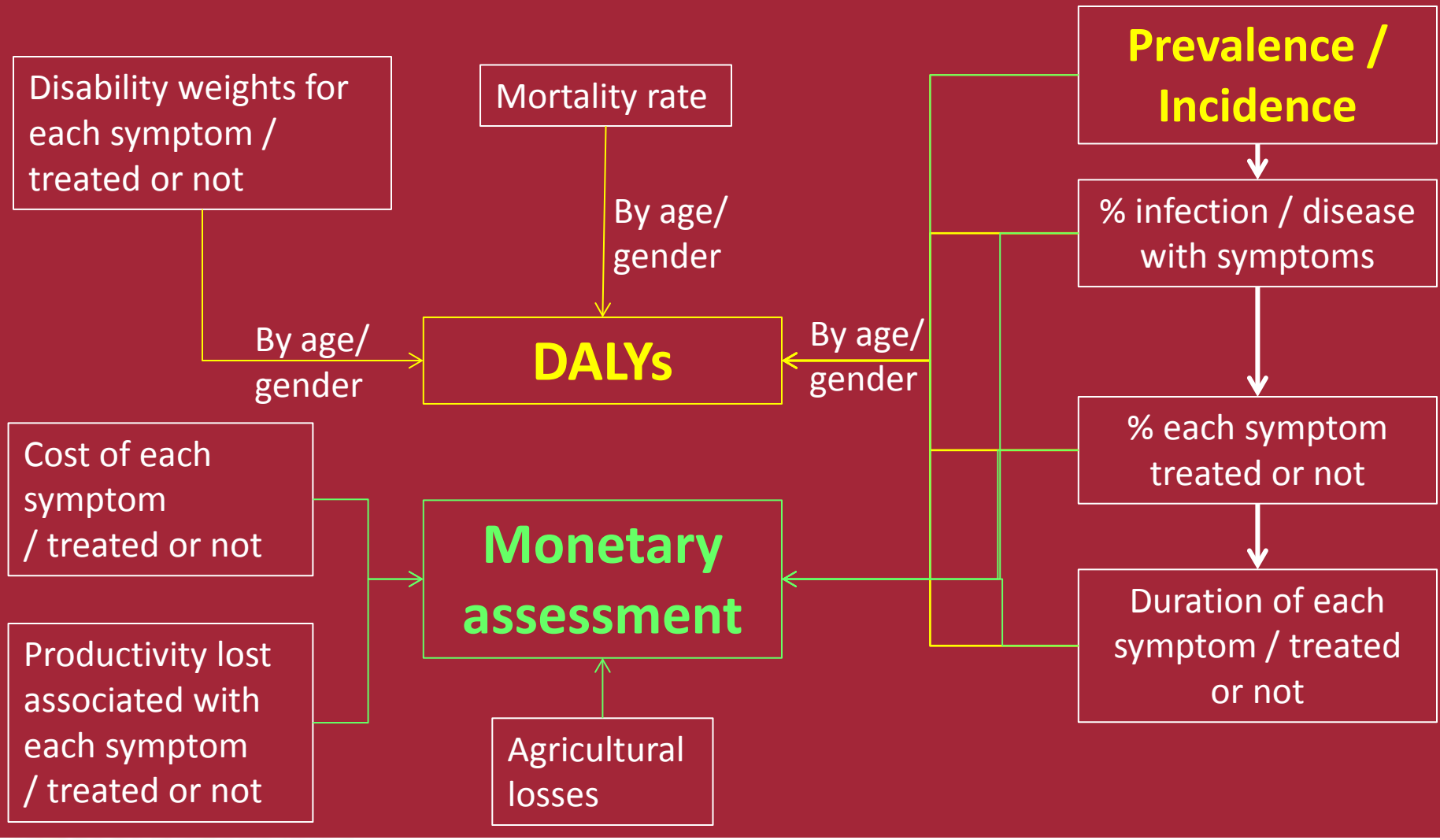
Figure 1 Decision analysis tree for estimating the cost of echinococcosis in humans in Tunisia.

Monetary value to measure human disease burden?

- PROS
  - Can combine several outcomes into 1 indicator
  - Can include social impact through losses of productivity and even community-level indicators
- CONS
  - Needs valid EPIDEMIOLOGICAL AND COSTS DATA
  - Data quality VERY variable
  - Applicable locally



Data required to estimate different burden measures applied to infections



Estimating and using Disability adjusted life years (DALYs)

H Carabin
CH King

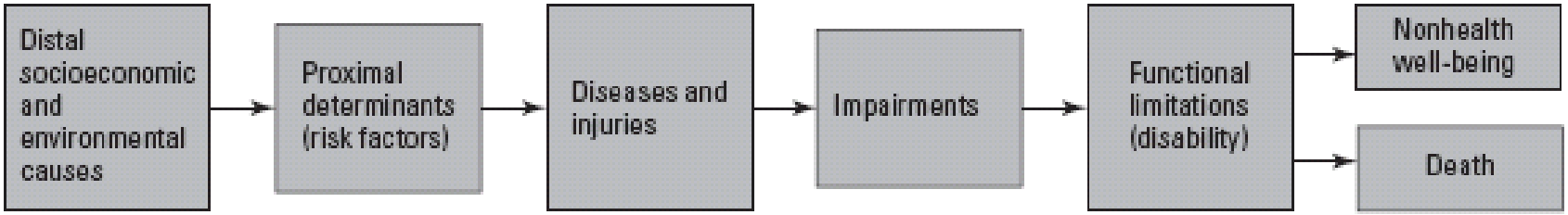
Part 1: The origins of DALYs

Rationale for the Global Burden of Disease initiative ~ 1991

- Societies need to make decisions about their provision of health services
- Policy makers must be aware of comparative burden of diseases and injuries and the risk factors that cause them
  - How modifying these factors can impact on the burden (effectiveness!)
- The issue is how to obtain a quantification of the importance of risk factors and their consequences that is comparable across nations

Lopez et al. Global Burden of Disease and Risk Factors, 2006

WHO/World Bank Global Burden of Disease Program framework for disease burden assessment & PH prevention

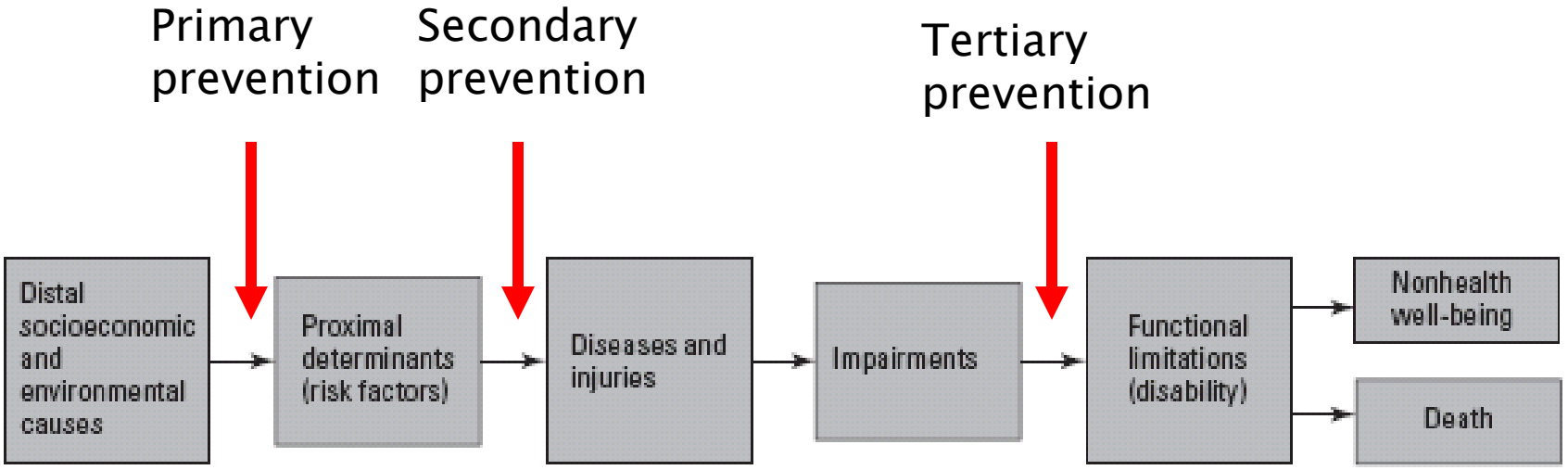


Source: Mathers and others 2002.

Note: This presentation is intended as a broad schema: for example, some exposures, such as environmental factors, can be proximate causes of disease, and injuries can lead directly to death.

Figure 1.1 Overview of Burden of Disease Framework

Where does PH prevention come into play in that scheme?



Source: Mathers and others 2002.

Note: This presentation is intended as a broad schema: for example, some exposures, such as environmental factors, can be proximate causes of disease, and injuries can lead directly to death.

Figure 1.1 Overview of Burden of Disease Framework

WHO Definition of Health

- "**Health** is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."

DALYs – Origins

- To obtain a common measure of health for
  - International comparison
  - Quantify the burden of disease and injuries
  - Determine the global and regional burden of diseases

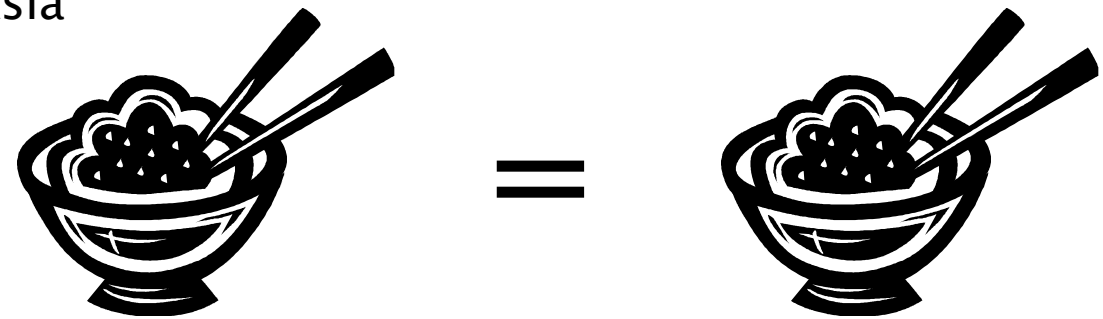
The GBD DALY measurement

- Newly invented in the 1990s
- Disability Adjusted Life Year = DALY
- A time-based measurement unit (metric) for estimating the health burden caused by different diseases
- Meant to be interchangeable and equivalent across locations and cultures
  - The 'Like-is-Like' philosophy
  - Climbing 10 steps in Ethiopia should require the same effort as climbing 10 steps in Canada

‘Like is Like’

Asia

Africa



The ‘fungible’ nature of goods is a basic economic concept

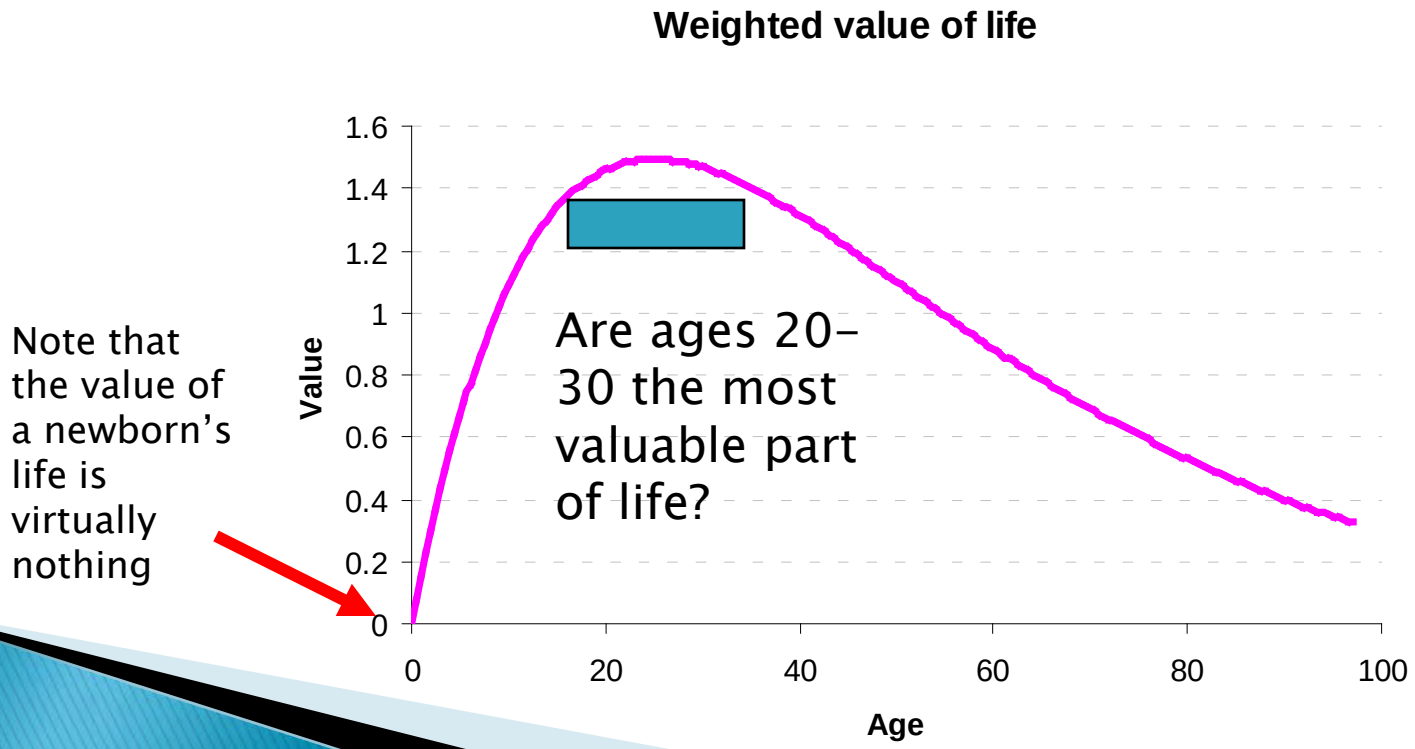
Part 2. The actual estimation of DALYs

The DALY construct

- Something about health that is "lost" rather than something "gained"
  - So 0 DALY is good and 1 is bad
  - versus the patient preference QALY, where 1 is excellent and 0 is bad
- Programs thus should aim at REDUCING DALYs
- Very controversially, in their first 1990s iteration, DALYs reflected age-specific differences in the value of health at different ages.

DALY Weighted value of life

- Specified the relative 'importance' of healthy life at different ages (World Health Organization, 1994)



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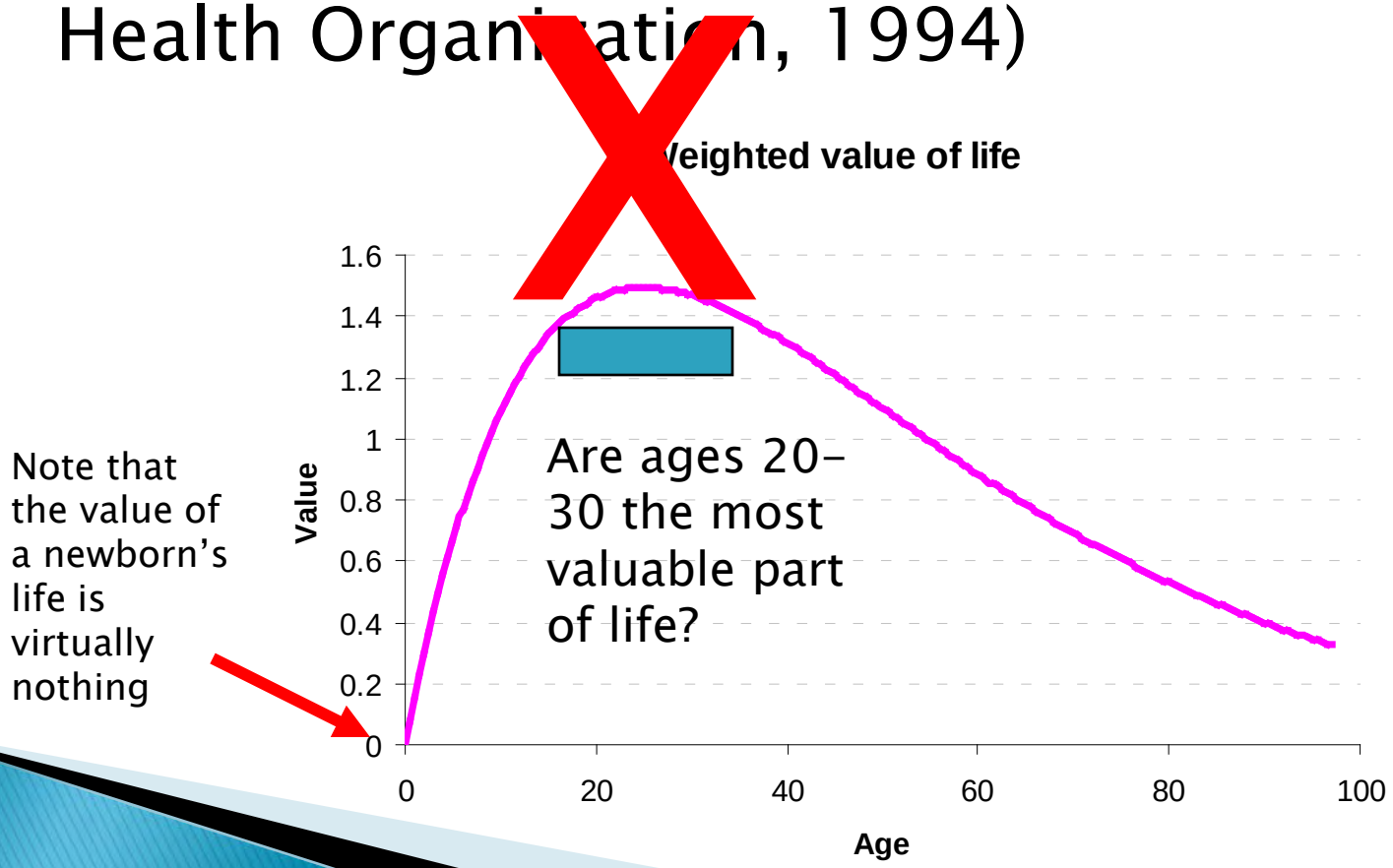


Elements of DALYs

- The DALY for a disease is the sum of
  - Present value of future **years of lifetime lost** through premature mortality = **YLL**
  - Present value of years of future lifetime adjusted for the average severity (frequency and intensity) of any mental or physical disability caused by a disease or injury = Years Lost to Disability (**YLD**)
  - **DALY = YLL + YLD**

YLL and YLD

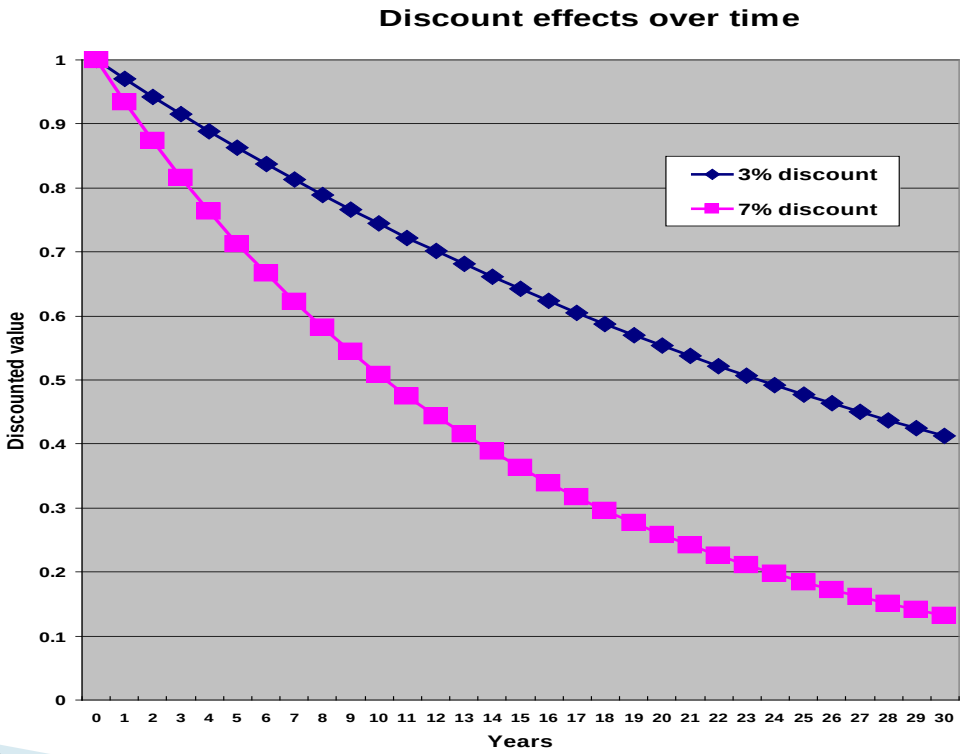
- YLL-Determine the years of life lost of premature mortality from specific diseases/injuries
- YLD -Each non-lethal state of health is assigned a 'disability weight' = Dw

Discounting

- Some health economists believe that future health burdens are discounted at a rate of 3% per year
  - A standard economic practice to avoid time-related paradox in spending decisions
  - This CAN undervalue infectious diseases since consequences can happen several years AFTER infection or acute symptoms
  - Contrasts with non-communicable disease where disease STARTS with symptoms
- Now DALYs are calculated both with and without discounting- you can choose.

Discounting of future events

- A standard health economics practice
- Debate is strong about the appropriate rate to use
- Both costs and utilities are discounted over time



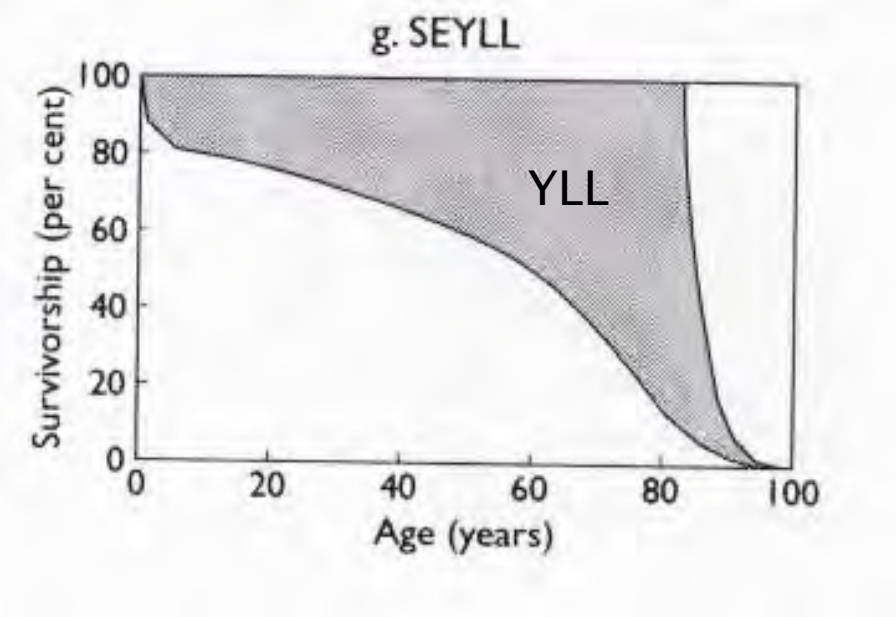
To the average policymaker, the DALYs for late, chronic onset outcomes will seem less 'compelling' than DALYs for acute outcomes, although investment today in prevention of late disease can be highly leveraged over time

DALY YLL Estimates of disease-specific age/sex mortality rates

- Uses the Standard Expected Years of Life Lost (SEYLL), compared to the best available (Japan), where females are expected to live 82.5 years and men 80 years

-- Biases large DALYs in favor of diseases that are 'childhood killers'

-- YLLs were ones of perfect health (really?)



DALY YLL Estimates of disease-specific age/sex mortality rates

- Another challenge: Need to find disease-specific death rates of comparable quality in each country
  - New implementation of demographic health surveys (DHSS) in multiple countries to provide birth, death vital statistics and disease incidence values.

