

Introduction to Economic Evaluation



Overview

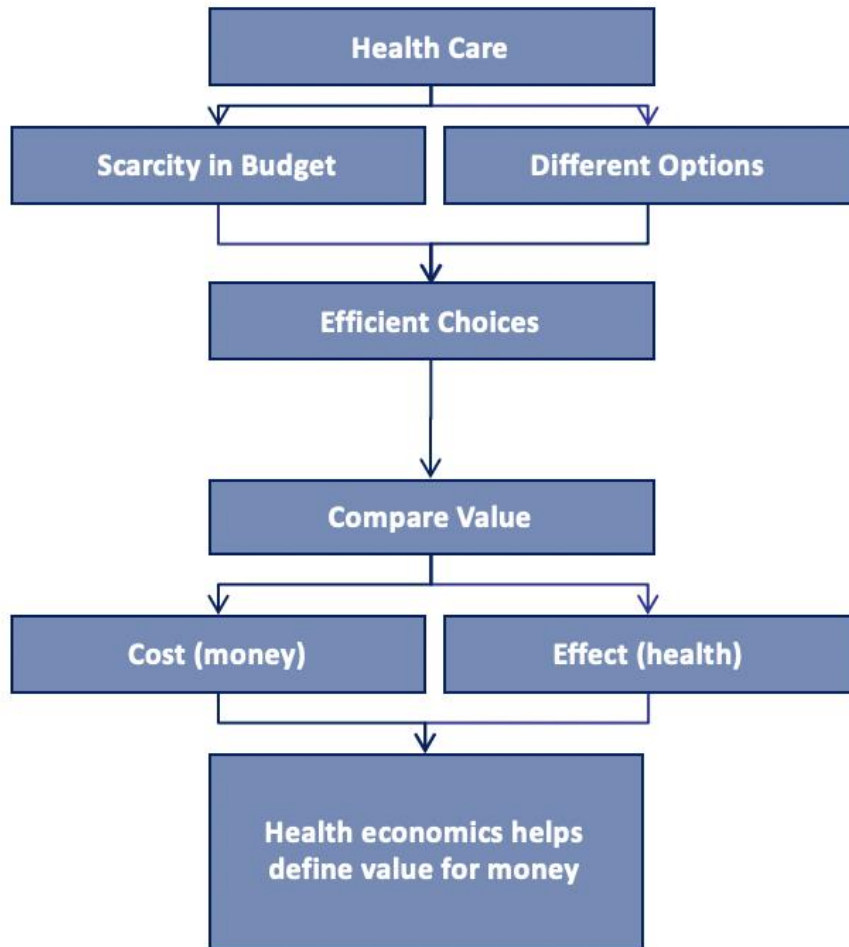
- Evidence base underlying vaccine introduction decisions
- Value for money
- Survey of methods for economic evaluation
- Components of a cost-effectiveness analysis
- Study perspectives and time horizon
- Decision modeling

Learning Objectives

- Define Basic Concepts of Economic Evaluation
- Understand different Methods and Tools of Economic Evaluation

What is Health Economics?

A tool for decision makers



Health Care is confronted with **scarcity** (limitations) in **resources** (budget)

Meanwhile **different options** exist for managing diseases (prevention vs treatment)

So **choices** have to be made between options because of budget limitations

➤ How to choose **efficiently** ?

By **comparing**, but comparing what?

➤ **Value** of (new) interventions:

Value in health care is expressed in **cost** (money) and in **effect** (health)

The way to compare value rationally is by looking at **incremental** differences!

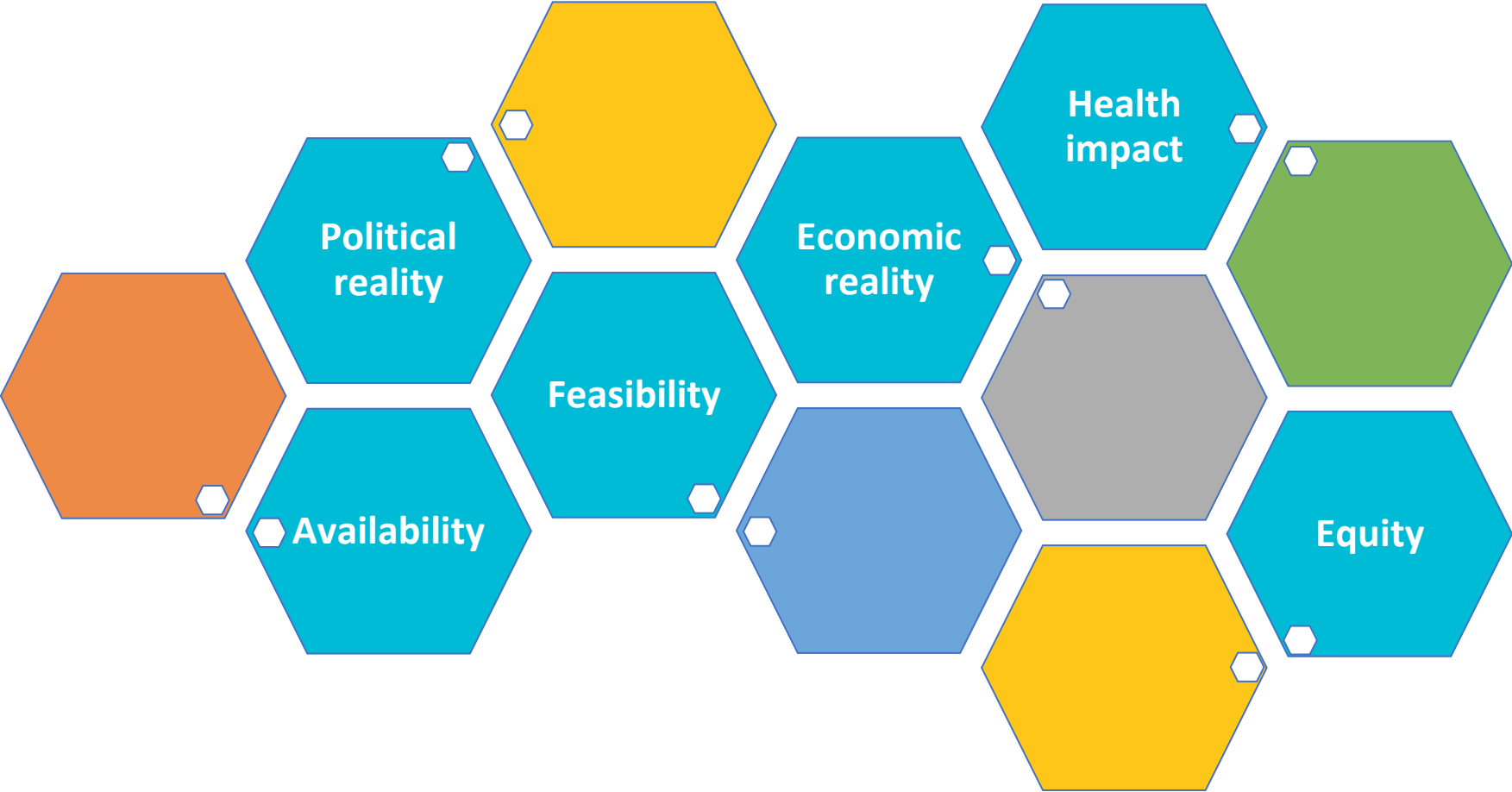
HE is therefore a tool for decision makers to make their selection **explicit**

But HE is also helpful for **equity distribution** of health care resources in the population

Economics and New Vaccine Introductions

- Economics plays important role in policy decisions to provide vaccines in the EPI
- Program managers want to know what investments would be needed for introducing a vaccine as against the benefits to be had.
- Common tools
 - Cost effectiveness analysis: "value for money" of a program relative to a feasible alternative
 - Budget impact: change in flow of funds when an organization substitutes a new program for the alternative (current) program

Choice of Whether to Invest In Vaccines is a Complex Dynamic



Evidence Base – Vaccine Introduction

Clinical

- Burden of disease
- Vaccine efficacy
- Vaccine safety
- Clinical resources
- Immunization program strategy

Political

- Demand
- Acceptability
- Political benefit
- Legal issues
- Equity issues
- Ethical issues
- Conformity to similar programs in other regions

Economic

- Program cost
- Health care budget
- External funding
- Competing priorities
- ***Cost-effectiveness***

Vaccine Value For Money: *Consumer Decision*



What do I get out of Vaccines? What do I give up?