Estimate the Years Lost to Disabilities (YLD)

- The simplest way to express this is:

$$YLD = I \times Dw \times L$$

- Where L is the duration of disability, Dw the disability weight and I the number of incident cases of the disability in the reference period

Deciding disability weights

- How can disabilities be quantified (for YLD)?
  - Need to estimate the sex/age stratified incidence rate of each condition in each region
  - Summarise each disease describing their disabilities in terms of
    - Probability of transition to next disability level
    - Duration of life with disability
    - Weight of disability (1-utility)
  -

GBD 2010–Determining which of 220 disease states are worse than the others

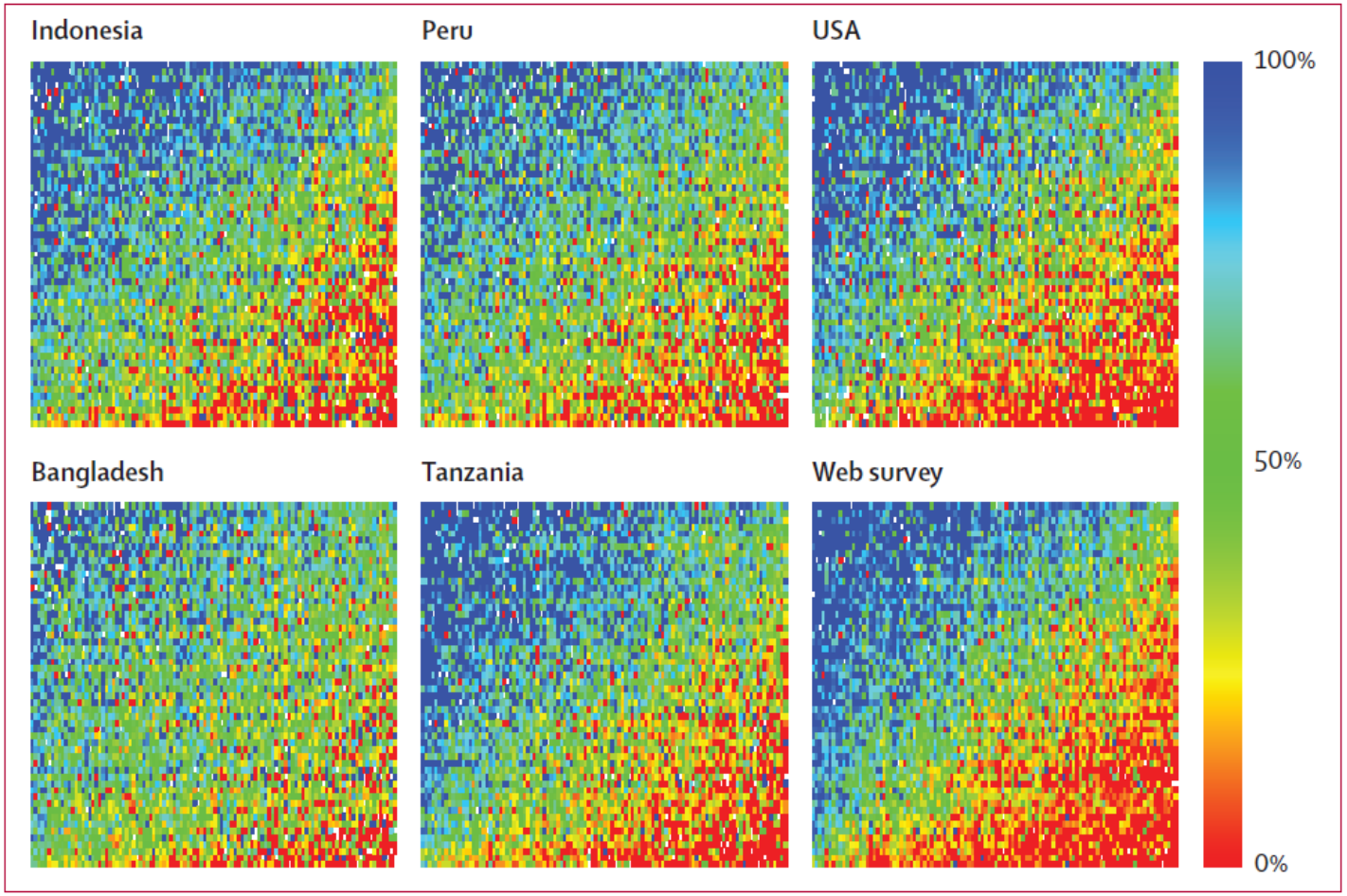


Figure 2: Response probabilities for paired comparisons in household surveys and the web survey

Some utility and 2012 DW values:

Disability	Utility	DW
Quadraplegia	0.327	0.673
Dementia	0.562	0.438
Blind people	0.805	0.195
Severe cognitive disability	0.843	0.157
Deaf	0.967	0.033
Infertile people	0.989	0.011
Protein calorie malnutrition	0.945	0.055

Salamon et al., Lancet 2012

Global burden of disease grouped by age and sex

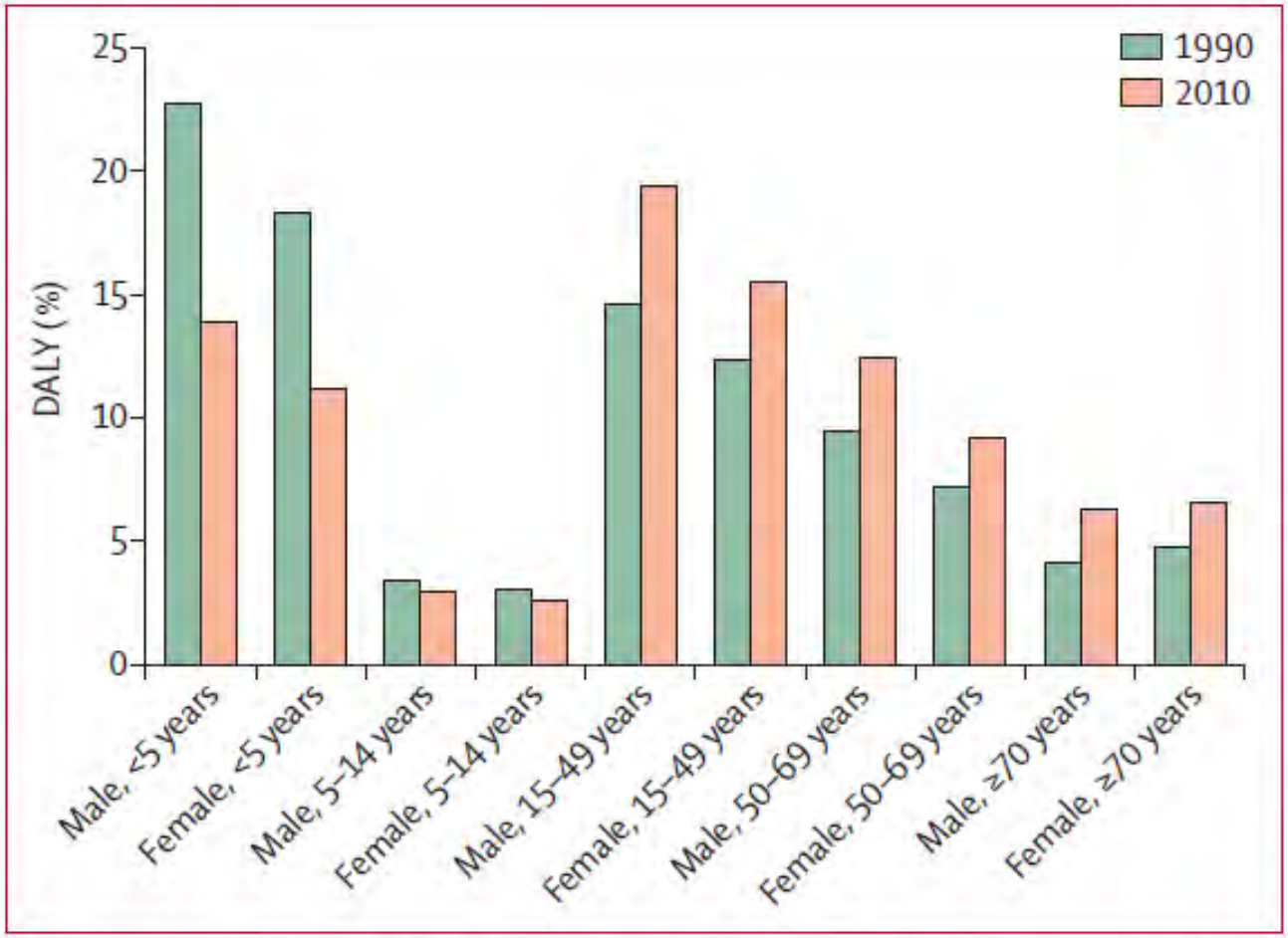
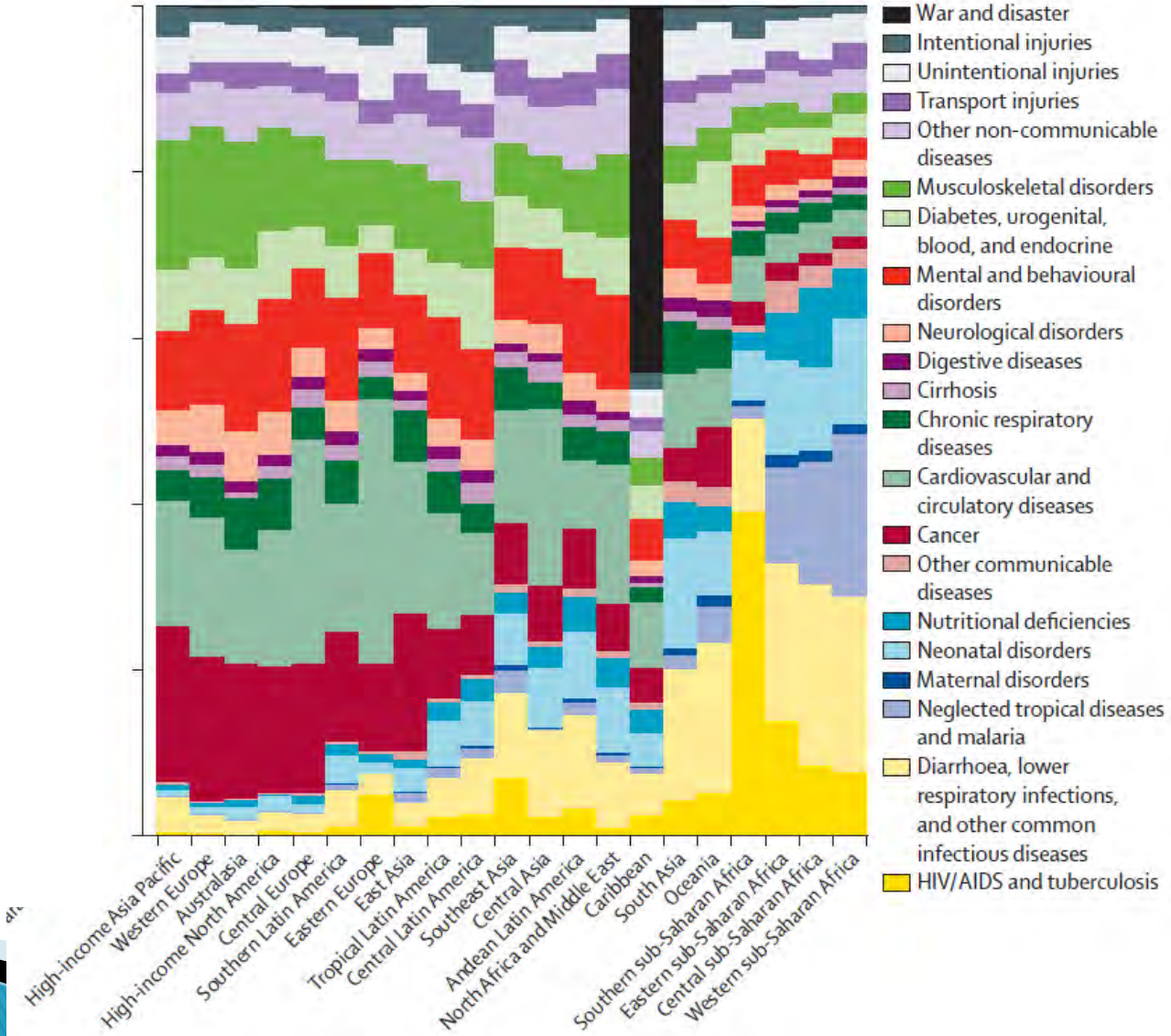


Figure 4: Proportion of disability-adjusted life years (DALYs) by age and sex, 1990 and 2010

Murray et al. Lancet 2012

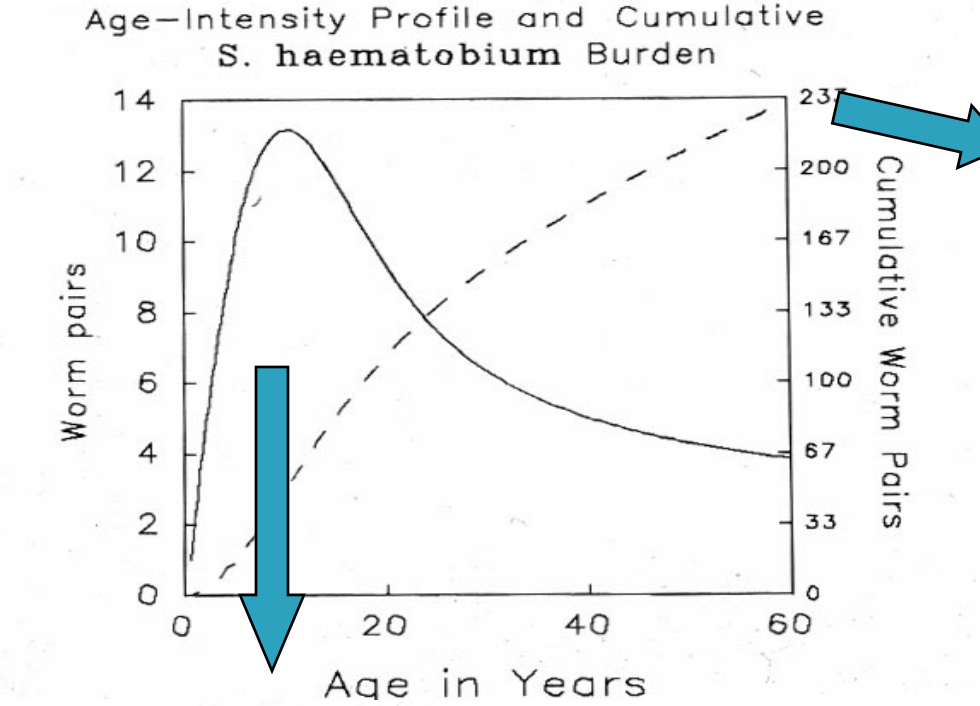
Global burden of diseases – DALYs by region



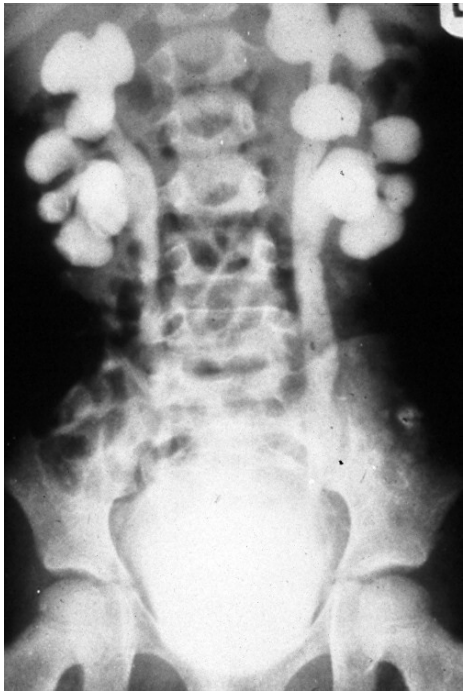
DALY Criticisms

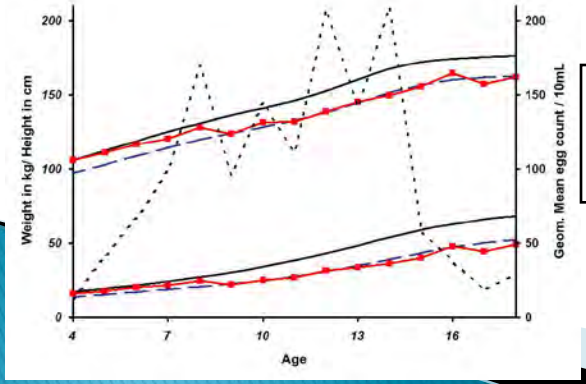
- Discounting future health gains & losses is disadvantageous for
  - Public Health, children, future generations
- Chosen estimates for life expectancy
  - Favourises women
- Age weighting disfavoured
  - Elderly and children
  - Those who are post-infection, i.e., When exactly, does disease occur as a consequence of parasitic infections?

When does disease occur?



Advanced fibrosis (late)





Growth stunting (early & persisting)

DALY Criticisms

- An inherently lower value is implied for extending disabled people's lives
- 'Like-is Like' Disability weights are the same in all countries, ignoring co-morbidities and the limited ability to adapt to disability in the face of poverty

DALY mantra

- DALY disability weights measure ‘health’ status, and not welfare
- ‘This is fair’ because it lets common perceptions of a disease state shape health policy and spending

Criticisms (cont'd)

- Death / birth registries
  - Quality varies significantly from country to country- underreporting in LDC biases against them in GBD calculations
- Incidence estimates
  - Based on literature
    - Validity? Many areas with only spotty or no data
    - What is reviewed?
    - How well???
    - These aspects are not well documented in the GBD reports

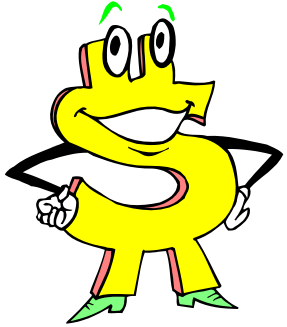
Part 3: Using DALYs to estimate utility…

Utility theory

- How people make decisions under conditions of uncertainty. Utility is the preference that people have for health outcomes along a continuum.
- Derived from Jeremy Bentham's 'Utilitarian Philosophy' (1789), as subsequently adopted for many kinds of economic analyses.
- Paretian welfare economics requires to accept that each individual is the best judge of his/her own welfare.

http://www.phac-aspc.gc.ca/phi-isp/state_preference-eng.php

Estimating "wellness"



		Measures		
		Natural units	Subjective values	Monetary values
"Feel good" indicators	Goods	No absolute scale, different "things"	Rank 2 alternatives Needs to assume cardinality	Convert utility in $ WTP, WTA
	Life-years	Change in risk of death under 2 scenarios	No measure	Contingent valuation (lecture 5)
	Health	Morbidity, pain, depression, disability, etc Very difficult	QALYs People remain best judges of their own welfare	Contingent valuation (lecture 5)

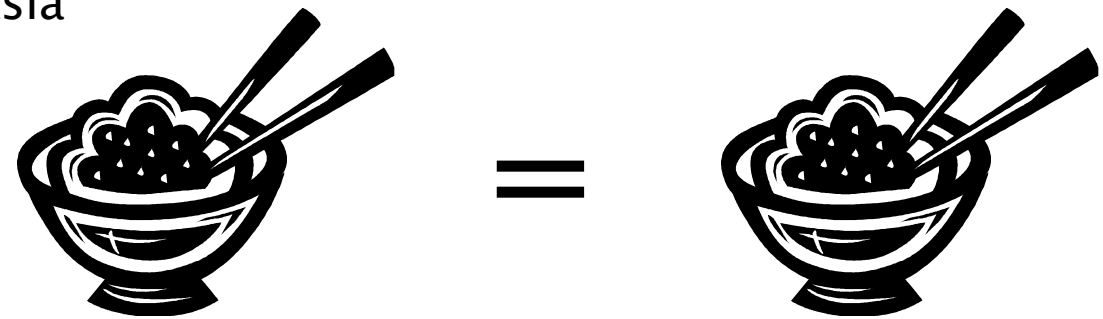
Estimating wellness

- Do the DALYs fit into these concepts?

‘Like is Like’

Asia

Africa



The ‘fungible’ nature of goods is a basic economic concept

Challenges in GBD assessment

- Multiplicity of health conditions to be assessed
- Multiple populations with different data reporting systems
  - Disease definitions
  - Quality of data support
    - Death certificates coding
    - Disease surveillance systems
- [Varying health impact across locations and cultures]
  - In theory, this should NOT be considered in GBD estimates….

Philosophy of Science Debates on health burden assessment–

- Positivist
  - Purpose is to develop principles and laws
  - Reality is based only on what is observable
  - Distinction between facts and values
  - Natural and social sciences should take the same approach
- Realist/Idealist
  - Individuals are capable of defining their own reality
  - Individual is an active creator of their social world
  - Research looks for mechanisms that determine reality

Varying approaches to health burden assessment- Level

- Sociological
  - The individual in terms of relations with others
  - Focus on groups and communities
  - System-level or aggregated data
- Individual
  - Impact on well-being, functioning, mental health
  - Objective or subjective reports on a given subject

Debates on health burden assessment- Measures

- Positivist
  - Inputs and Outcomes are defined, measured, operationalized
  - Researcher and subject are separate
  - Input cause predictable results
  - Collect 'value-free' facts
- Naturalistic
  - Multidimensional constructs, holistic
  - Requires close interaction with subject
  - More difficult to assign cause and effect
  - Values are made explicit in interpreting results

Important Health Status factors

- Assessments
  - Death
  - Disease
  - Disability
  - Discomfort
  - Illness
  - Wellness
  - Well-being
  - Functional Status
    - Self care
    - Work
    - Activity
- Dimensions
  - Physical health
  - Psychological health
  - Mobility
  - Independence
  - Social interaction: Family, Career, Religion
  - General satisfaction

The DALY construct:

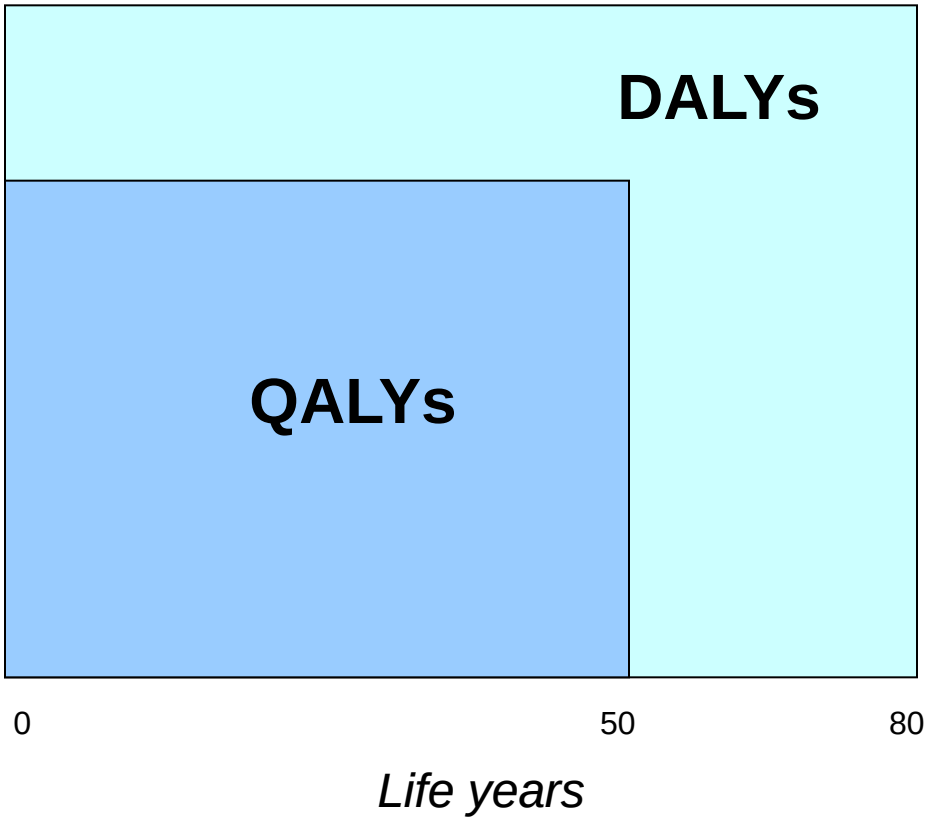
- Positivist approach to obtain an objective, context-free quantity
- Use of ‘community standards’ to determine disease impact
- Create a ‘normative’ value
- Useful for social policies and programs

The QALY alternative

- Quality Adjusted Life Year
- Life-years with a health condition are given a subjective value between 0 (death) and 1 (perfect health) based on patient and non-patient evaluations.
- Methods:
  - Standard descriptive systems such as the EuroQol EQ-5D or SF-12 questionnaires, which categorise health states according to dimensions such as mobility, pain and anxiety
  - Standard scales have been linked to utilities
  - Time-trade off or Standard Gamble also used
  - Weight assigned to a particular condition may vary, depending on the population surveyed. Those who do not suffer from the disease will, on average, overestimate the detrimental effect on quality of life, compared to those who are afflicted. This is due to adaptation.

How does it work? (idealized)

Disability weighting	QALY	Health State
0	1.0	**Perfect**
0.33	0.67	**Deafness**
	▪	
	▪	
	▪	
	▪	
1.0	0	**Death**



Arnesen & Nord, 1999

Some Hidden Assumptions

- In a Cost-Utility calculation, we assume that there is a consistent linear relationship between costs and outcomes
- In GBD assessments, we assume that the impact of disease is the same in all settings
- We assume that the consumer is well informed and behaves rationally in making choices.

BUT, Who decides the value?

- A basic law of economics is:
  - "The value of an item must not be based on its price, but rather on the utility that it yields."
    - Daniel Bernoulli, 1738
  - Utility of a purchase means usefulness or satisfaction to the consumer, and not the monetary value of the purchase.
    - Ex utility of a radio vs that of a TV for a blind person vs a seeing person

Who decides the utility?

- Is it a policy maker or the patient who is the consumer for public health interventions?

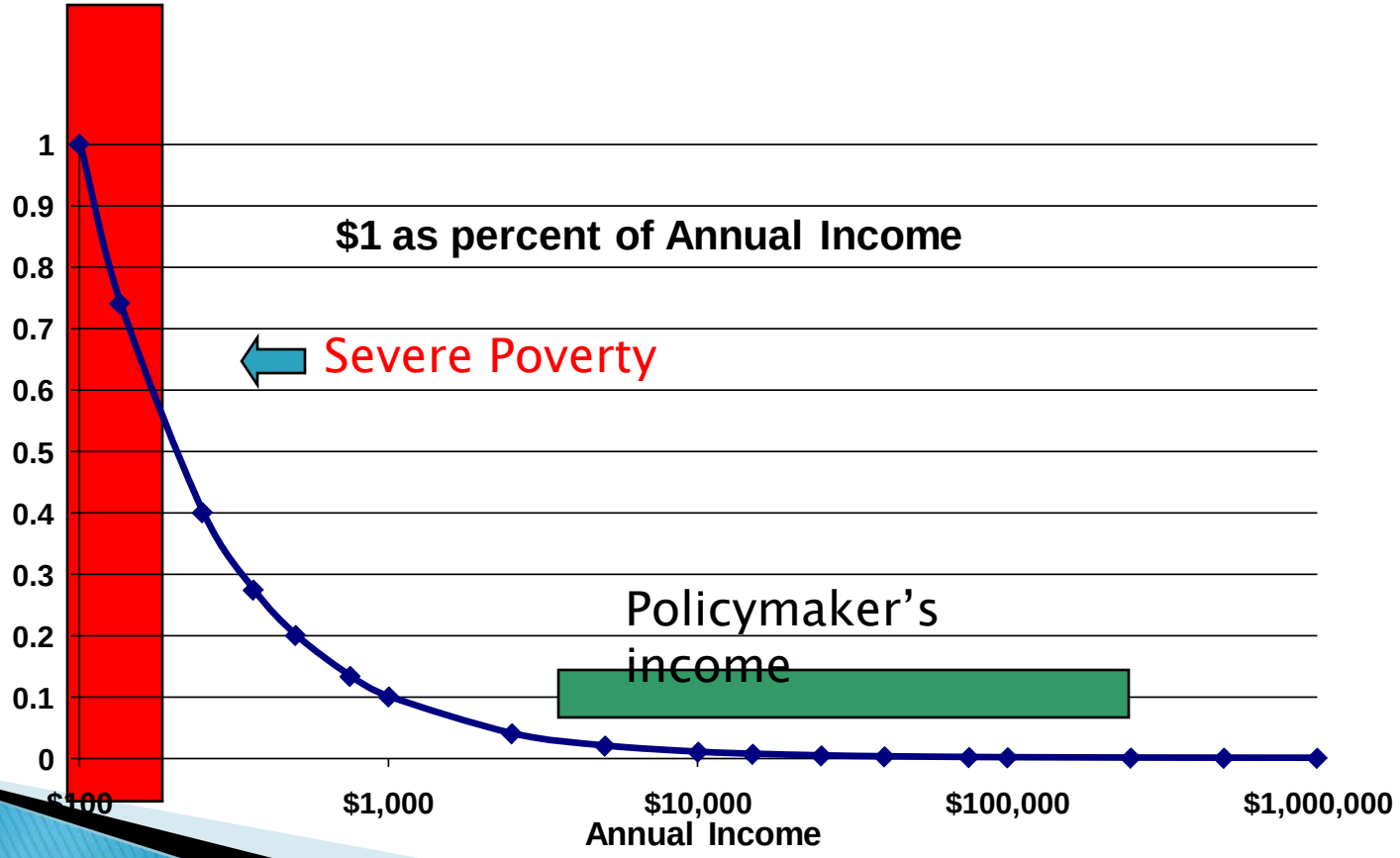
Deciding on interventions:

- “Any decision relating to risk involves two distinct and yet inseparable elements: the objective facts and a subjective view about the desirability of what is to be gained, or lost, by the decision. Both objective measurement and subjective degrees of belief are essential; neither is sufficient by itself.”
  - P. Bernstein, 1996

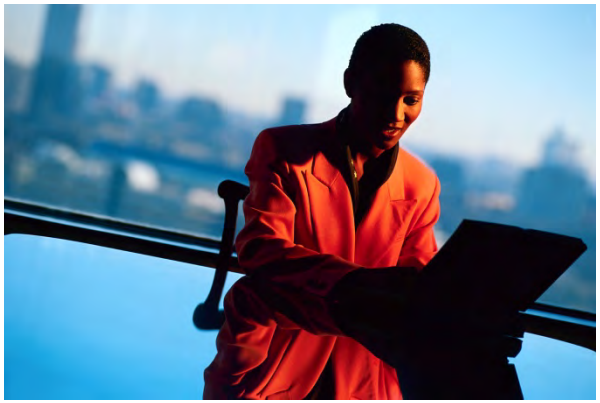
ALSO, utility can depend strongly on context, and is non-linear in poverty

- "The utility resulting from any small increase in wealth will be inversely proportionate to the quantity of goods previously possessed"
  - -Daniel Bernoulli 1738
- This can have a strong asymmetric effect on decision-making

Non-linear outlook on program costs and health gains

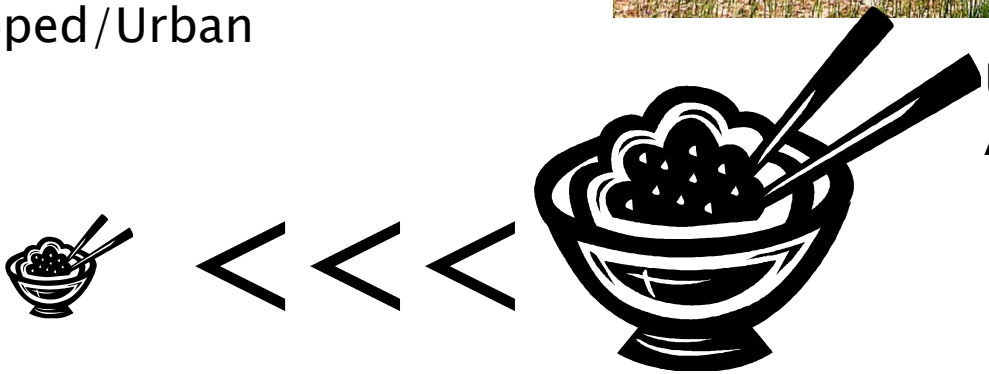


‘Like is NOT Like’



Developed/Urban

Underdeveloped Africa

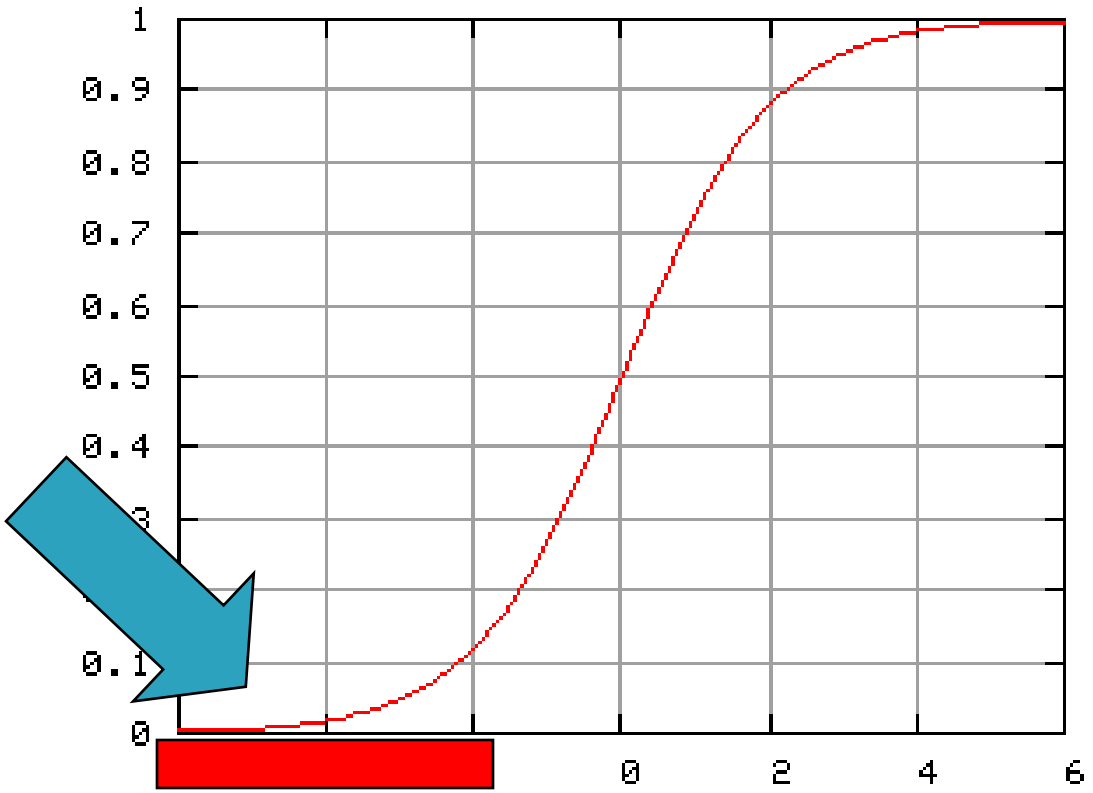


The relative utility of goods will depend on context

In the context of poverty there are non-linear differences in the efficacy of treatment on health outcomes

Individual poverty *and* residence in an impoverished environment combine synergistically to impair improvement from single health interventions.

Co-morbidities are important effect modifiers



The 'poverty trap'

Schwartz, Am J Pub Hlth, 1994; Sachs *The End of* Poverty, 2005

In the context of poverty…

- Are patients truly informed about the causes for infection, the complications of infection (acute and chronic symptoms), and the potential risks and benefits of treatment?? (KAP studies)
- If NO, then standard economic analysis does not apply…

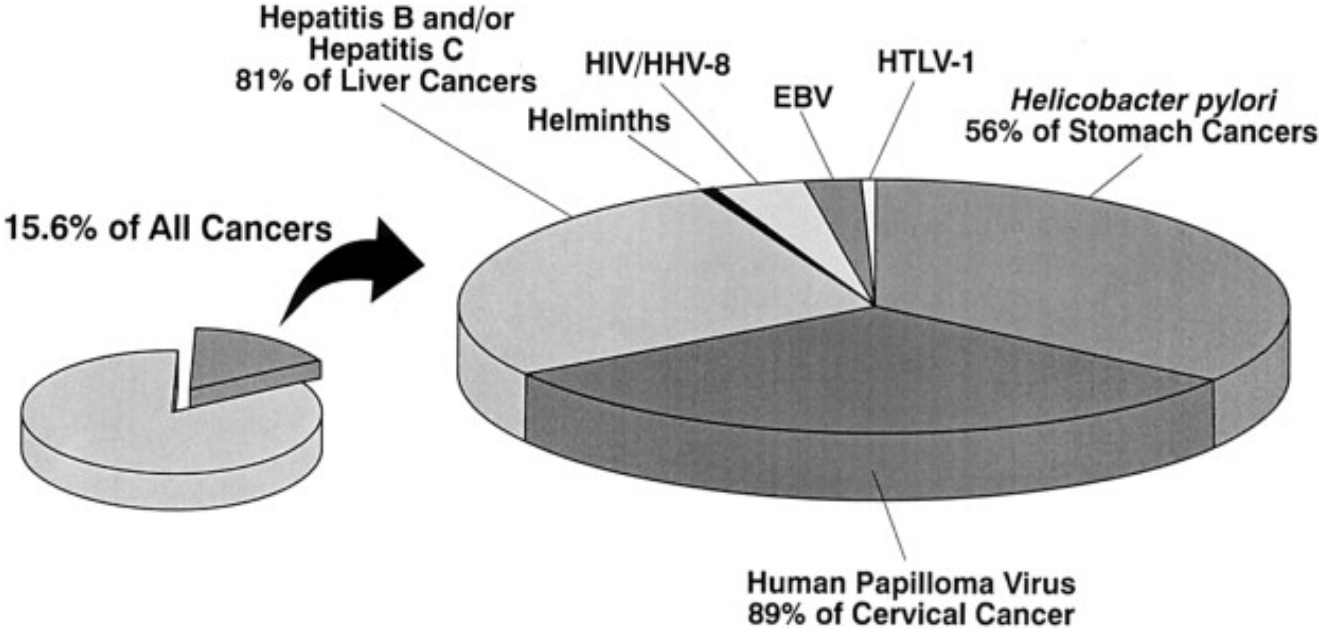
Other DALY limitations

- Only One-person = one disease is allowed
- The use of lists from International Classification of Diseases (ICD-10):
  - GBD often conflates well-defined diseases with other undifferentiated syndromes (e.g., anemia, infertility) that are caused by multiple etiologies
  - DALY weights can thereby separate chronic infections from their common complications
  - Concurrent morbid conditions could not be included in DALY burden estimates
  - Infections with multiple symptoms not accounted for
  - Consequences of infection counted in chronic disease, NOT in infection

Other DALYs limitation

- ICD coding / misclassifications
- Chronic diseases caused by infections
  - CVD
    - Some could be explained by ID
  - Neoplasms
    - Cervical cancers, liver cancers
  - Neuropsychiatric
    - Several ID

Other DALYs limitations



From: Pisani P, Parkin D[illegible] Munoz N, Ferlay J. Cancer and infection: estimates of the attributable fraction in 1990. Cancer Epidemiol Biomarkers Prev **1997**, [illegible]7-400.

Other DALY limitations

- For cause of death, there was very highly variable quality of data inputs
  - National vital statistics differ
  - Many entries based on best guesses
- For disability weights, reliance on 'average' age-specific impact, with limited knowledge about range and asymmetry of disease distribution.
- Too difficult to disaggregate attributable risk for syndromes with multiple causes (anemia, epilepsy, depression, etc.)

QALY limitations

- Disease impact may vary depending on location
- A more global measure, which means its is more difficult to assign cause and effect, attributable risk
- Non-linearities of poverty still make cost-utility analysis problematic

DALY vs. QALY

	DALY	QALY
Disease burden assessment	Expert Panel PTO ranking	Patient interview with standardized questionnaire
Metric	Perceived disability impact, ranked without adaptation	Fraction of full health, based on evaluation of multiple dimensions of performance
Perspective	'Societal', but based only on expert panel input	'Societal', based on patient and community inputs
Rationale	Single standard ('Like-is-Like') means 'fairness' across all settings	Asymmetries and complexity of disease formation require consideration of context. Patient perception defines adherence to care
Consumer	Policymaker, World Bank	Patient
Likely Outcome	Program Efficacy	Effectiveness (Welfare)

Ex DALYs for schisosomiasis

- The initial 1990s GBD initiative allocated a Dw to all forms of schistosomiasis infections in a combined weight:
  - Did not reflect associated long-term morbidities
  - Ranged between 0.005 to 0.006
  - This means that
    - extending the life of 1000 healthy people is the equivalent of extending the life of 1005 or 1006 people with schistosomiasis for exactly 1 year
    - Extending the life of 1000 health people for 1 year is the equivalent of treating 1005 or 1006 people with schistosomiasis for 1 year…
    - So basically, someone with schistosomiasis looses 0.5% of his/her utility

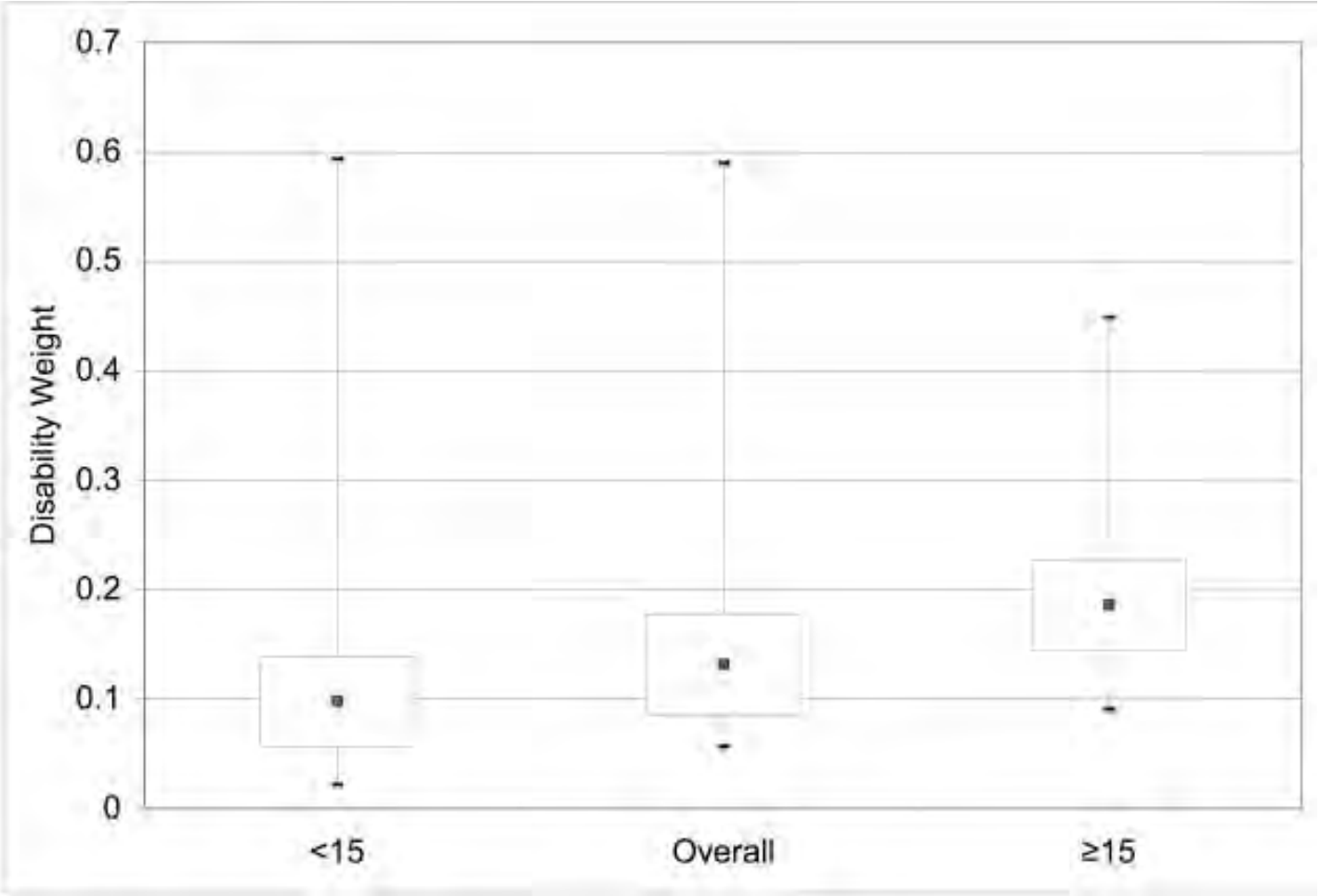
Example: DALYs for schisto

- Evidence-based reviews of all morbidities known to be associated with schisotome infection and their schisto-attributable fractions (AF), indicate a 2%-15% overall disability for all forms of schistosomiasis, and a greater 10-20% disability for *S. japonicum.*

King, et al., Lancet 2005; Finkelstein et al, 2008

Example: DALYs for S. japonicum

- Lit review of publications on morbidities associated with *S. japonicum.*



Finkelstein et al, 2008

Example: QALYs for schisto

- In 2004-5, residents of two schisto-endemic counties in China with *S. japonicum* were assessed for disability and morbidity using the European quality-of-life questionnaire with cognitive dimension (the "EQ-5D plus") and ultrasonography.
- Diarrhea was the most common symptom (46%), followed by abdominal pain (33%), impaired capacity to work or study (31%), and blood in the stool (11%).
- More than half of respondents reported impairment in at least one dimension of the EQ-5D plus, particularly pain or discomfort (48%) and anxiety or depression (39%).
- The overall calculated disability weight was 19%, and age-specific weights ranged from 9.5% among those aged 5–14 yr to 25% among those aged > 60 yr.

Jia et al, Bull WHO 2007

Next Lecture

- More about QALYs, how they are measured and how they are used as utility estimates.

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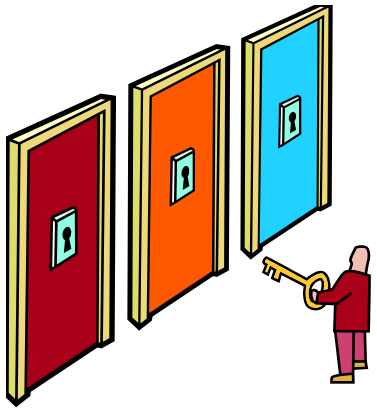
Lecture 4: Using the QALY Alternative

C King MD MPH
H Carabin DVM PhD

Part 1: Cost-utility analyses



Difference between cost-effectiveness and cost-utility

- Natural units
- Single
- Programme-specific
- Unvalued
- Intermediate output ok

Outcomes of CEA

- QALYs or DALYs
  - DALYs to be debated
- May be multiple
- Generic
- Valued
- Need final outcomes
- Uses utility weights to reflect relative desirability of health states

Outcomes of CUA

Why use cost-utility analyses?

- Outcome of interest IS health-related quality of life (ex arthritis)
- Health-related QoL IS an important part of outcome (ex. ICU for VLBW babies)
- Need a common outcome for morbidity AND mortality
- Several diseases studied (HUMAN diseases)
- Want to compare to other CUAs

Utility, value and preference

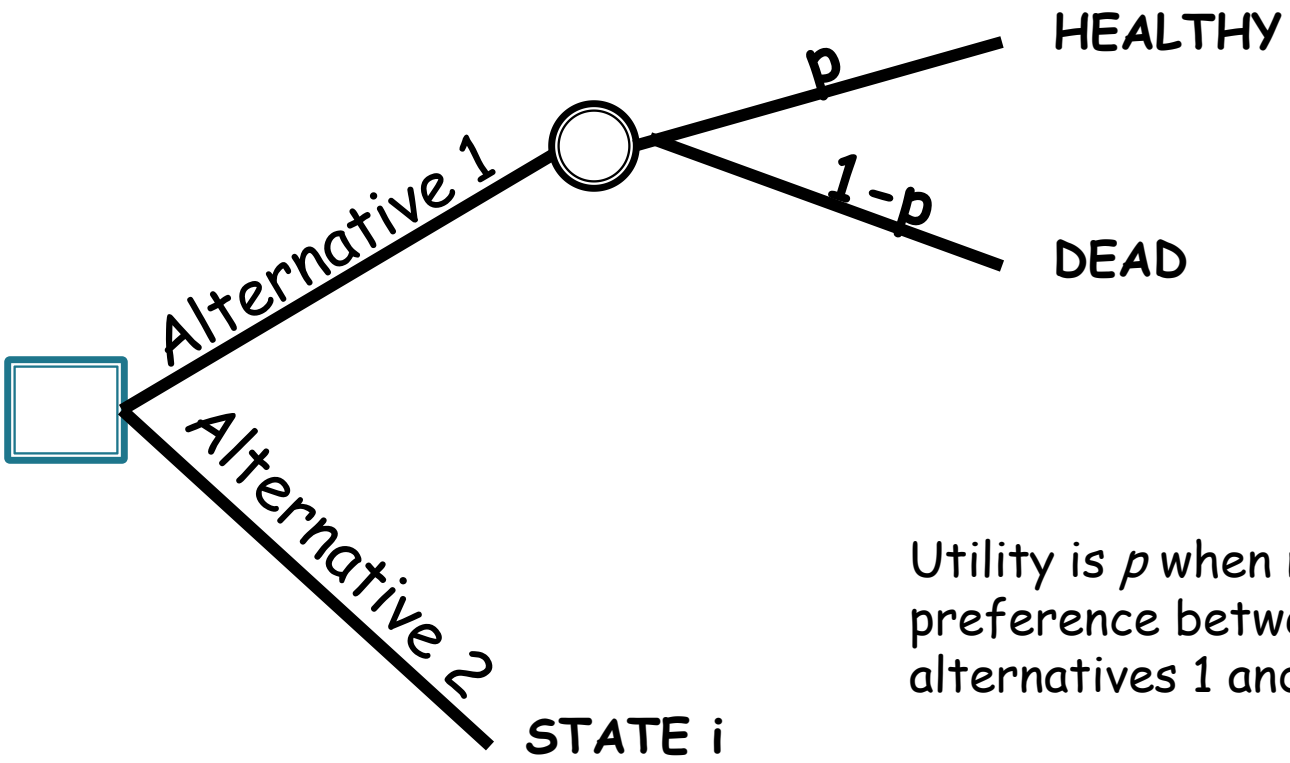
Response method	Question framing	
	Certainty (values)	Uncertainty (utilities)
Scaling	Rating scale Category scaling Visual Analog Scale Ratio Scale	
Choice	Time trade-off Paired comparison Equivalence Person trade-off	Standard Gamble

Taken from Drummond et al., 2005 (p 143)

Utility, values and preferences

- Question framed with certainty
  - Does not measure risk attitude
  - Uncertainty requires probabilities of outcomes
- Response method
  - Scaling
    - takes less time
    - Introspective questioning
  - Choice
    - More natural
    - Comes from economics concept of revealed preference approach
  - Choice-based methods generally preferred

Example – utility with standard gamble



Utility is *p* when no preference between alternatives 1 and 2

Taken from Drummond et al., 2005 (p 150)

Utility, values and preferences

- All measures in the table measure PREFERENCES
- Only standard gamble measures UTILITY
  - But other measures of choice can be rescaled to estimate utility
  - Even then, not quite utility in the economics sense
- For states preferred to death
  - SG > TTO > VAS scores
- Differences between choice-based measures
  - Risk attitude

Multi-attribute health status classification systems

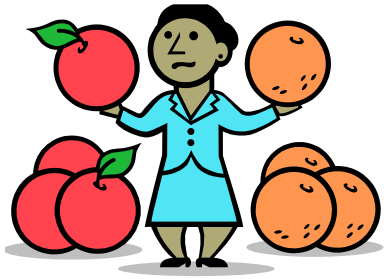
- Alternative to bypass measurement task of choice based measures
- Uses a pre-scored multi-attribute classification system
- Standardized and validated
  - General health (generic)
  - Disease-specific
- Examples of generic scales:
  - Quality of Well Being (QWB)
  - Health Utility Index (HUI)
  - EQ-5D (developed by EuroQol)
  - SF-6 (developed by RAND corporation)

Multi-attribute health status classification systems

- Attributes (domains)
  - Those included depend on the questionnaire
  - Ex. mobility, self-care, pain, role functioning, social functioning, etc
- Levels of each attributes
  - Number
  - Description
  - Severity of the most severe level
- Instruments used to determine preference scoring
  - Standard-gamble, TTO, etc
- Theoretical method to model utility
  - Econometrics, utility, etc

DALYs vs QALYs

- An example with schistosomiasis



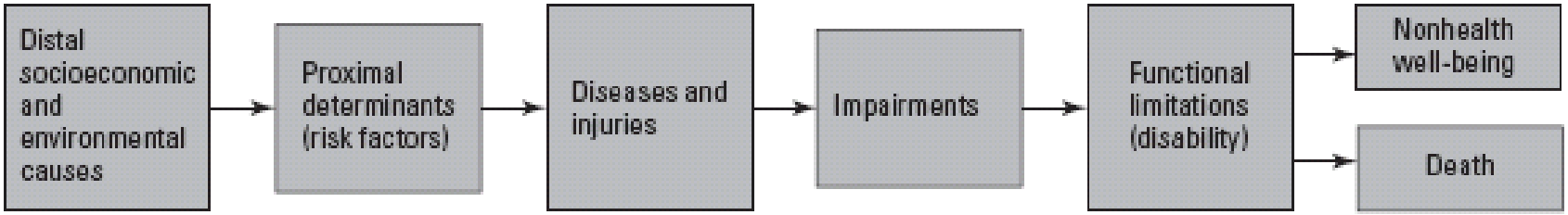
DALY, QALY, what's the difference?

- The first disability factors (Dw) for the DALY was assigned by focus groups
  - The person trade-off (PTO) method
  - Limited number of utility values
  - The new version (published in 2012) used paired comparison, category scaling and pseudo PTO methods
    - Group of experts made up vignettes for health states
    - Select groups of healthy people in developing countries chose preferences between paired vignettes
    - Methods described by Salomon et al., Lancet 2012
- QALY disabilities are based on *patient* interviews and patient preference techniques

Why Quantify Disability?