Benefits

- Why do I want a Vaccine?
- How will it prevent the spread of infectious disease?

Alternatives

- Other Vaccines?
- Prevention?
- Education?
- Infrastructure?
- Doing Nothing?

Costs

- What expenses?
- To Whom?
- Who pays?
- Unintended Consequences?

Paying the costs

- Savings?
- Return on Investment?
- Prevention compared to Treatment
- Reduce spending on other items?

Value For Money: *Healthcare Sector*

Benefits

Child
Family
Community
Nation
What metrics?

Alternatives

Status quo (no new program)
Polyvalent vaccine
Treatment

Vaccine Program



<https://www.health-e.org.za/2014/03/10/shots-dark-vaccines-south-africa/>

Costs

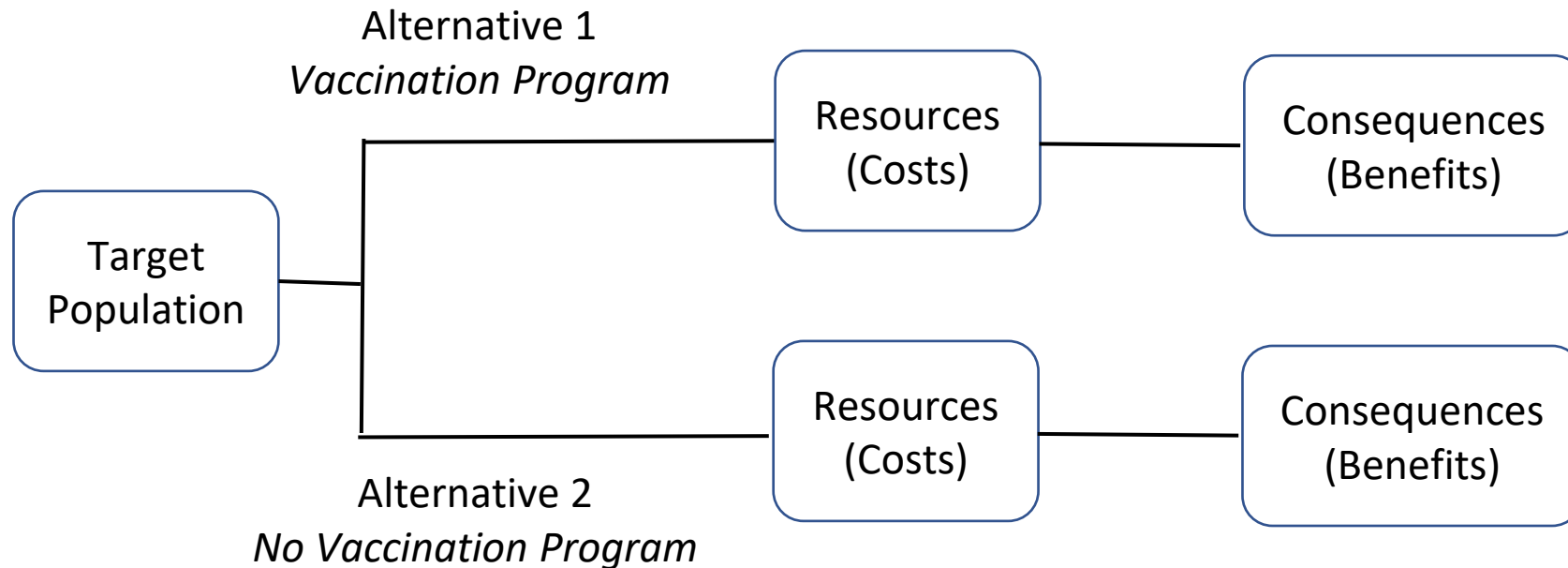
Vaccine
Personnel
Supply chain
Cost to patient & family

Paying the costs

Available funds
Shift budget
Fee for service
New taxes
NGO

Economic Evaluation In Health Care

Resources are scarce – choices must be made!