- Disability = 1 – utility
- Policy-makers and donors wish to provide maximum "benefits" for resources expended
- Want a utilitarian comparison across all possible disease control strategies
- Maximize cost-effectiveness of funds spent:
  - $[cost_1 - cost_2] / [utility_1 - utility_2]$
- This was impetus for earlier DALY rankings in the Global Burden of Disease projects

WHO/World Bank Global Burden of Disease Program framework for disease burden assessment & Public Health prevention

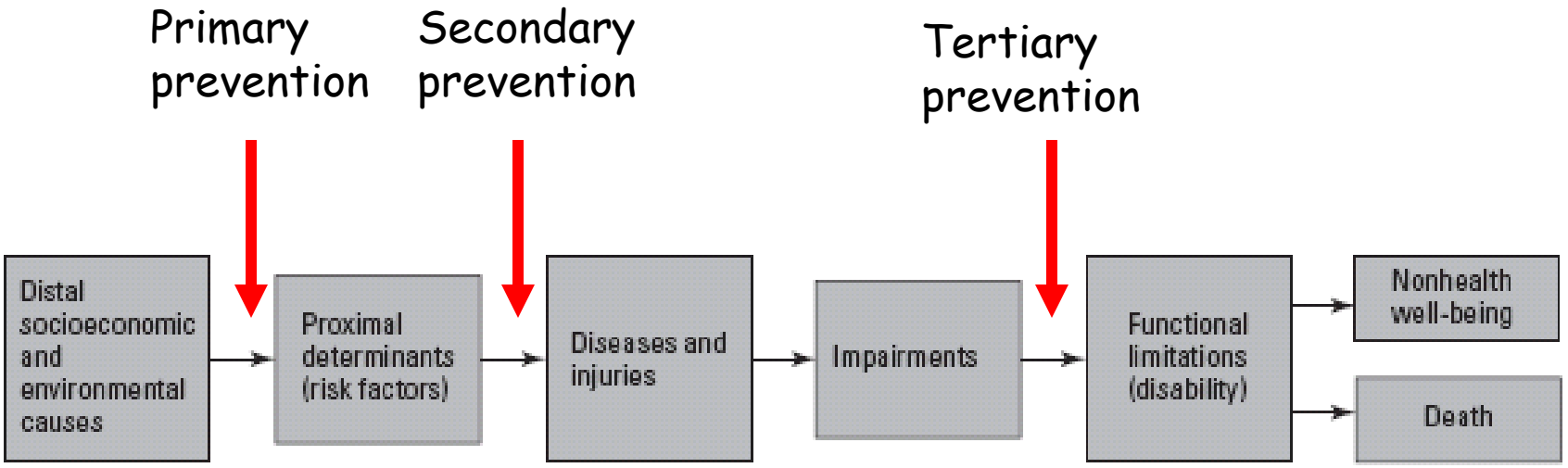


Source: Mathers and others 2002.

Note: This presentation is intended as a broad schema: for example, some exposures, such as environmental factors, can be proximate causes of disease, and injuries can lead directly to death.

Figure 1.1 Overview of Burden of Disease Framework

Where does PH prevention come into play in that scheme?



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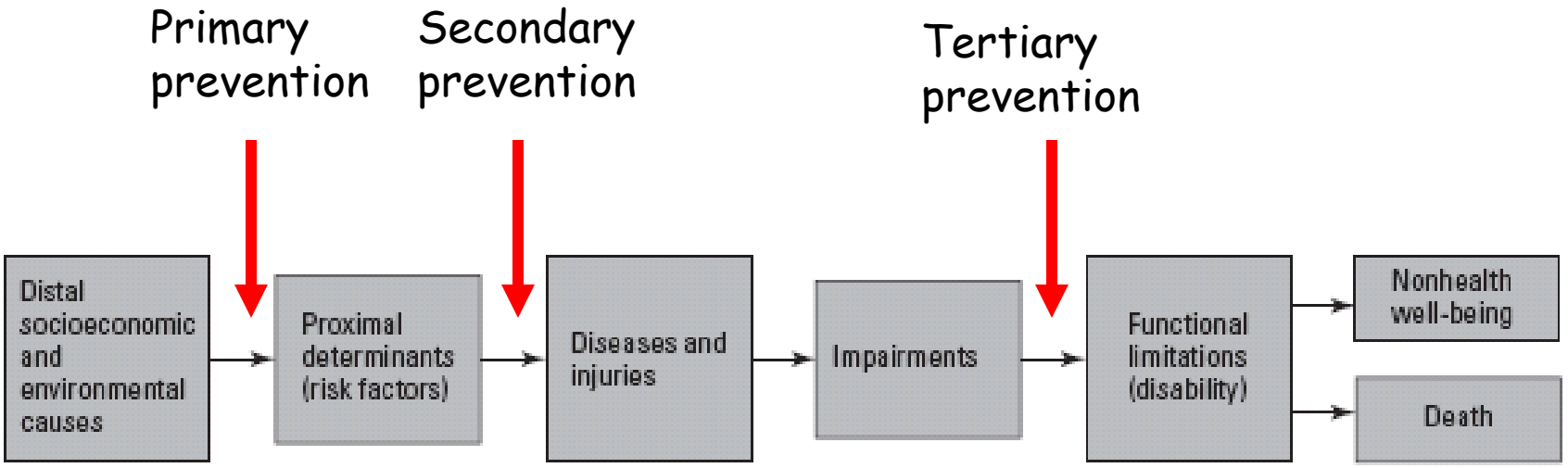

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Does everyone with the same impairment have the same disability?

Where does PH prevention come into play in that scheme?

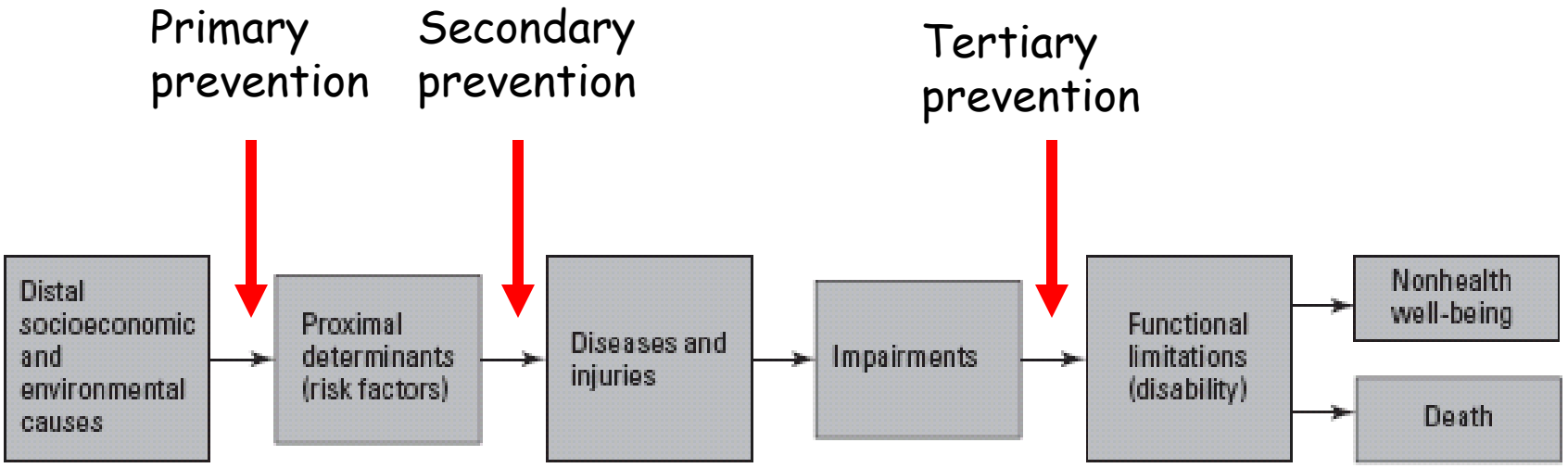

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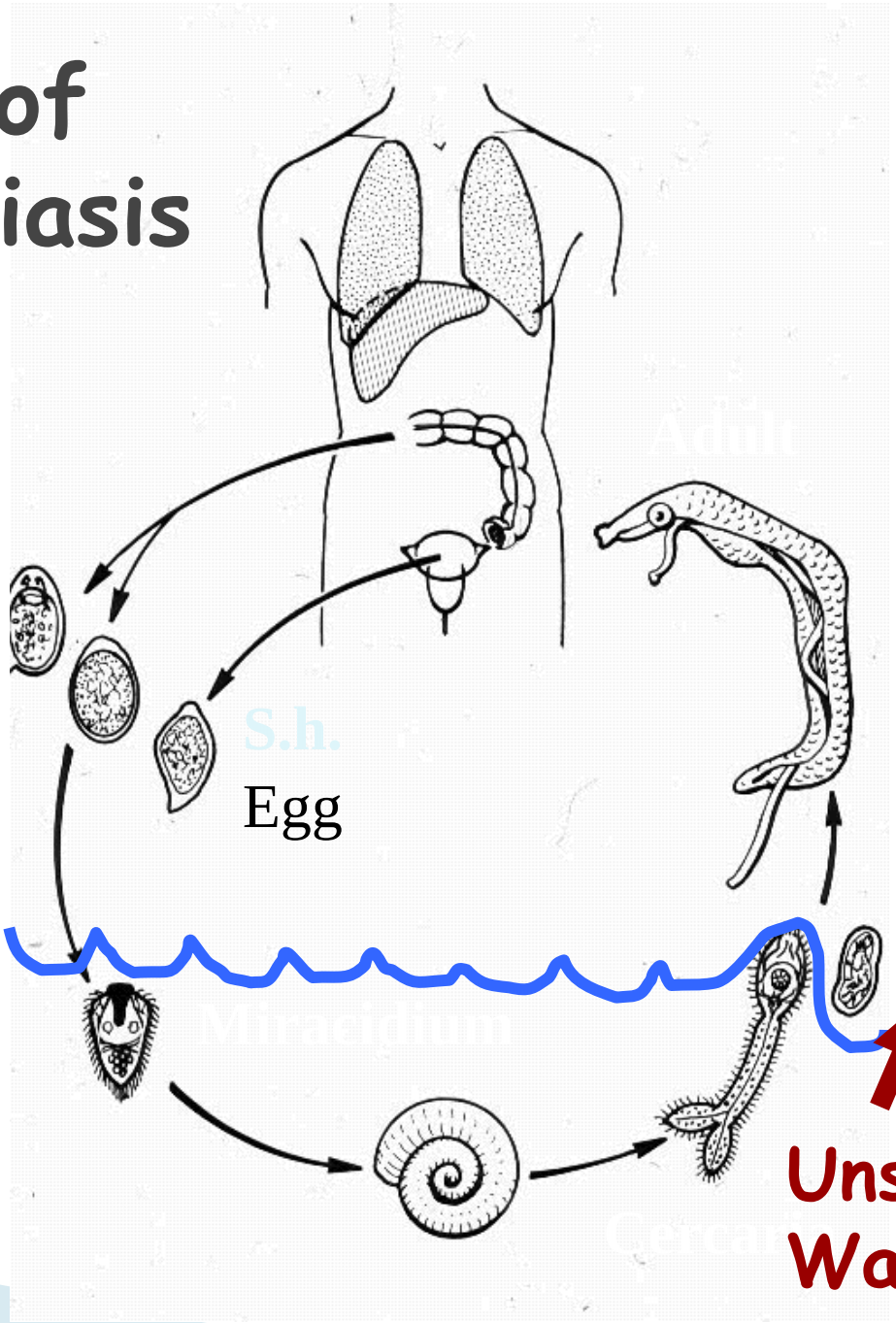
Figure 1.1 Overview of Burden of Disease Framework

Does everyone with the same impairment have the same disability?

NO!

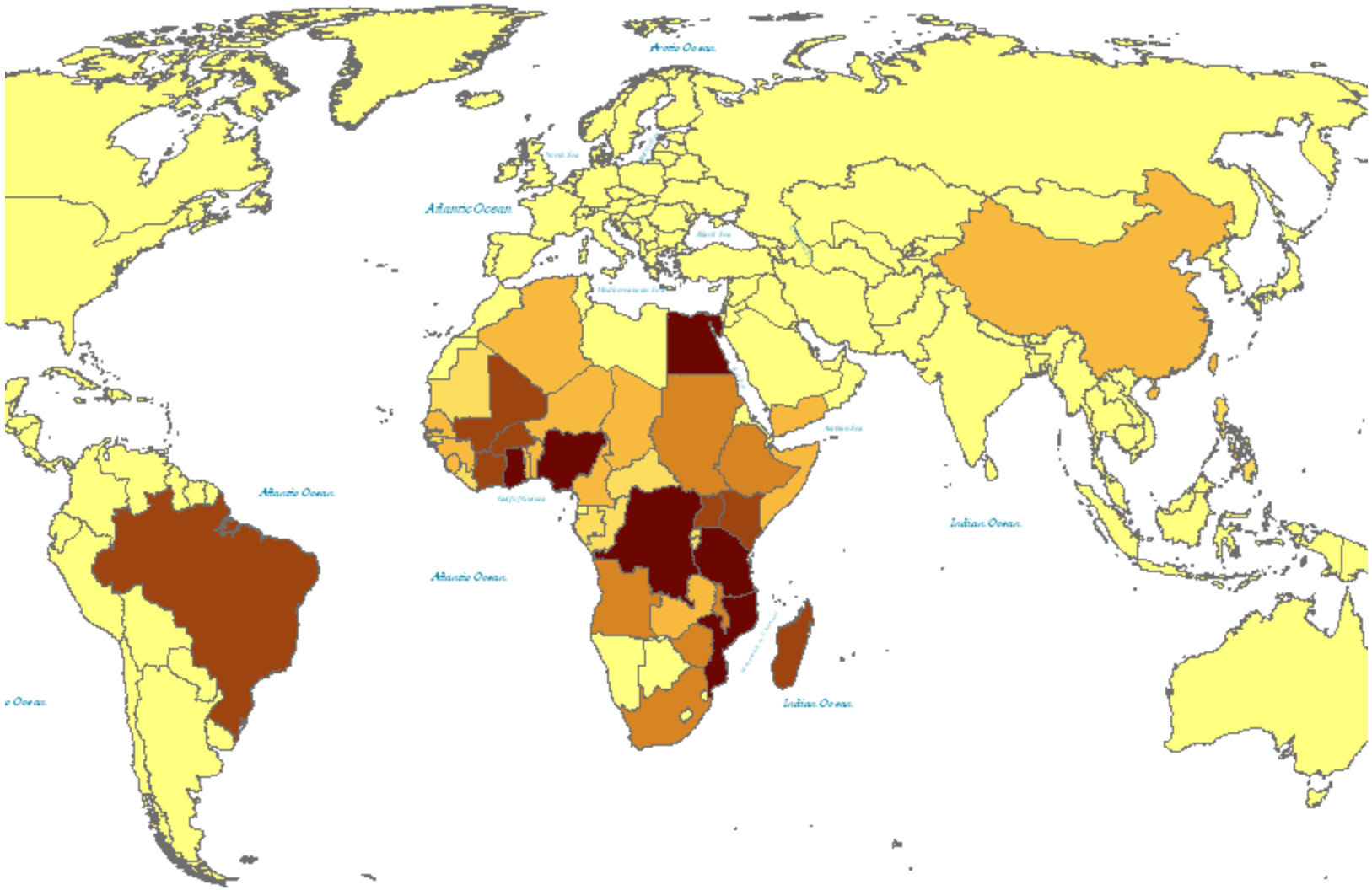
Life Cycle of Schistosomiasis



Sewage Contamination

Unsafe Water

S. japonicum transmission site



The Global Problem: 207 million cases, 779 million at risk

An important question for calculating the Global Burden of Disease：

What is the
average *disability*
of a person infected by
schistosomes?

Choosing the QALY

- Why use patient preference approaches to disability assessment?

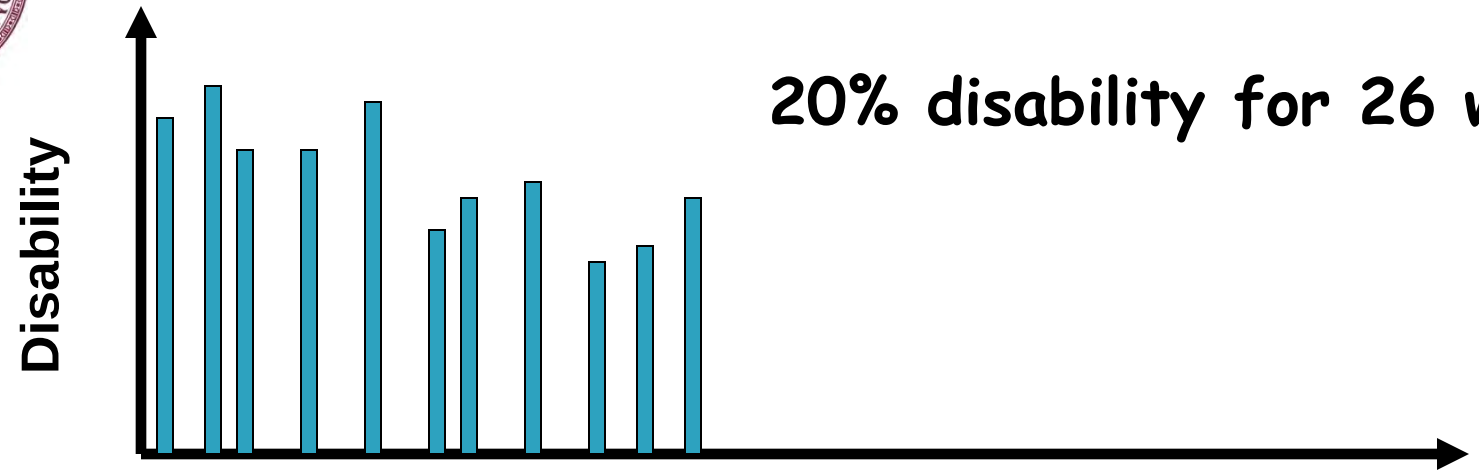
Choosing the QALY

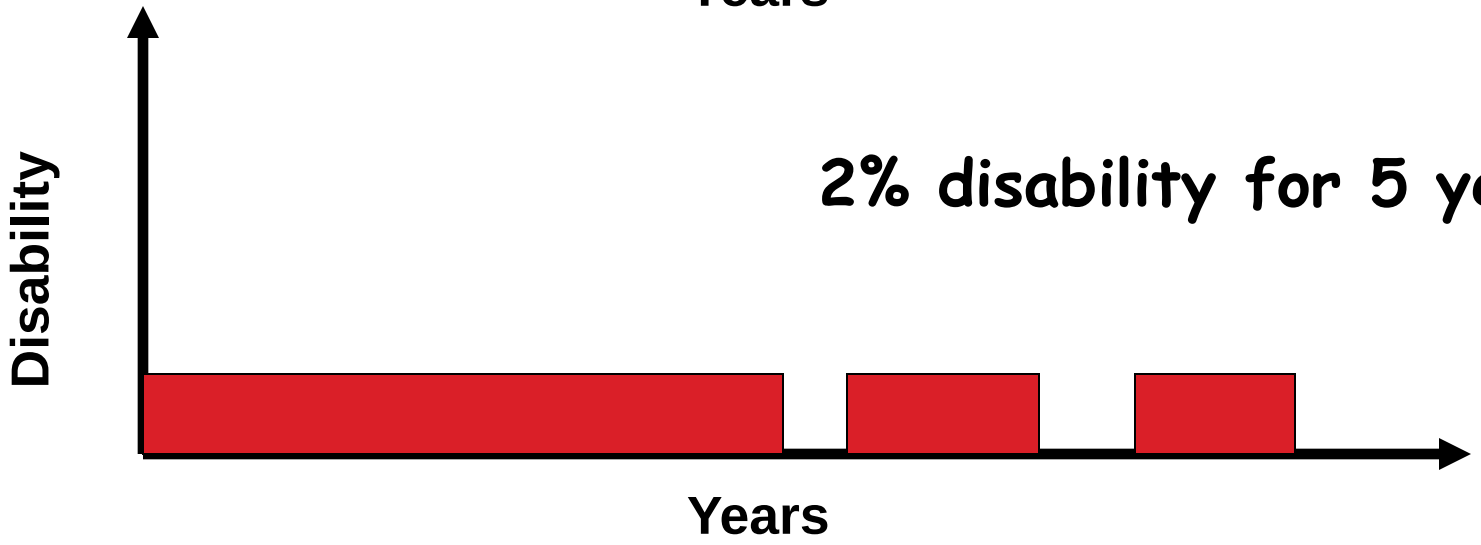
- Why use patient preference approaches to disability assessment?
- Persons without experience of the disease will not fully appreciate its impact

Problem # 1

- Appreciating the impact of schistosomiasis on patient health status and day-to-day performance

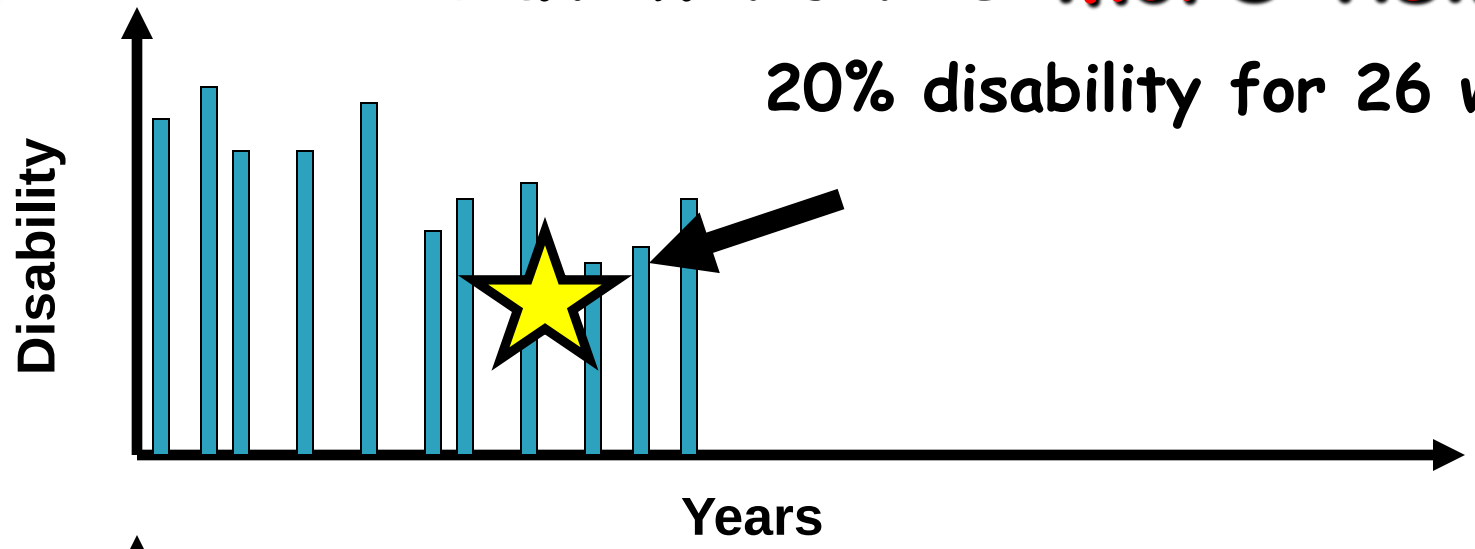
Which is worse?

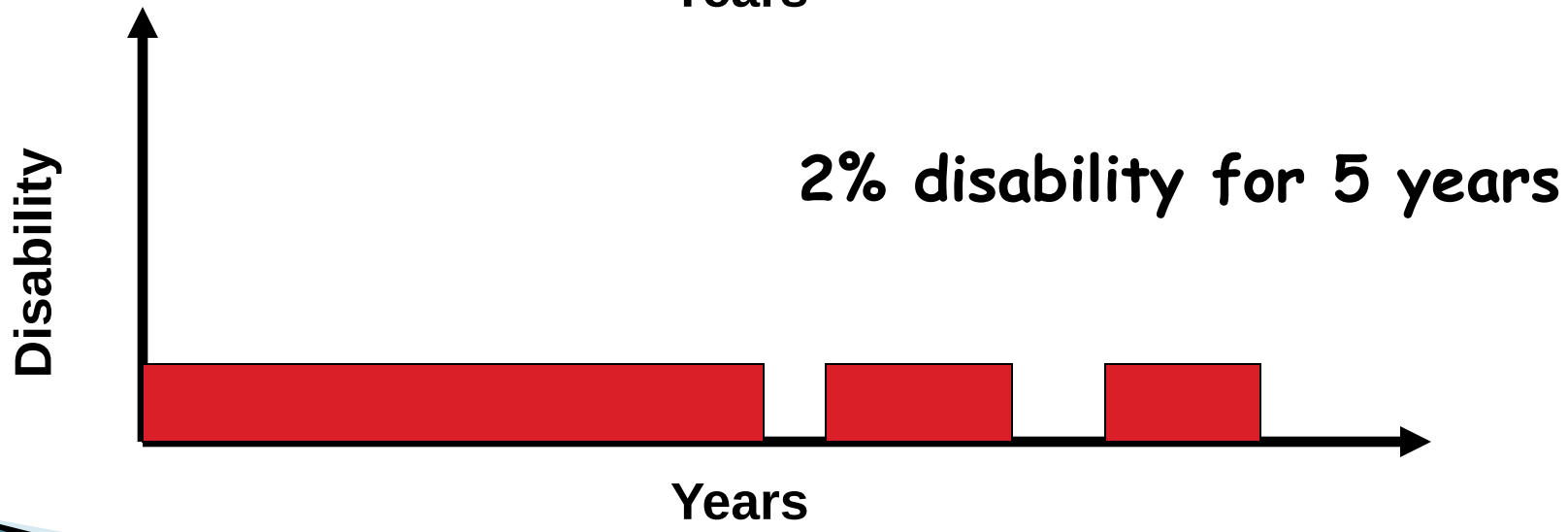




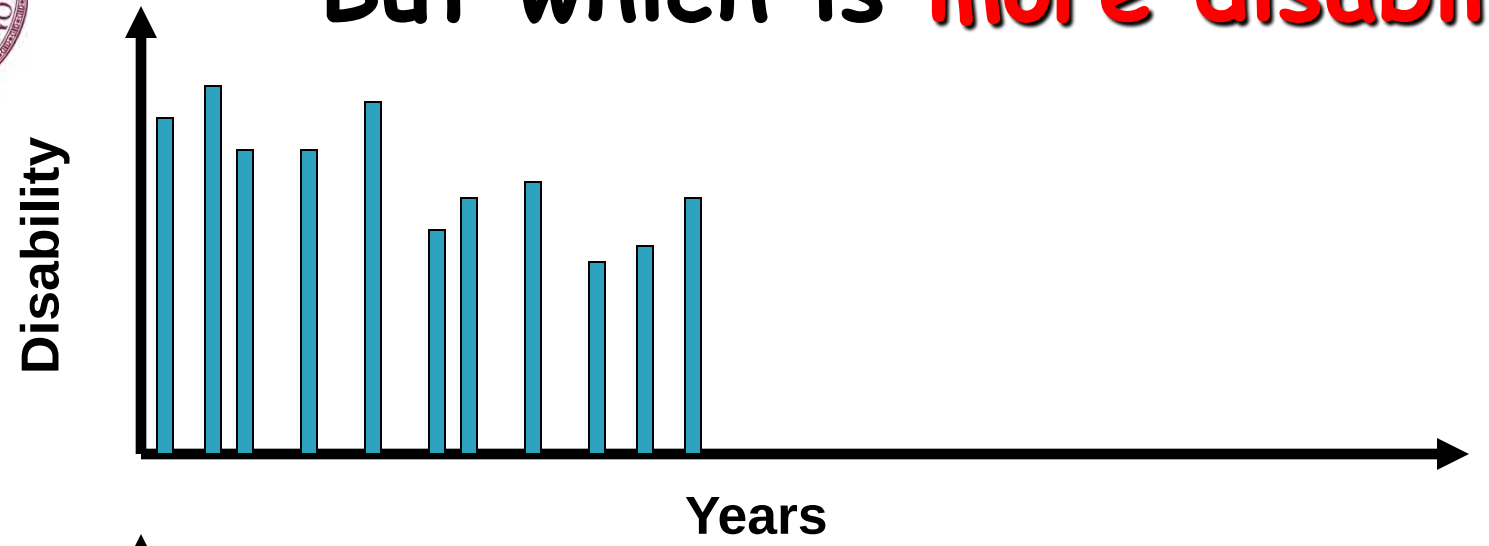
A. By basic DALY computation, 1 is worse (due to discounting)

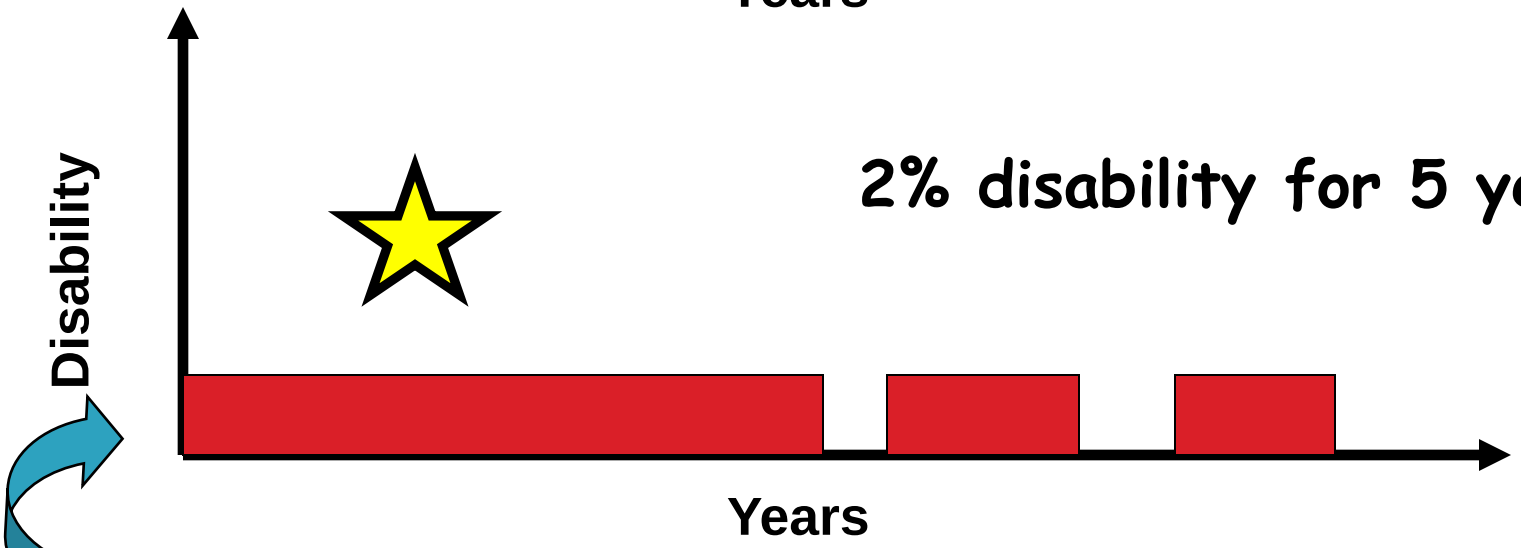
But which is more visible?





But which is more disabling?





2% disability for 5 years

'Small' values are more difficult to measure objectively, but may be highly significant to the patient in causing their disability

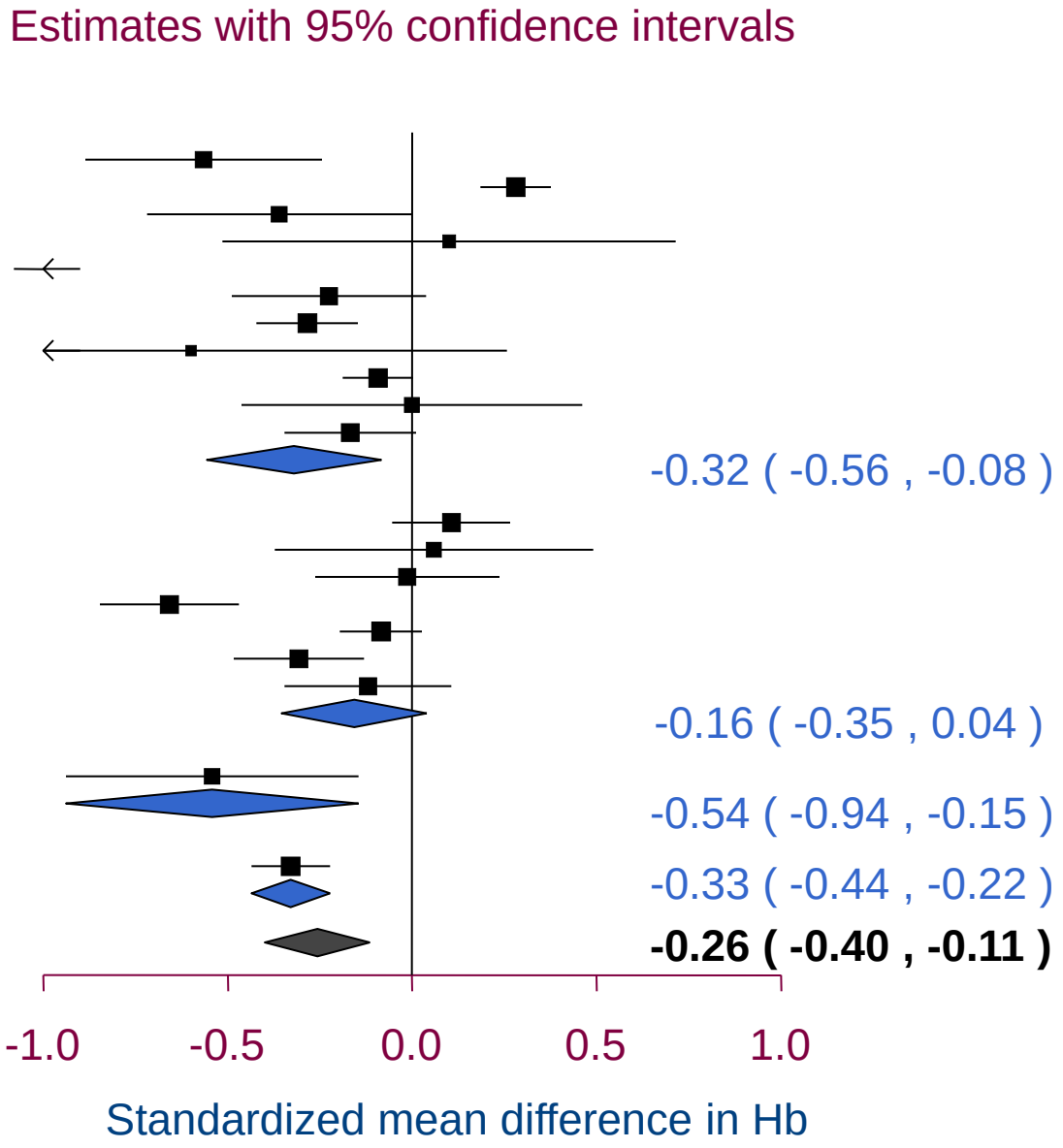
- What is the available evidence about schistosomiasis?

Background :Meta-analysis of disability-associated outcomes:

- Exercise intolerance
- Work yield
- School performance
- Personal care
- Religious activity
- Pain
- Diarrhea
- Infertility
- Health care needs
- Anemia
- Weight deficit
- Height deficit
- Skin-fold thickness
- BMI
- Serum protein
- Vitamin A levels
- VO_2^{max} deficit
- Cognition deficit

King, Dickman, & Tisch, *Lancet* 2005

Schistosomiasis infection status and anemia



Schistosomiasis means hemoglobin deficits

- Average difference = 0.4 gm/dL
- Heterogeneity by SES, diet quality
- Schisto reduces average Hb to less than 12 gm/dL

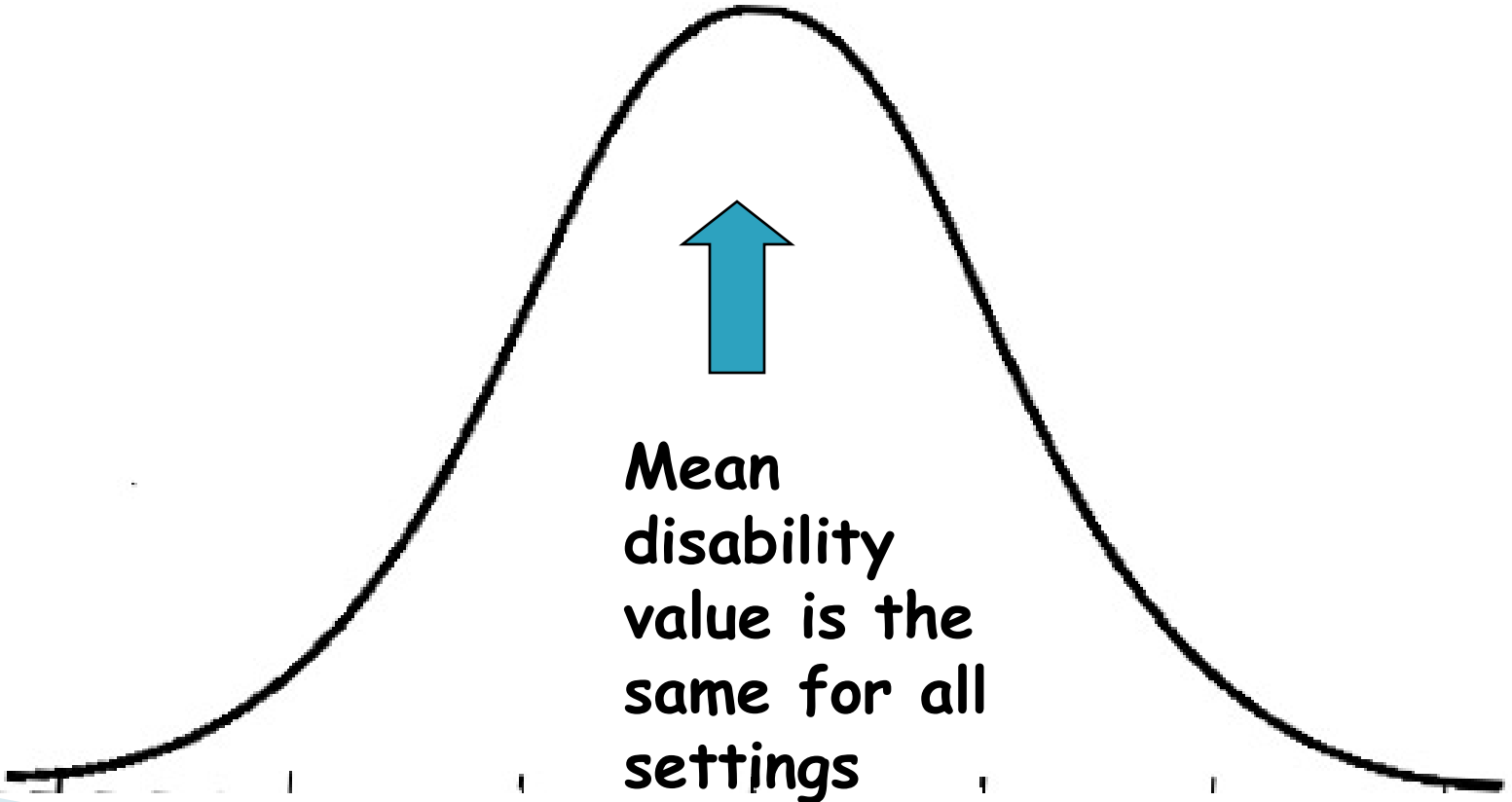
Schistosomiasis means hemoglobin deficits

- Average difference = 0.4 gm/dL
- Heterogeneity by SES, diet quality
- Schisto reduces average Hb to less than 12 gm/dL
- These levels associated with
  - 3–5% reduction in work output
  - 60% reduction in peak workload capacity (Guyatt H, *Parasitol Today,* 2000)

Problem # 2

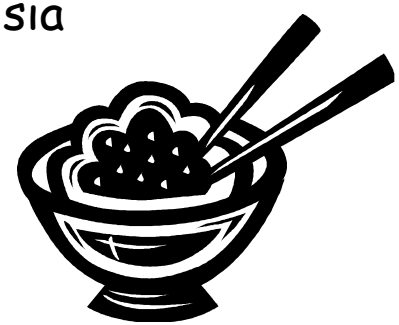
- Do schistosomiasis complications cause an ‘average’ disability??

GBD DALY calculations assume that schistomiasis complications cause an 'average' disability



GBD assumes 'Like is Like' for impairments across all settings

Asia



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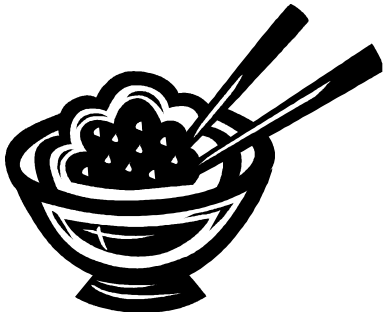
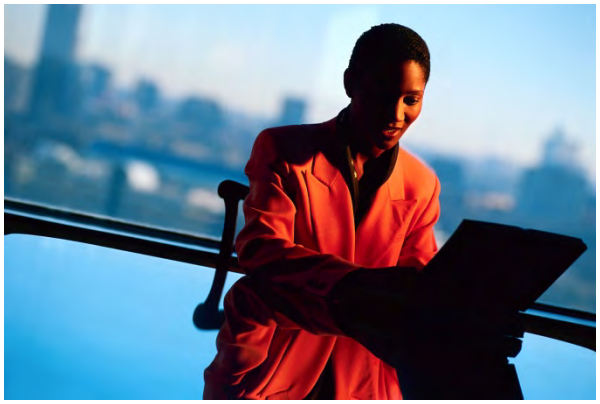


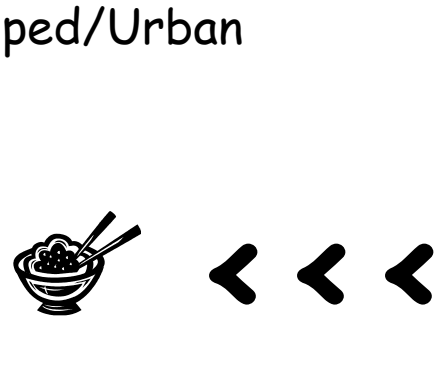
Africa

But Like is NOT Like --



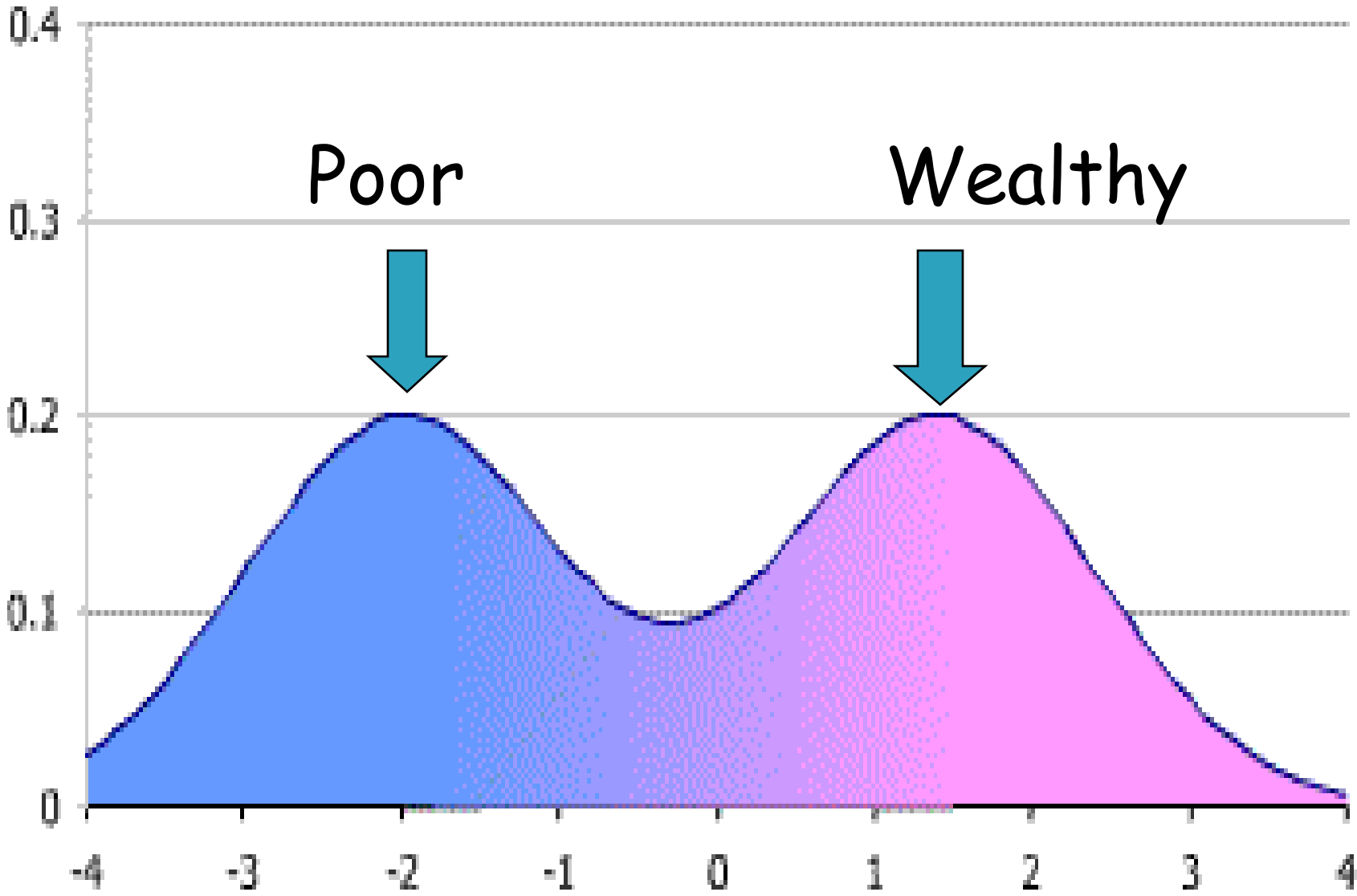
Developed/Urban

Underdeveloped Africa

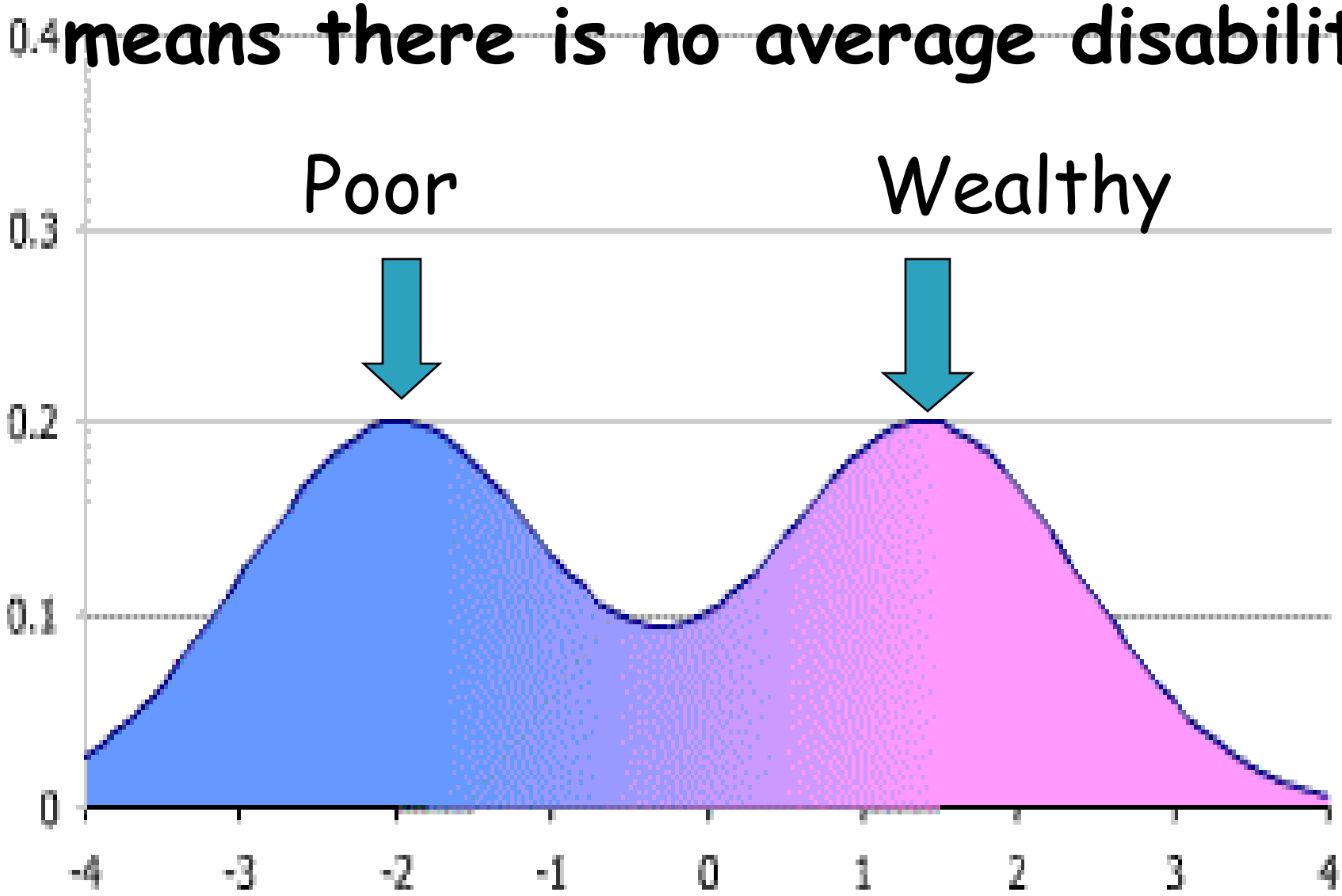


Relative utility of goods depend strongly on context

The 'Barbell' Distribution of Wealth



The 'Barbell' Distribution of Wealth means there is no average disability



So, who decides the value?

- A basic law of economics is:
  - "The value of an item must not be based on its price, but rather on the utility that it yields."
    - Daniel Bernoulli, 1738
  - Utility of a purchase means usefulness or satisfaction to the consumer, and not the monetary value of the purchase.
    - Ex utility of a radio vs that of a TV for a blind person vs a seeing person

Classically, how have we measured schistosomiasis health impact?

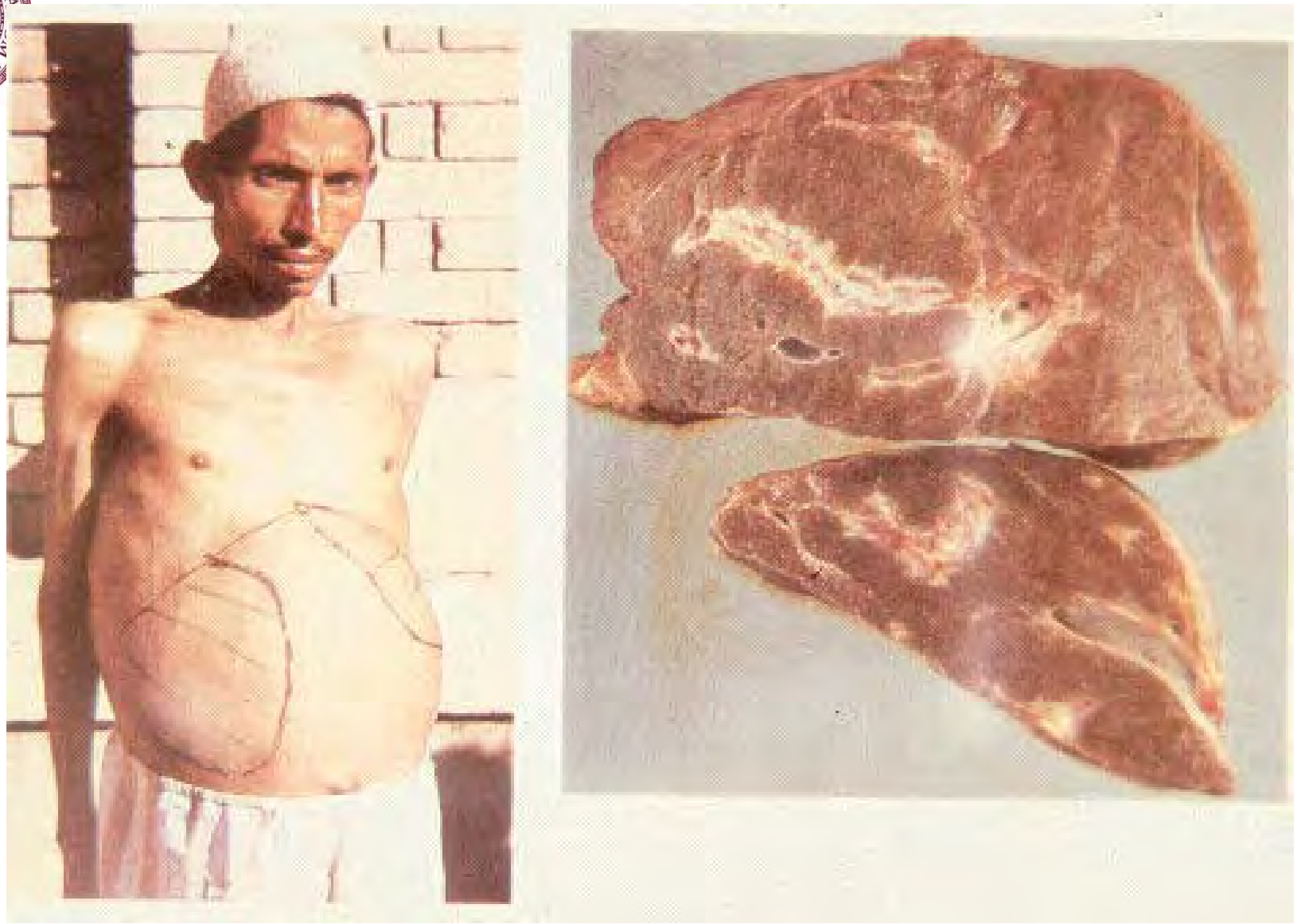
- Infection prevalence
- Infection intensity
- Mortality
- 'Objective' morbidities
  - Hepatosplenomegaly
  - Hematuria
  - Ultrasound
  - Advanced clinical disease

How should we measure schistosomiasis health burden?