Study Design

- Characteristics of the target population
- Specification of alternative programs/interventions
- Quantify resources consumed – valuation of resources
- Identification of consequences – measurement of benefit

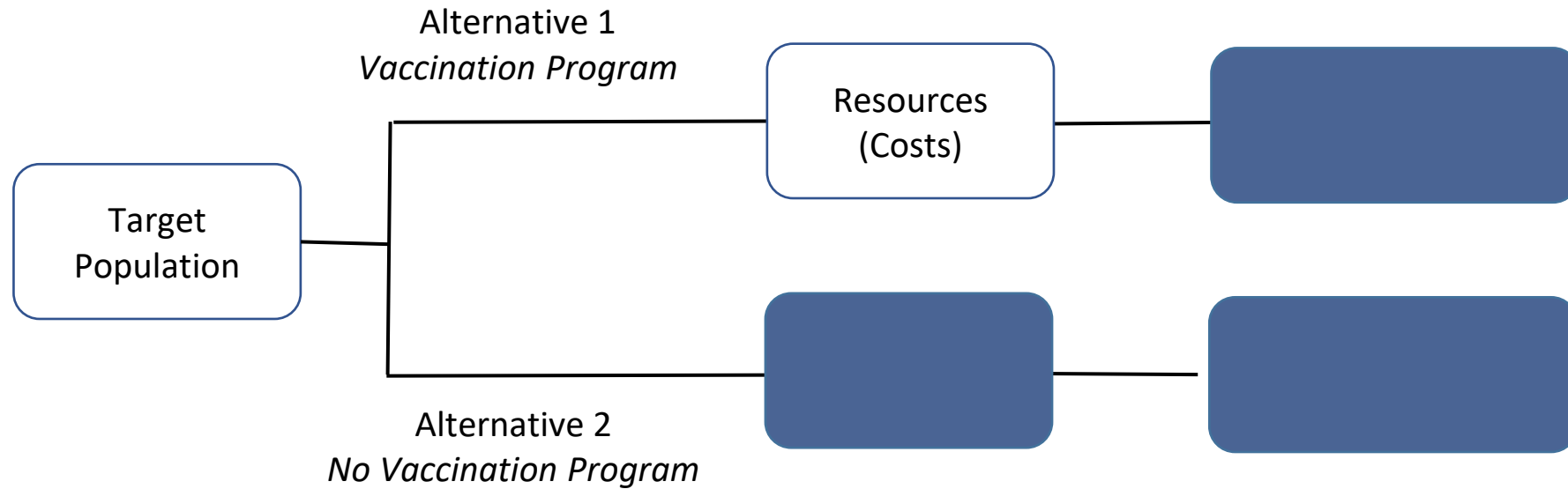
Economic Evaluation Methods For Vaccine Care

Economic Evaluation Methods

- Cost Finding
- Cost-minimization
- Cost (burden) of Illness
- Cost-Consequence
- Cost-Effectiveness
- Cost-Benefit

Economic Evaluation Methods

Cost Finding



Objectives:

- Identify resources consumed in the provision of a specific program or intervention
- Estimate the monetary value of these resources

What is the Aim of Costing?