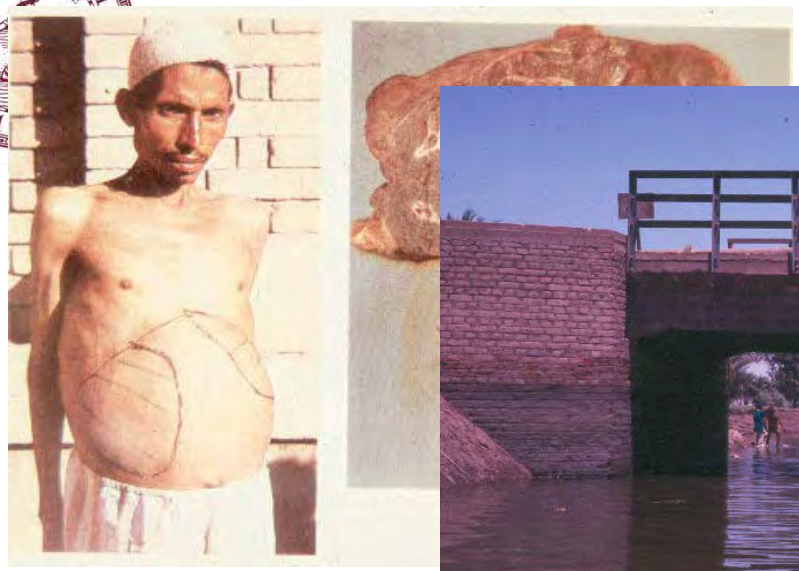
- Patient-based Disability

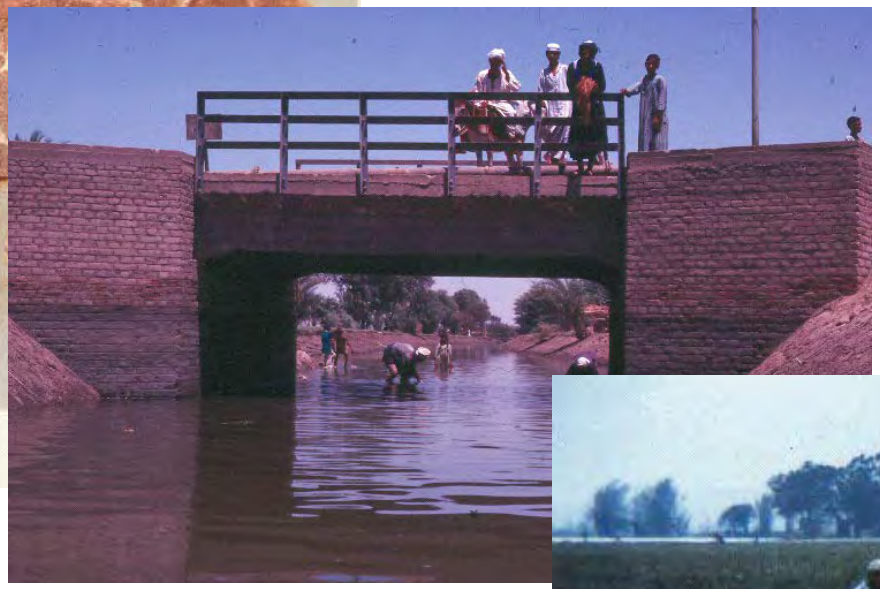
Problem # 3:

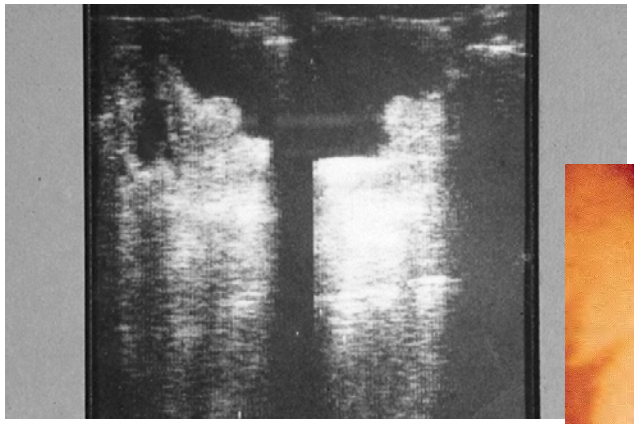
- Questions about duration:
  - How long does schistosomiasis last?
  - When does it end?

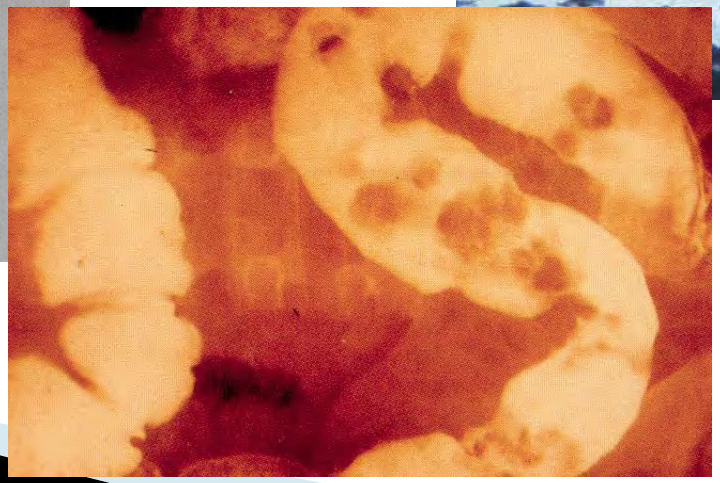


Do we focus on advanced disease?





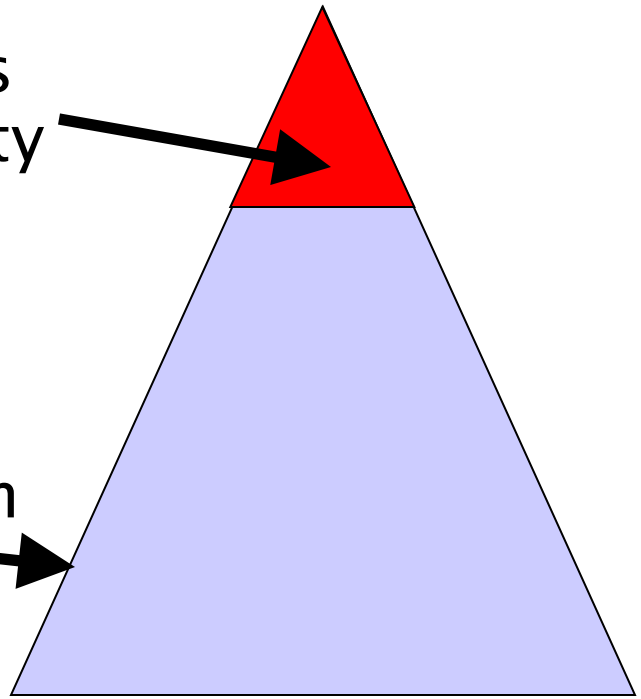




What about more 'subtle' or insidious morbidities??

Schisto Disability Summary

- Our former 'objective' morbidity standards (*e.g.*, hepatosplenomegaly, hematuria) is only the tip of the disease/disability iceberg
- Pain, diarrhea, undernutrition, and anemia are clearly associated with infection, worse with heavier infection, and reversible, at least in part, with specific therapy



Measuring QALYs

»

Measuring Quality of Life (QoL)

- The unit, quality-adjusted life-year (QALY), accounts for both quantity and the quality of life generated by interventions
  - Disease duration X the quality of the affected life-years
- Quality of life (QoL) embraces many different facets of people's lives not just their health status.
- Its dimensions relate to physical, social and mental functioning.

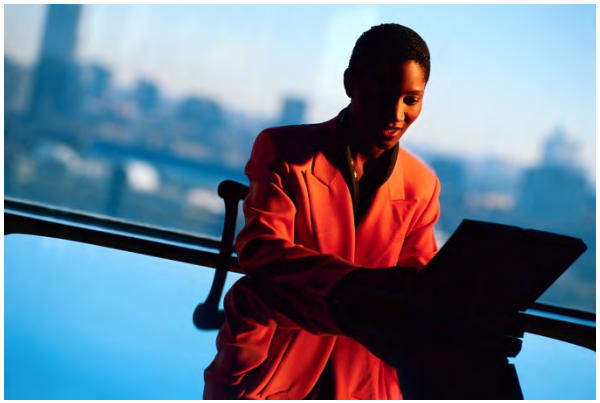
Quality weights

- Based on preferences
  - Most preferable state receives more weight
- Anchored on perfect health and death
  - 0 death (but could be less)
  - 1 perfect health (some argue could be more)
- Measured on an interval scale
  - Difference in score from 0.2 to 0.4 same as 0.6 to 0.8
  - No true 0

How are QALYs calculated?

- The amount of time spent in a health state is weighted by the utility score given to that health state.
  - It takes one year of perfect health (utility score of 1) to be one QALY, but regards one year in a health state valued at 0.5 to be equivalent to half a QALY.
  - Thus an intervention that generates four additional years in a health state valued at 0.75 will generate one more QALY than an intervention that generates four additional years in a health state valued at 0.5.

QALY weights will allow head-to-head comparison of disease states and more valid Cost-Utility Analysis



Developed/Urban

Underdeveloped Africa

1 QALY= 1 QALY

The more subjective QoL accounts for context

QALY effects do not have to be uniform over time…

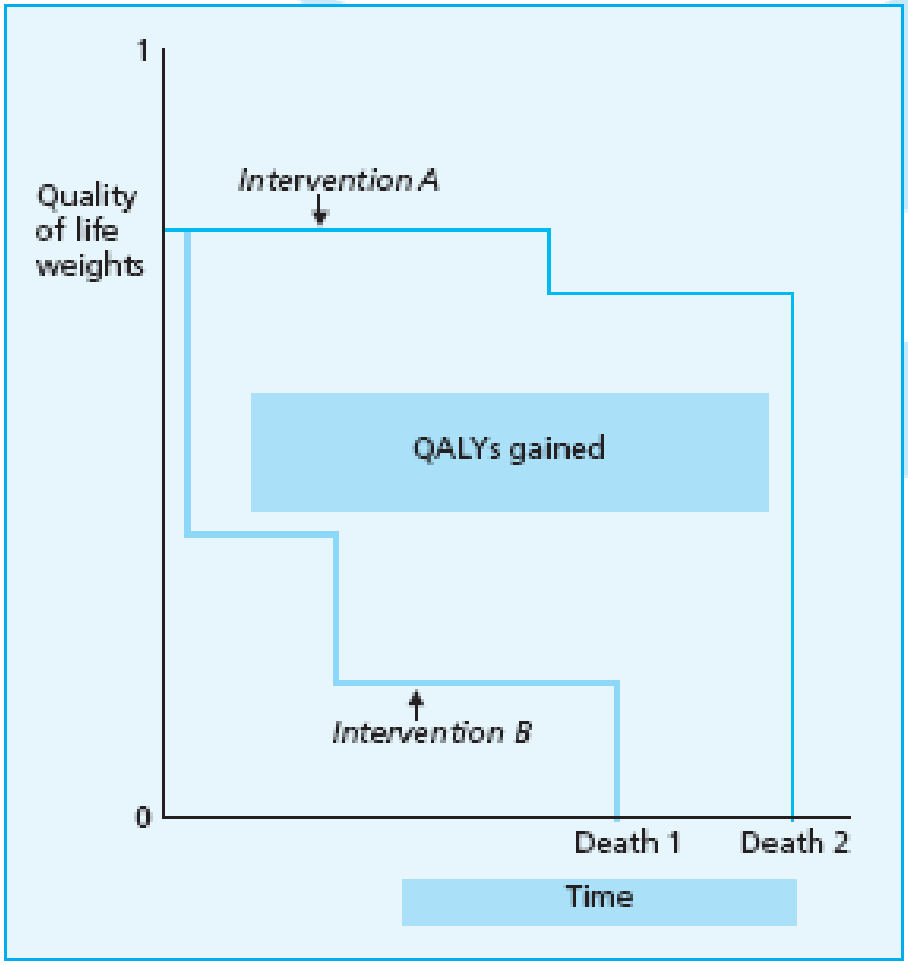


Figure 2a.

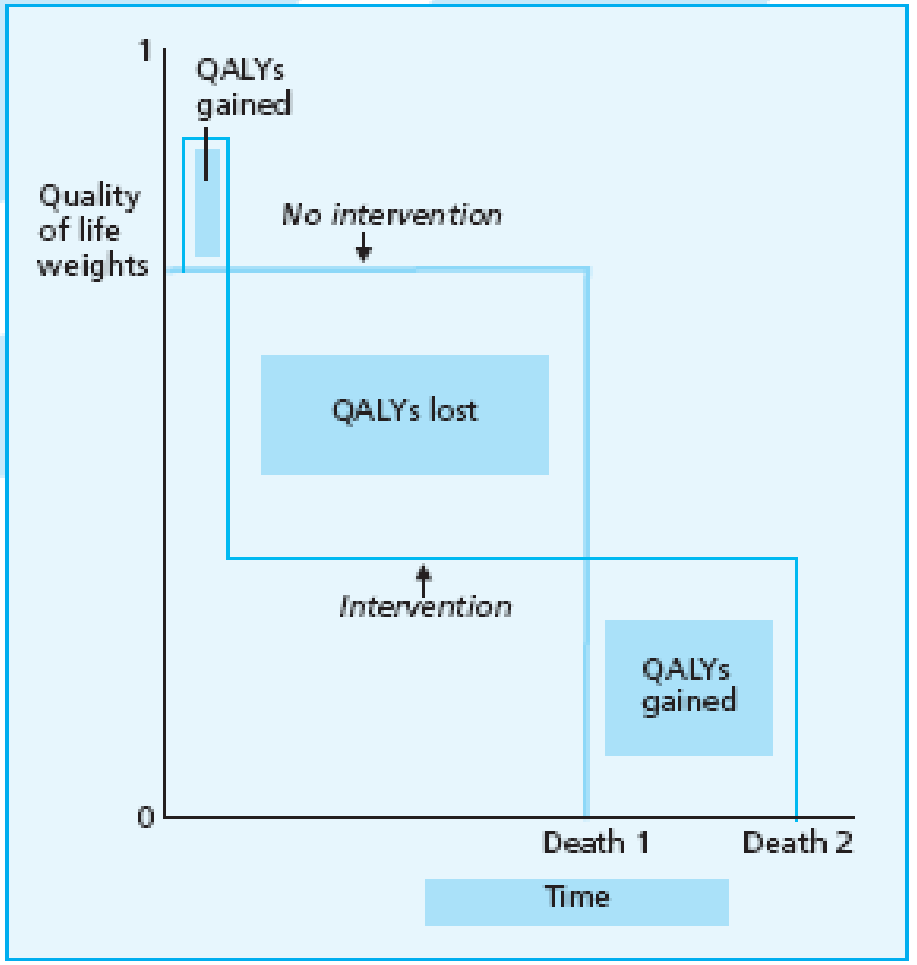


Figure 2b.

QoL captures some of the unmeasured 'externalities' of a disease state:

- Sub-clinical disease states and their effect on performance status
- Indirect effects on family and caregivers
- Impact on social standing – Stigma
- Link to environmental factors
- So, in theory, should capture effect of animal health on farmers' welfare

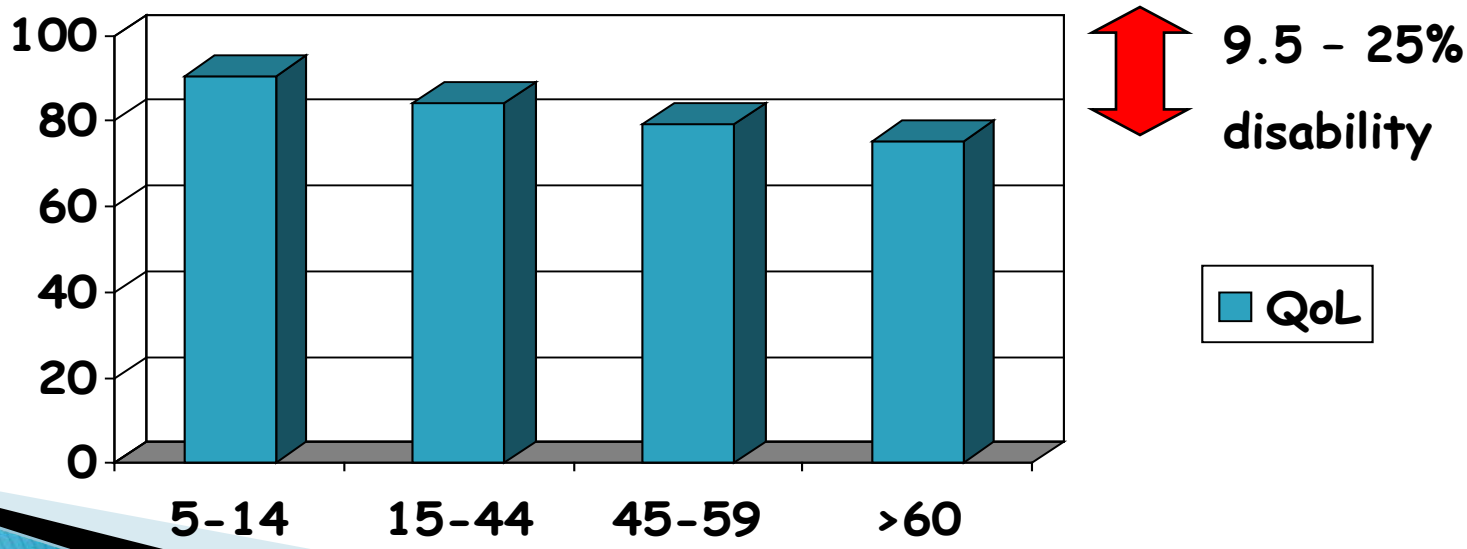
Results of some recent QALY assessments for chronic parasitic zoonoses

- Schistosomiasis japonica in Dangtu and Hanshou Counties
  - Jia et al., Bull WHO 2007
- Cystic echinococcosis in Tibet
  - Budke, et al., AJTMH, 2004
- NCC in Mexico
  - Batharai et al., AJTMH 2011

Example 1: Patient-based Disability weights for *S. japonicum* in China

Table 4. **Calculated mean disability weights for chronic schistosomiasis japonica, stratified by age, in two counties in China, October 2004–January 2005**

Age group (years)	No. of cases (n = 1369)[a]	Mean disability weight score[b]	Standard deviation	95% confidence interval	Minimum score (No. of cases)	Maximum score (No. of cases)
5–14	31	0.095[c]	0.052	0.076–0.115	0.00 (1)	0.20 (3)
15–44	556	0.159[c]	0.089	0.152–0.167	0.00 (3)	0.50 (2)
45–59	587	0.207[c]	0.088	0.200–0.214	0.05 (17)	0.50 (1)
⩾ 60	195	0.246[c]	0.120	0.229–0.263	0.05 (4)	0.99 (1)
All	1369	0.191	0.099	0.185–0.196	0 (4)	0.99 (1)



Jia et al., Bull WHO 2007

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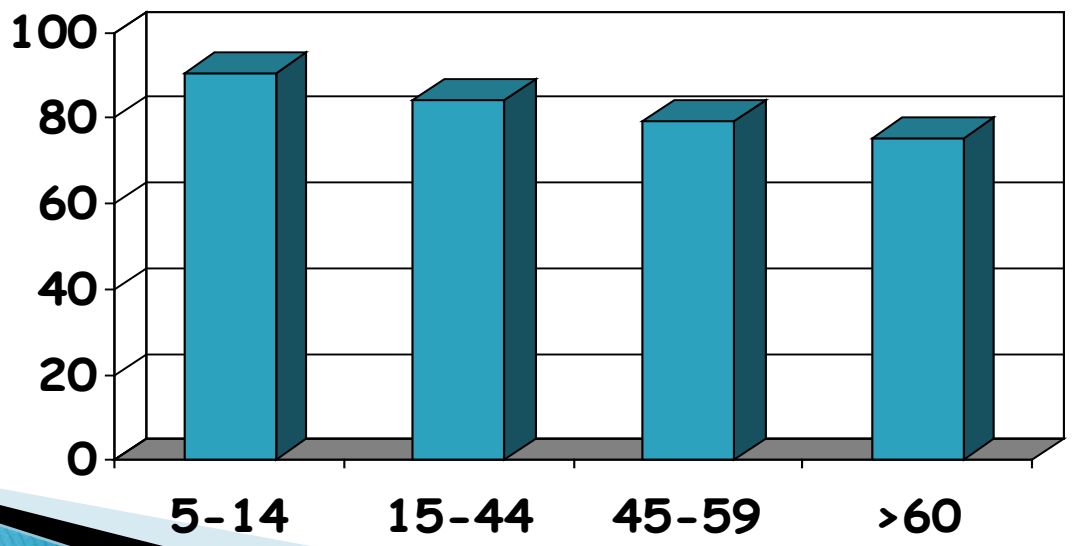


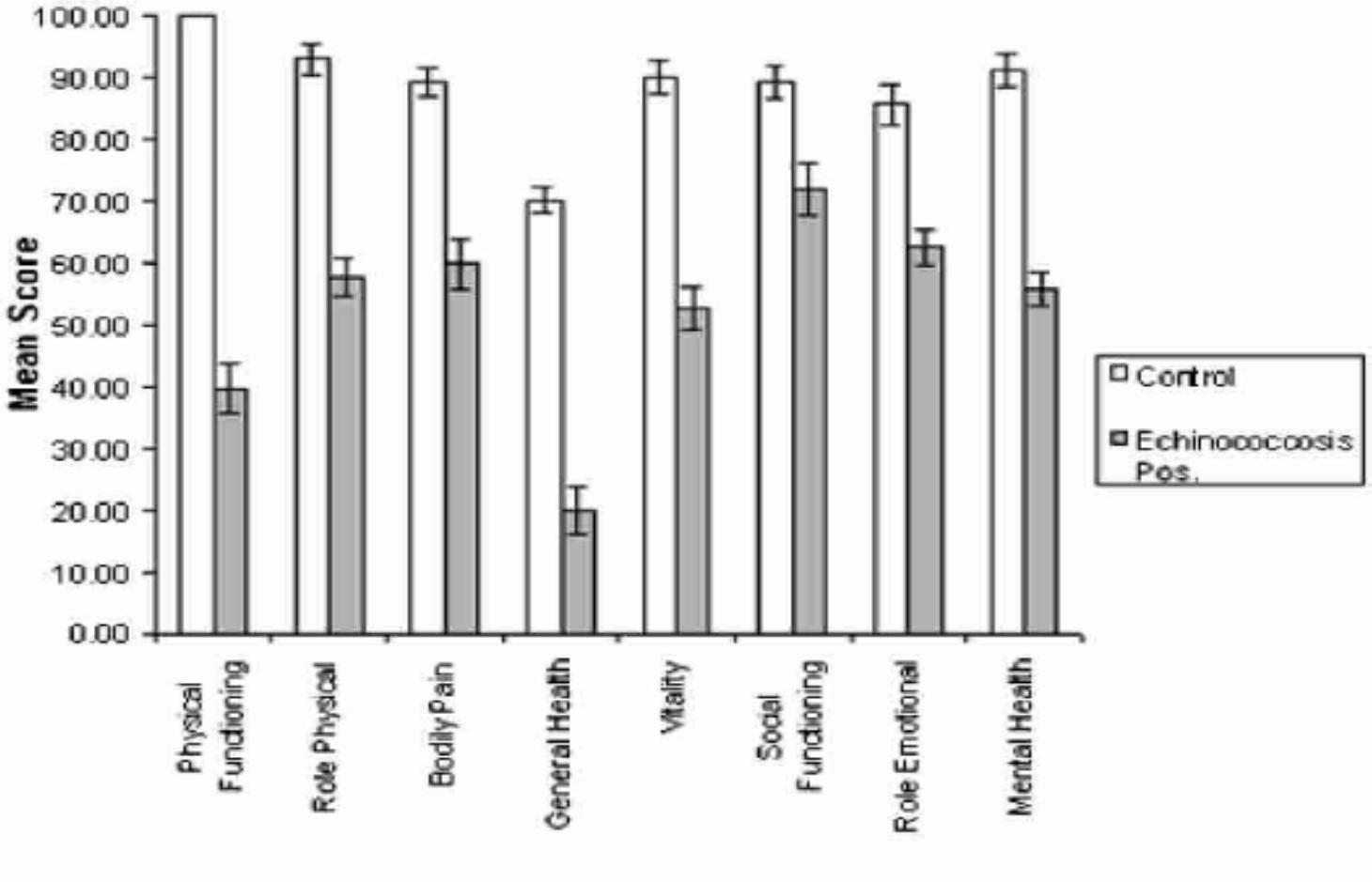
9.5 - 25% disability

QoL

Compare this to 0.5% disability wt. assigned in DALY rankings

Jia et al., Bull WHO 2007

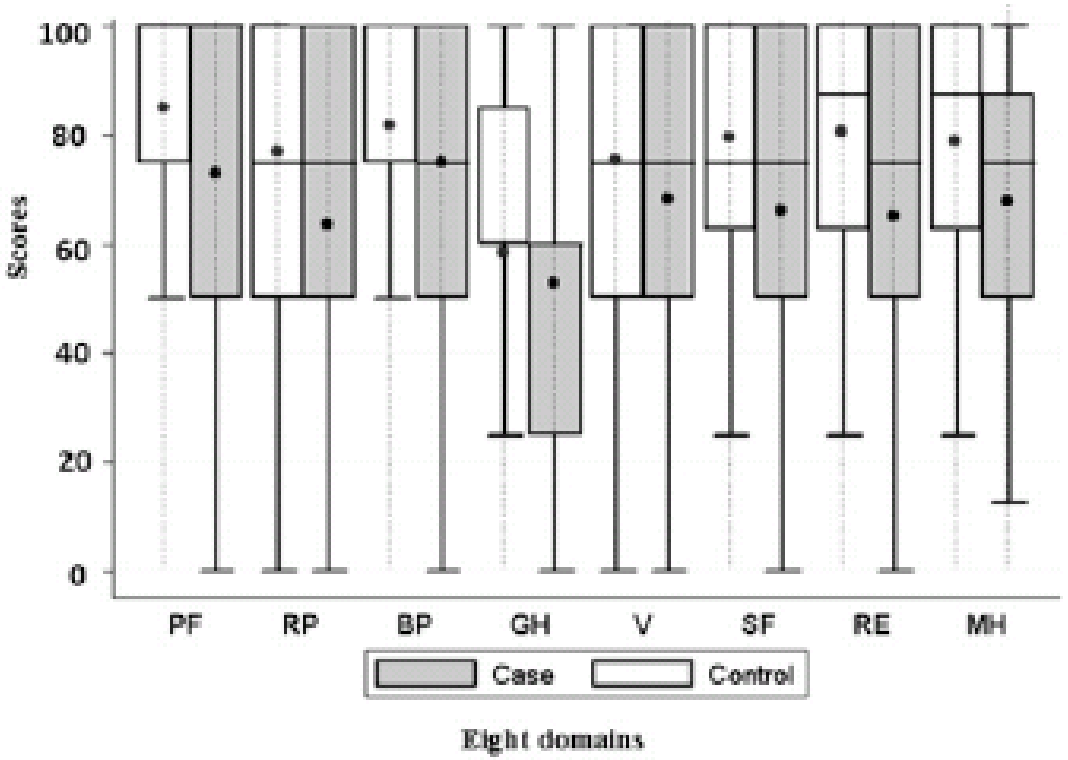
Example 2: SF-12 Performance scores in Tibetan Echinococcosis



Budke et al., AJTMH 2004

Ex 3: NCC in Mexico

FIGURE 2. Health scores from the SF-12 v2 health survey for neurocysticercosis (NCC) patients vs. their matched control group (overall population).



PF = Physical functioning, RP = Role physical, BP = Bodily pain, GH= General health, V = Vitality, SF = Social functioning, RE= Role emotional, MH= Mental health.

Bhattarai et al, AJTMH 2011

What are the limitations of the Patient Preference techniques??

- The QoL level may have multiple causes
- Although more comprehensive, the questionnaire approach may not be able to disaggregate the specific disease-attributable fraction of disability
- Adaptation may mask the impact of chronic disability
- Patient may not even be aware there is an alternative health state

What are the limitations of the Patient Preference techniques??

- People have different attitudes towards risk taking
  - Standard gamble, TTO, PTO will be affected
- Most of those tools should be repeated through time and compared within the same person
  - This is rarely done because it takes time.

Specific limitations to questionnaires approach

- Requires several validating steps
  - Validity:
    - Criterion validity, construct validity, internal validity, face validity, convergent validity, discriminant validity,
  - Reliability
    - test-retest, internal consistency, inter and intra rater realiability,
  - Most scales have not been tested for all those aspects
- USE previously validated scales
  - In the language to be used
  - In the culture to be used.
- Different instrument will give different scores for same patients groups

Why not use QALY??

- Much more intensive work is involved in developing valid QoL estimates for all diseases
- Does not include the impact on intervention on non-patient factors
- BUT
  - Is more accurate to assess the WHO aspects of health than DALYs or morbidity/mortality measures.
  - Capture pain and suffering which money cannot measure.

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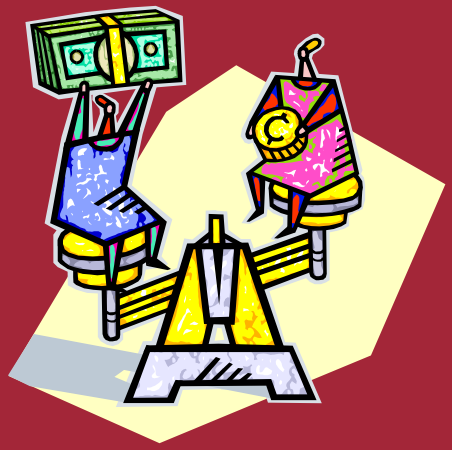

Estimating monetary burden and cost-benefit analysis

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PART 1: GENERAL STRUCTURE OF COST-BENEFIT ANALYSES

Cost-benefit analysis

- When should CBA be used?
  - Several outcomes (the effectiveness measure does not include everything)
  - QALYs are individual-based, not society based
  - Impact of the intervention outside of the human health domain (eg zoonoses / agricultural impact / other)

Cost-benefit analysis

- The consequences of the control strategies are allocated a monetary value
- Needs to identify ALL consequences of ALL strategies and value them
- Should always take a societal approach (that's the whole idea!)

Cost-benefit analysis

- Overall benefit (Net Social Benefit - NSB) –

$$NBS = \sum \frac{B_t}{(1+r)^t} - \sum \frac{C_t}{(1+r)^t}$$

- Extra cost per extra dollar gained

$$ICBR = \frac{PV_{C1} - PV_{C2}}{PV_{B1} - PV_{B2}}$$

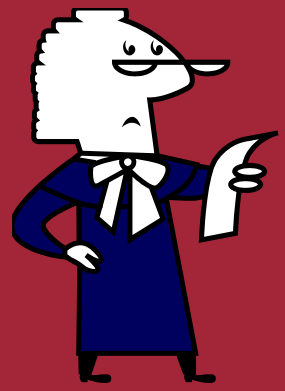
- Extra benefit per extra dollar spent

$$IBCR = \frac{PV_{B1} - PV_{B2}}{PV_{C1} - PV_{C2}}$$

Be careful!

- Do not double count..
  - Can happen in CBA
  - Compare 2 alternatives
    - Alt 1 has costs for screening
    - Alt 2 has no costs for screening
    - Cost of screening should be counted in the costs of alt 1 OR in the benefits of alt 2 (SAVES 1 screening), NOT BOTH!!!
  - Focus on the BENEFITS of comparing 2 alternatives, not on the COST of the disease

CBA vs CEA/CUA



- CEA/CUA
  - Cost per gain in effectiveness (YLS) or utility (QALY)
    - What is **JUDGED** cost-effective???
    - Arbitrary standards for QALYs
      - Ex league Tables (Table 10.1, Drummond)
      - Compare with other studies, but does not mean it is worth it..
  - Decision makers often attribute arbitrary monetary values on these outcomes…
    - Not systematic…

Example of “league” figure

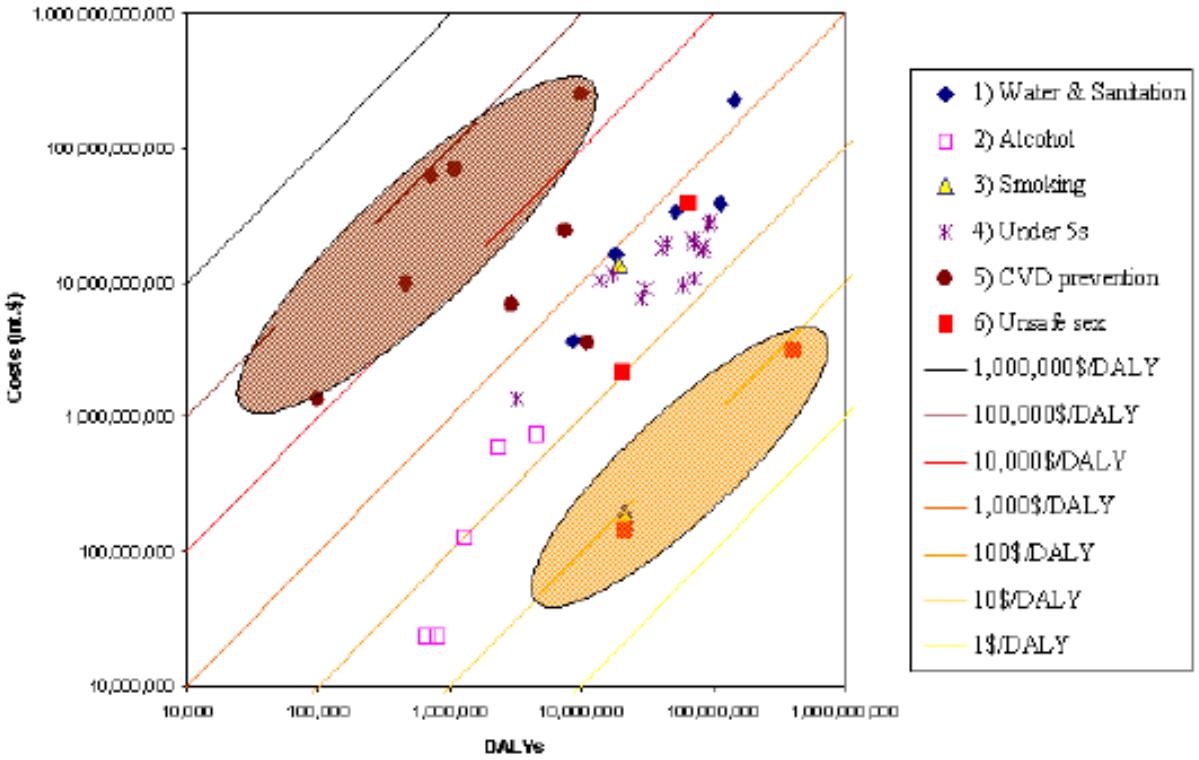


Figure 2
Cost-effectiveness of selected interventions for epidemiological sub-region AfrD (total population: 294 million).

From: Hutubessy R et al. Cost Effectiveness Resource Allocation 2003; 1: 8

Example of a league Table

Table 1 – Overview of outcomes of economic evaluations making use of ATAC clinical trial data, in order of increasing cost-effectiveness.

Author, journal, year of publication	Country	Life-years gained	QALYs gained	Incremental costs ($)	Cost per LY gained ($)	Cost per QALY gained ($)	Industry sponsored
Moeremans et al., Int J Gynecol Cancer, 2006;16:576-8	Belgium	0.353	0.378	1,718	4,868	4,546	No
Karnon et al., Eur J Health Econ, 2008;9:171-83*	UK	0.350	0.360	3,793	10,836	10,536	Yes
Fonseca et al., Rev Assoc Med Bras, 2009;55:410-5	Brazil	0.550	NA	12,213	22,042	NA	Yes
Karnon et al., Eur J Health Econ, 2008;9:171-83†	UK	0.250	0.260	4,348	17,374	16,965	Yes
Locker et al., Breast Cancer Res Treat, 2007;106:229-38	US	0.221	0.257	5,173	17,392	20,096	Yes
Rocchi and Verma, Support Care Cancer, 2006;14:917-27‡	Canada	0.194	0.218	4,536	23,404	20,805	Yes
Skedgel et al., Breast, 2007;16:252-61	Belgium	NA	0.231	5,306	NA	22,967	Yes
Skedgel et al., Breast Cancer Res Treat, 2007;101:325-33§	Canada	NA	0.227	5,055	NA	22,259	No
Rocchi and Verma, Support Care Cancer, 2006;14:917-27‖	Canada	0.192	0.208	4,670	24,286	22,465	Yes
Lux et al., Onkologie, 2010;33:155-66	Germany	0.290	0.320	7,753	26,730	23,952	Yes
Mansel et al., Br J Cancer, 2007;97:152-61	UK	0.230	0.244	6,605	28,626	27,024	Yes
Skedgel et al., Breast Cancer Res Treat, 2007;101:325-33¶	Canada	NA	0.092	4,970	NA	54,006	No
Hillner et al., Am Cancer Soc, 2004;101:1311-22	US	0.160	0.123	6,649	40,298	75,338	No
Gil et al., Clin Transl Oncol, 2006;8:339-48#	Spain	0.535	0.285	25,261	47,216	88,634	Yes
Gil et al., Clin Transl Oncol, 2006;8:339-48**	Spain	0.182	0.114	16,863	92,657	147,926	Yes

CBA vs CEA/CUA

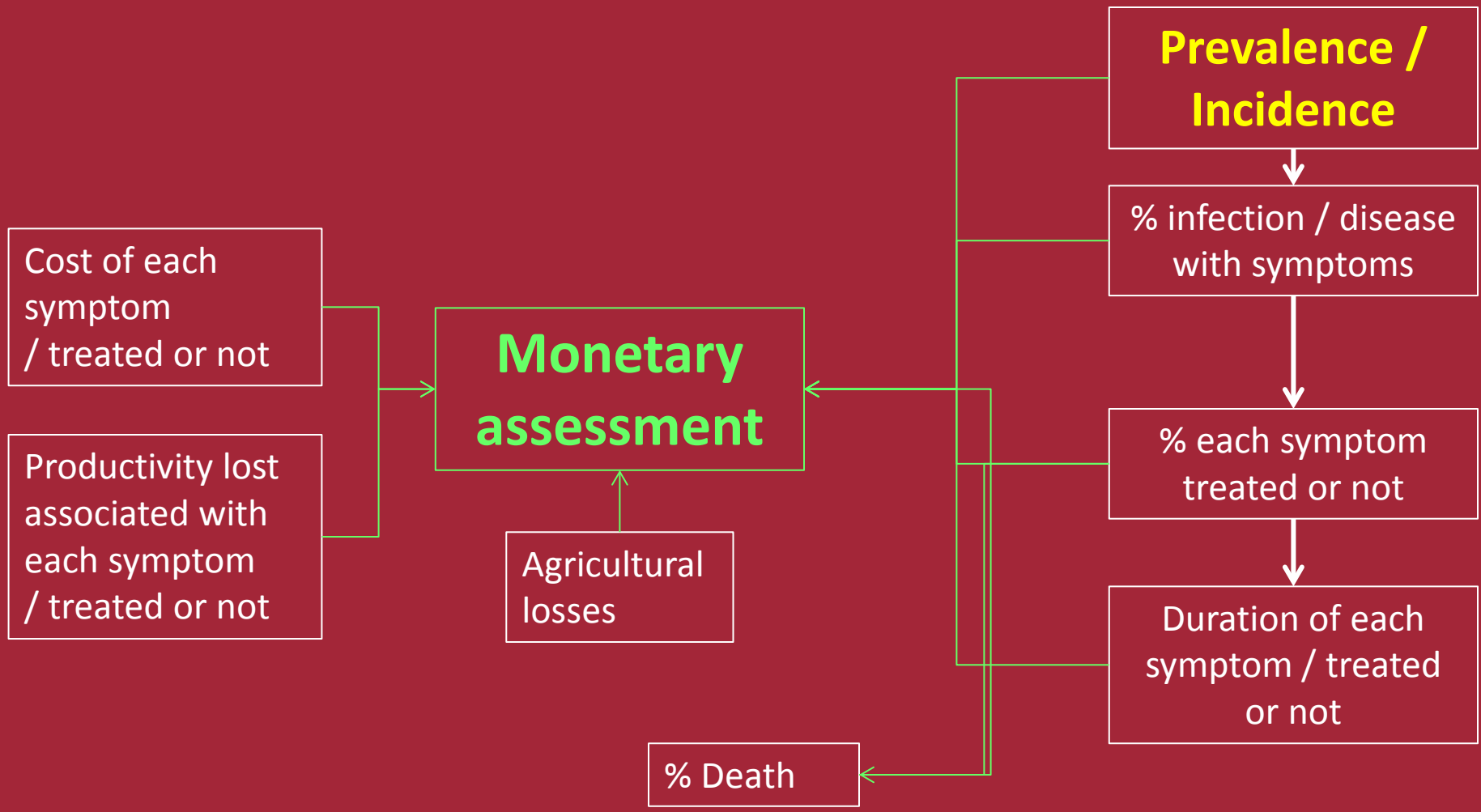
- CEA/CUA
  - Restricted to 1 outcome
    - Production efficiency
- CBA
  - Assigns value to health AND non-health consequences
    - Allocative efficiency

PART 2: ELEMENTS TO INCLUDE IN MONETARY BURDEN ASSESSMENT

First – Identify distributions of consequences

- This needs to be done for CUA as well
- Identify, for the infection of interest, all consequences and, if possible, time from infection to onset of symptoms (incubation period)
- Identify distribution of treatment for each consequence
- Identify duration of each consequence

Data required to estimate monetary burden applied to infections



First –Decision trees

- Generally helpful to organize the distribution of consequences and their treatment with decision trees.
- Each branch has a probability of occurrence
- The end of the branch indicates the probability of occurrence of a consequence with a certain treatment.
- Helpful also when conducting uncertainty analyses.

Ex. Cystic echinococcosis in Tunisia

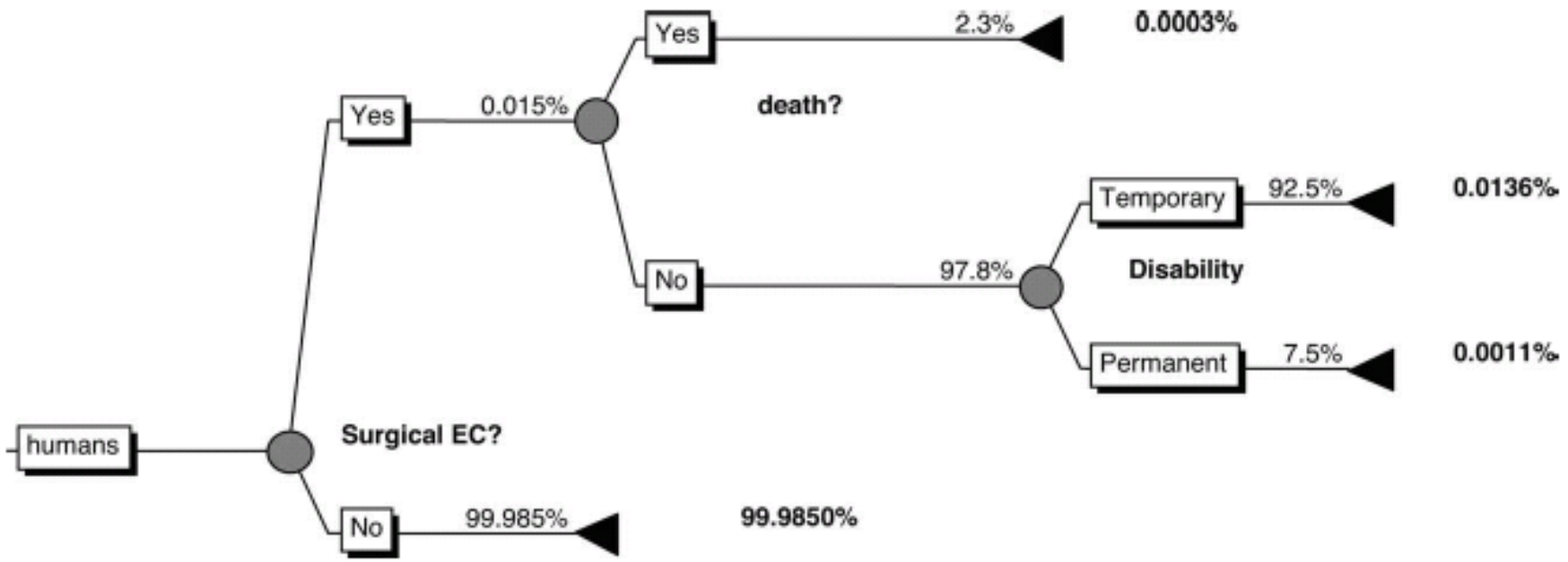


Figure 1 Decision analysis tree for estimating the cost of echinococcosis in humans in Tunisia.

Ex. NCC in Eastern Cape, South Africa

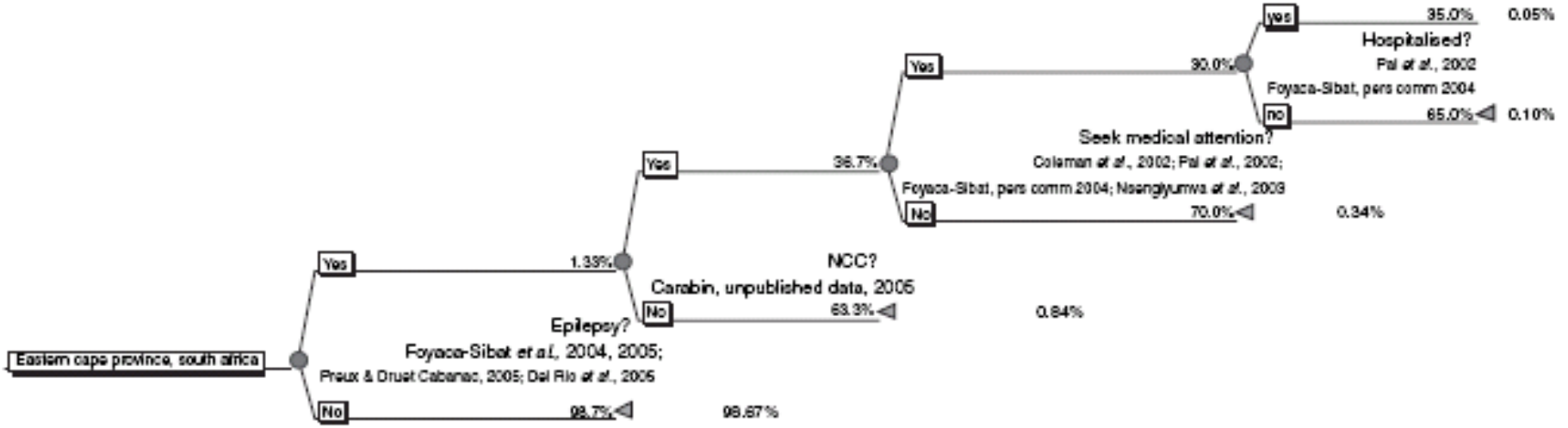


Figure 1 Decision tree for estimating the monetary burden of NCC in Eastern Cape Province, South Africa. Circle, a chance node; triangle, an end node. The number at the end of each branch indicates the probability of that event to occur (the percentage at each branch represent the average values used in the uncertainty analysis).

Ex Neonatal HSV

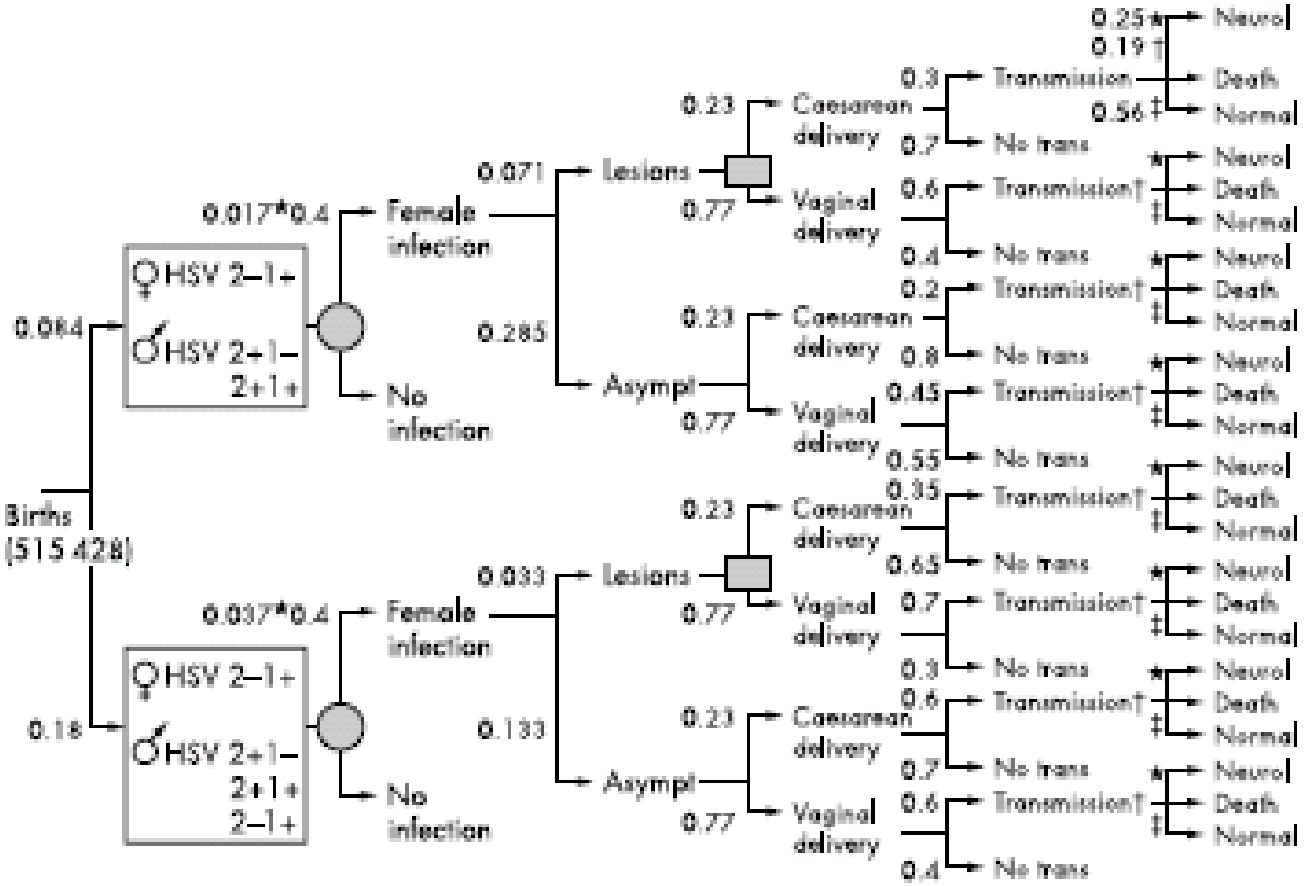


Figure 1 Decision analysis model representing primary and non-primary first episode HSV infection among pregnant women in California in 2000 and consequent mother to child transmission of HSV. The decision analysis model shows the chance of incident HSV infection among women in the third trimester of pregnancy in California in 2000 and the subsequent chance of neonatal herpes. Women infected in the third trimester were calculated by the product of incident HSV infection in pregnancy and the fraction that were infected in the third trimester.[3] Asympt = asymptomatic shedding; No trans = no transmission; Neurol = neurological disability. Cases of neonatal herpes were classified as neurological disability, death, or normal (indicating no long term complications of HSV infection). Probability of event: *0.25; †0. 19; ‡0.56. Intervention P2 (shaded squares) = increased caesarean sections with lesions (to 85%). Intervention P3 (shaded circles) = suppression decreases transmission (by 80%).

Source of information for epidemiological data

- Specific research (best)
- Literature review (often)
- National / regional data
  - Best for notifiable diseases
- Patients' charts data
  - Micro-economics
- Experts' opinion
- Uncertainty analyses
  - Recommended for most cases

Second – Estimate the cost of each consequence / treatment

- For each branch of the decision tree
  - Identify the equivalent cost
  - Typically uses itemized cost menu
  - Sometimes this cost will include several components

Ex. Cost of treating human cystic echinococcosis in Spain

Table 3. Age-gender stratified wages in the Basque Country in 2005 and costs of treatment and diagnostic test to treat CE patients in Alava, 2005.

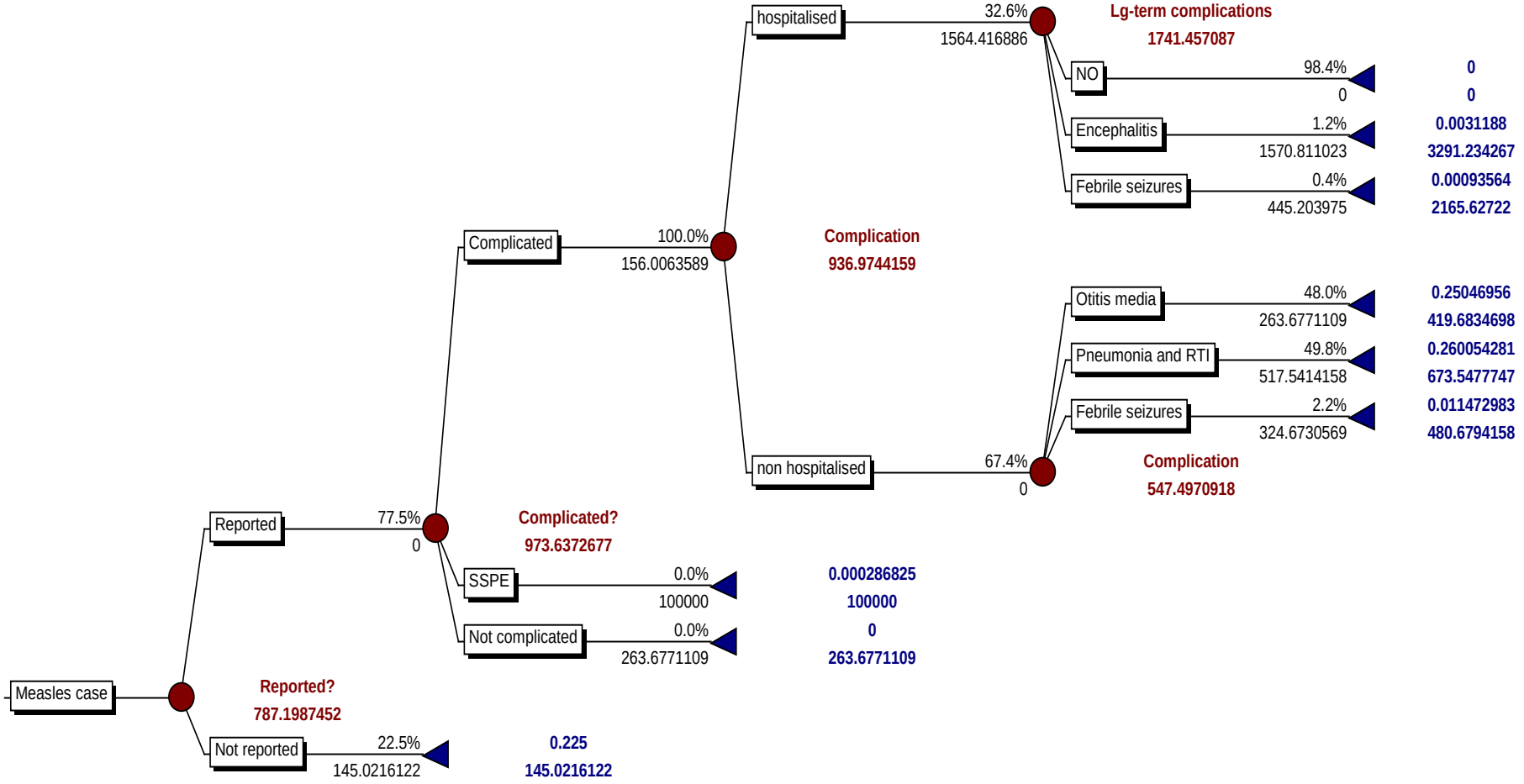
Economic Parameters	Value	Reference
Average yearly wage (€)		
For males, by age group (years)		
<25	16,508	[20]
25–34	20,872	[20]
35–44	23,343	[20]
45–54	31,100	[20]
≥55	29,482	[20]
For females, by age group (years)		
<25	12,309	[20]
25–34	16,873	[20]
35–44	19,253	[20]
45–54	21,570	[20]
≥55	21,138	[20]
Cost of diagnostic procedures and medical treatment/care (€ per case)		
Chest X-ray	9.7–11.9	Uniform distribution from Txagorritxu Hospital
CT	98.6	Txagorritxu Hospital
MRI	222.7	Txagorritxu Hospital
Ultrasonography	38.5	Txagorritxu Hospital
ECG	6.3	Txagorritxu Hospital
Standard analyses	13.1	Txagorritxu Hospital
Serology (hydatidosis)	20.1	Txagorritxu Hospital
Chemotherapy (Mbz/Albz)	59.3	Txagorritxu Hospital
Initial Outpatient medical visit	103.2	Txagorritxu Hospital
Follow-up outpatient medical visits	52.03	Txagorritxu Hospital
CBC count	13.1	Txagorritxu Hospital
Cost of surgical procedures (€ per case)*		
	2,832–3,776€	Uniform distribution from Txagorritxu Hospital

From Carabin et al. PLoS NTDs 2014; 8: e3069

Third: Estimate the cost of each branch

- For each consequence identify all components of costs
  - Again, similar to itemized cost menu
  - Includes
    - treatment costs (health provider costs)
    - Out-of-pocket costs
    - Productivity losses etc
- Some of those may be “hidden”

Ex - measles



From: Carabin et al. BMC PH 2002; 2: 22

PART 3: ASSIGNING MONEY VALUES TO HEALTH OUTCOMES

Valuing health outcomes

- Human capital
  - Uses the current costs of services to value the outcome
- Revealed preference
  - Wage-risk based

- Stated preference (contingent valuation)
  - Willingness To Pay methods

Human capital approach

- Probably the most widely used in CBA
- Places monetary weights on healthy time
- The benefits of the programmes are evaluated (partly or in totality) with
  - Present value of future earnings
    - Uses market salary values
    - Healthy working time gained
  - Present value of treatment of sick individuals
- Cannot measure pain and suffering

Human capital approach

- Can be used to value
  - All aspects of health improvements
    - Rarely done
  - Part of the benefits of health care intervention
    - Value productivity changes only
    - Most common

Issues with human capital approach

- Productivity losses

  - Wage rates
    - Should reflect marginal productivity but…
      - Gender, age, ethnicity?
  - Non workers' time (see next slides)
  - Death
    - Loss of wage over the lifetime..
      - Realistic?
      - Sometimes based on insurance premiums for dangerous jobs

Human capital approach

- Productivity losses
  - Not everybody works in the official market place
    - Homemakers, small farmers in developing countries
    - Shadow prices (see Canadian recommendations for housewives)
      - Opportunity cost of time
        - » At least as great as what earned in the labour market
      - Replacement cost
        - » Replace the homemaker with services from market
  - What about children?
    - Not paid before adulthood
      - Discount until reach 18?
      - Does that mean a child is not worth it?

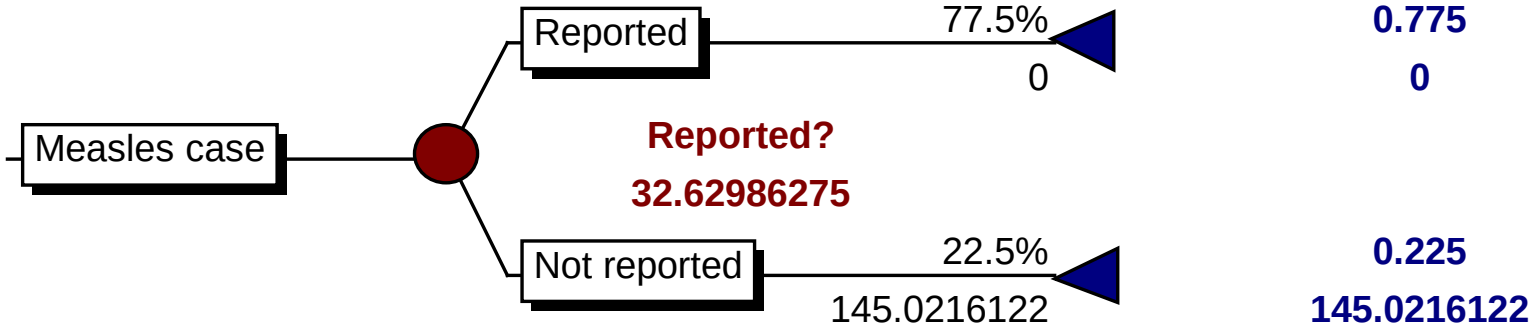
Human capital approach

- Friction costs
  - No one is irreplaceable (otherwise the society could not function!)
    - Can usually train someone to do the same job
    - Only the time required to train a new employee to replace the disabled one should be accounted for
    - How long would it take?
  - Economic situation
    - Unemployment rate
      - If everyone is employed, harder/longer to find replacement

Human capital approach

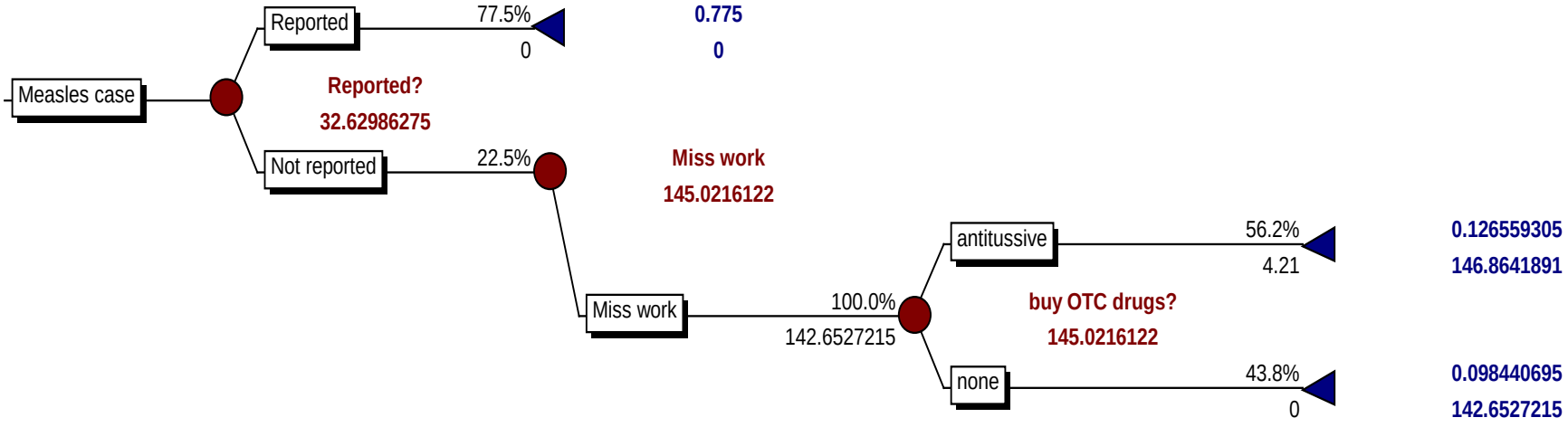
- Friction costs
  - What about short-time absenteeism?
    - Could the person affected work on it at a later time with over hours?
    - Could there be an immediate replacement (no friction period)?
  - Those are still under debate

Ex. Human capital approach - measles, non reported cases (in kids!)



Example - measles

- Where does $145 come from?



Example - measles

- Where does $145 come from?
  - 100% parents miss 12 hours of work (mostly women)
    - Women in the UK paid US$11.89 per hour
  - 16% parents will buy antipyretics
    - Average US$4.06 per standard bottle
  - 40% parents will buy antitussives
    - Average US$4.27 per standard dose
- 11.89x12x1 + 4.06x0.16 + 4.27x0.40

= US$ 145!

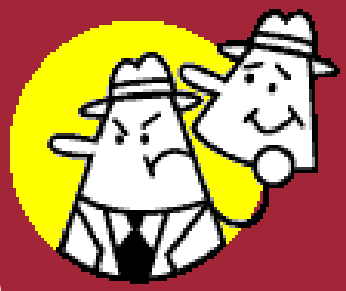
Revealed preference

- Use job wages as indicator of health risk, and hence to value health
- Drummond's example
  - Job A has 1/10,000 more death / yr vs job B
  - Job A is paid US$500 more per year vs job B
  - So life is valued at US$ 5 million in job B
    - Job B workers willing to forgo $500 per year for a 1-in-10,000 lower annual risk

Revealed preference

- Strength
  - Based on consumers' data
    - no hypothetical scenarios or preference
- Weaknesses
  - Large variations
  - Context & job-specific
  - Confounders of link between risk and wage
  - Perception of occupational risk?

Contingent valuation



- Survey-based
- Hypothetical scenarios about the problem
  - Think about the *contingency* of an actual market existing for a specific programme
  - Reveal *maximum* they are willing to pay for this programme
- Example
  - Eg what would be the maximum price you would pay for a mars bar?
    - Max price – market price = consumer surplus

Contingent valuation

- Less obvious for health programmes
- Trade-off between new health programme benefits and sacrifice in other programmes
- Aggregate of consumer surplus across individuals
  - Basis of cost-benefit calculus
  - Attempts to replace “missing markets”

Contingent valuation WTP example

- Suggest an improved food safety method:
  - New risk of foodborne infection is 1/100 million per meal
- 20 bids made
  - First 10 bids: no information
  - Following 10 bids are informed
    - 1/ 137,000 for salmonella (per meal) or 1/125 per yr
    - 1/ 2,628,000 for trichinella (per meal) or 1/2400 per year
    - 1 / 1000 Salmonella cases will die per year
    - 1 / 100 trichinella cases will die per year
    - $220 to treat mild salmonellosis
    - $2485 to treat mild trichinellosis

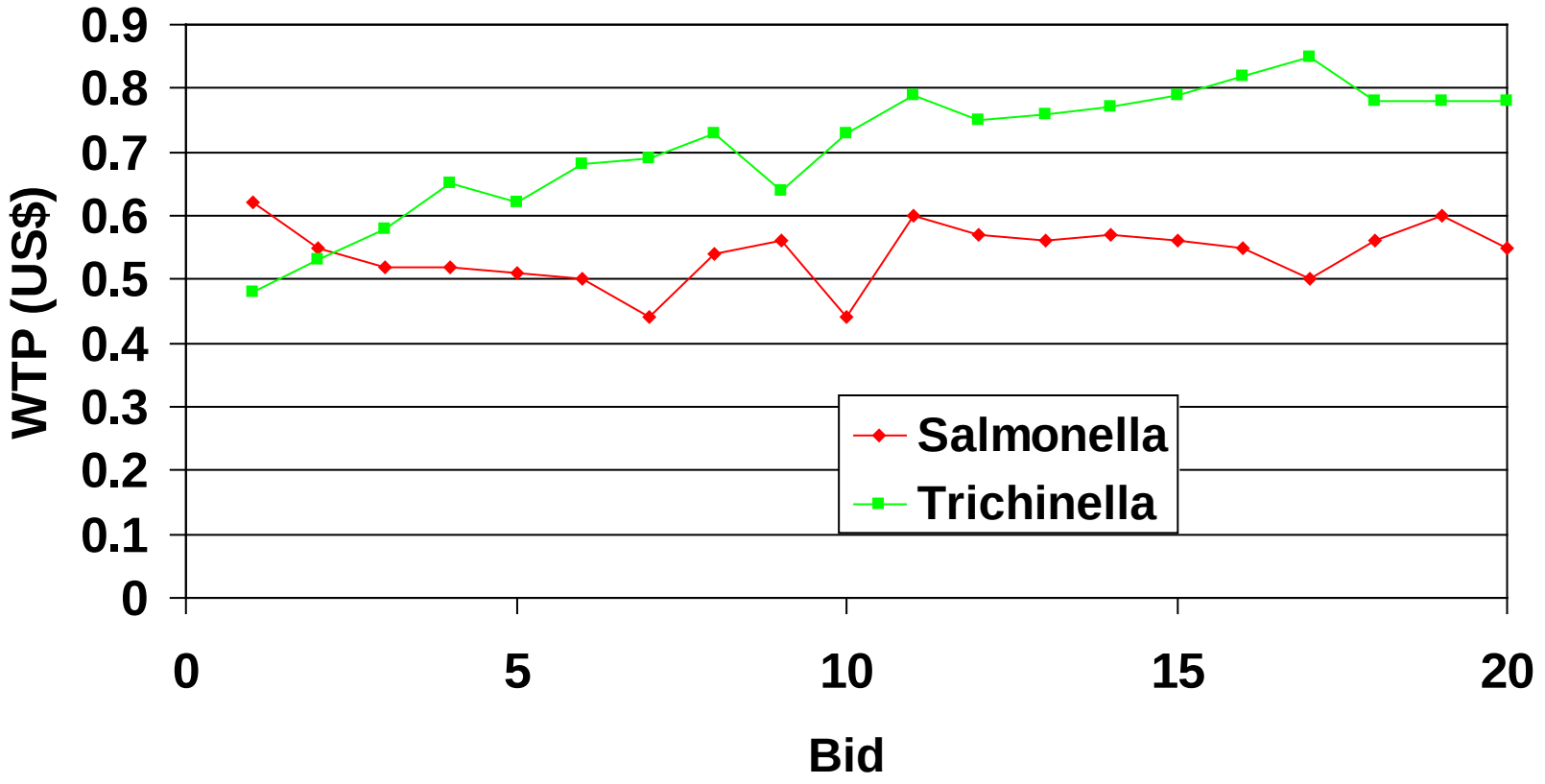
From Shin et al., 1992

Contingent valuation WTP

- 15 students
  - After 20 bids:
    - Computer selected at random 1 bid
    - The winner had to pay the 2nd largest bid, kept $15-bid, ate the safe food
    - The other kept $15 and ate the normal food

From Shin et al., 1992

Contingent valuation



From Shin et al., 1992

Contingent valuation WTP

- *Salmonella*: WTP of extra 55 cents per meal for a safer product with 1/100 million chance of contamination
- Trichinella: WTP of extra 80 cents per meal for a safer product with 1/100 million chance of contamination
- For *Salmonella*: Say there are 520 meals/yr
  - $289 per person-year
- This would value the benefit component of CBA

From Shin et al., 1992

A better example

- Cross sectional study of 293 with reported incontinence
- Willingness to pay for incontinence improvement estimated
- Women asked to
  - "imagine that a new treatment for incontinence becomes available that has no side effects. This new treatment reduces the number of times you leak urine by one quarter (25%). (For example, if you currently leak urine 4 times a day, with this new treatment you would leak urine only 3 times a day."
- Women were asked to estimate
  - "the most money that you would be willing to pay per month out of your own pocket for this treatment?"
  - Response options of $0, $5, $10, $15, $20, $25, $30, $40, $50, $75, $100,$150, or $200 or more.

Subak et al., 2006

A better example

- Women were willing to pay per month an average
  - $28 per month for 25% improvement
  - $39 for 50% improvement
  - $49 for 75% improvement
  - $70 for 100% improvement or $840 per year
- The WTP for improvement exceeds routine care costs by 3-7 times
  - Effective incontinence treatment may be economically beneficial as well as improve quality of life.
  - This could be used to value episodes of incontinence

Subak et al., 2006

Contingent valuation Willingness to Accept

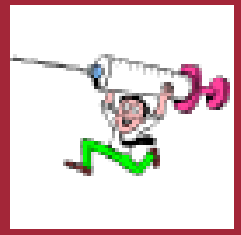
- The risk of death from vCJD is 1/1,000,000 per joint of beef
- The price must drop by 50p for you to buy a joint of beef (49p would not be quite enough)
- Then your marginal willingness to accept for an additional risk of 1/1,000,000 is 50p
- And your marginal willingness to accept for an additional risk of 1 is £500,000
  - i.e. you are implicitly valuing your own life at £500,000

2nd dose of measles vaccine in Canada

EXAMPLE OF A CBA USING THE HUMAN CAPITAL APPROACH

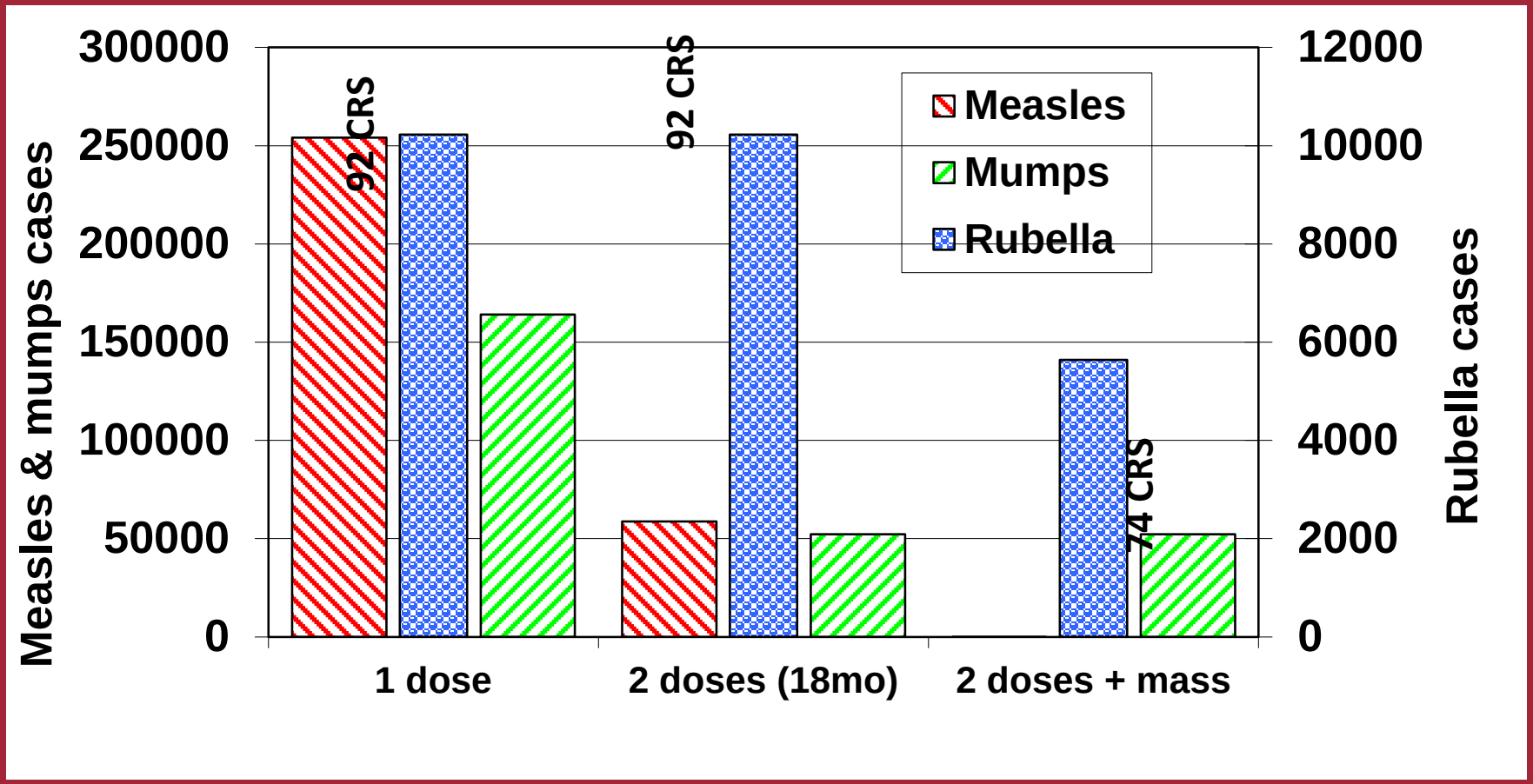
Examples CBA 2nd dose of measles in Canada (Pelletier)

- Four scenarios (alternatives) – in addition to already implemented 1st dose MMR
  - 1) routine 2nd MMR at 18 months + mass campaign with MR from 18mo-18yr
  - 2) routine 2nd MMR at 5 years + catch-up with MR from 5-18yr
  - 3) routine 2nd MMR at 18 months
  - 4) routine 2nd MMR at 5 years
- Transmission dynamics to predict cases averted under each scenario



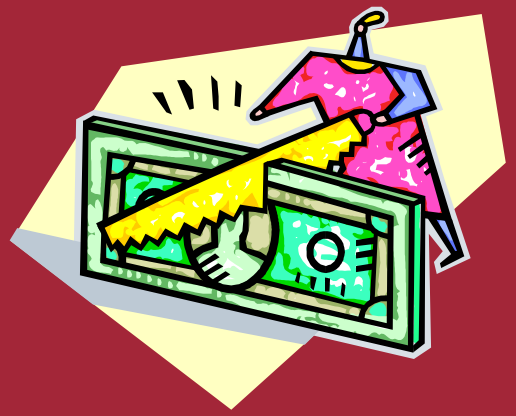
Examples CBA 2nd dose of measles in Canada (Pelletier)

- Let's focus on 2 alternatives



Examples CBA 2nd dose of measles in Canada (Pelletier)

- Costs per average case
  - $929 per measles case (includes outbreaks)
  - $390 per mumps case
  - $394 per rubella case
  - $514853 per CRS case
- Costs of vaccination
  - $0.13 per AEFI per vaccinnee (2nd dose)
  - $9.21 per vaccinee for routine MMR 2nd dose
  - $14.21 per vaccinee for mass MMR 2nd dose
  - Other mass campaign costs: $2,000,000
  - Wastage: 10-15% routine and 5% mass



Examples CBA 2nd dose of measles in Canada (Pelletier)

Alternative	Incremental Costs	Incremental Benefits	IBCR	NSB
1 dose vs 2 doses	$53,385,395	$190,883,235	$3.58	$137,497,840
1 dose vs 2 doses + mass	$108,654,522	$283,700,349	$2.61	$175,045,827
2 doses vs 2 doses + mass	$55,269,155	$92,817,114	$0.17	$37,547,959

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