Value the use of scarce of resources needed to produce a certain health effect

$$\text{ICER} = \frac{\begin{array}{l} \text{Value of} \\ \text{change in use} \\ \text{of health care} \\ \text{resources} \end{array} + \begin{array}{l} \text{Value of} \\ \text{change in use} \\ \text{of non-health} \\ \text{care} \\ \text{resources} \end{array} + \begin{array}{l} \text{Value of} \\ \text{change in use} \\ \text{of patient} \\ \text{time for} \\ \text{treatment} \end{array} + \begin{array}{l} \text{Value of} \\ \text{change in use} \\ \text{of family} \\ \text{caregiver time} \end{array} + \begin{array}{l} \text{Value of} \\ \text{change in} \\ \text{patient} \\ \text{productivity} \\ \text{(work)} \end{array}}{\begin{array}{l} \text{Change in Output} \\ \text{(e.g. quantity and} \\ \text{quality of life} \\ \text{QALY - DALY} \end{array}}$$

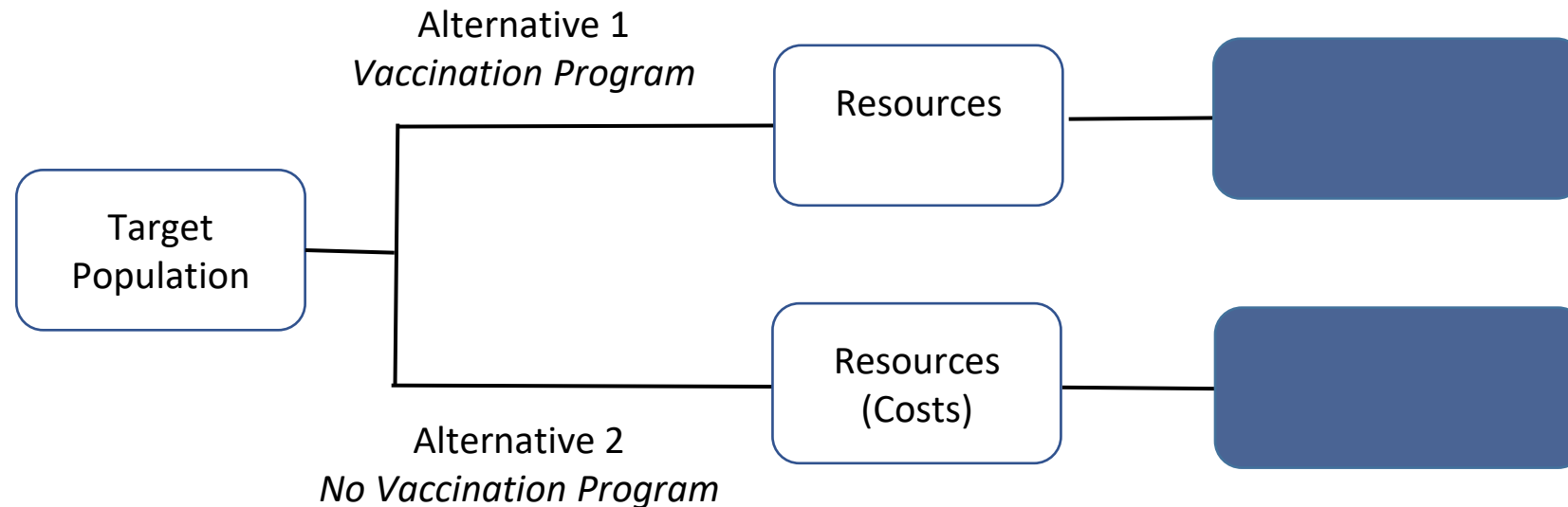
Weighing the sacrifices against the gains of the intervention to determine the relative desirability of such intervention

Examples Of Different Types Of Costs

Category of Cost	Examples
Health care resources	<ul style="list-style-type: none">• Hospital, ambulatory care, home care• Medications, bed days, procedures• Tests, ancillary services, professional fees, facilities• Time patients' spend during treatment and medical care
Non-health care resources	<ul style="list-style-type: none">• Childcare• Transportation
Patient time for treatment	<ul style="list-style-type: none">• Patient time waiting for medical care• Patient time receiving medical care
Family caregiver time	<ul style="list-style-type: none">• Family time• Uncompensated caregiver time
Patient productivity	<ul style="list-style-type: none">• Patient's lost or impaired ability to work due to morbidity• Patient's lost productivity due to premature mortality

Economic Evaluation Methods

Cost-Minimization Analysis (CMA)

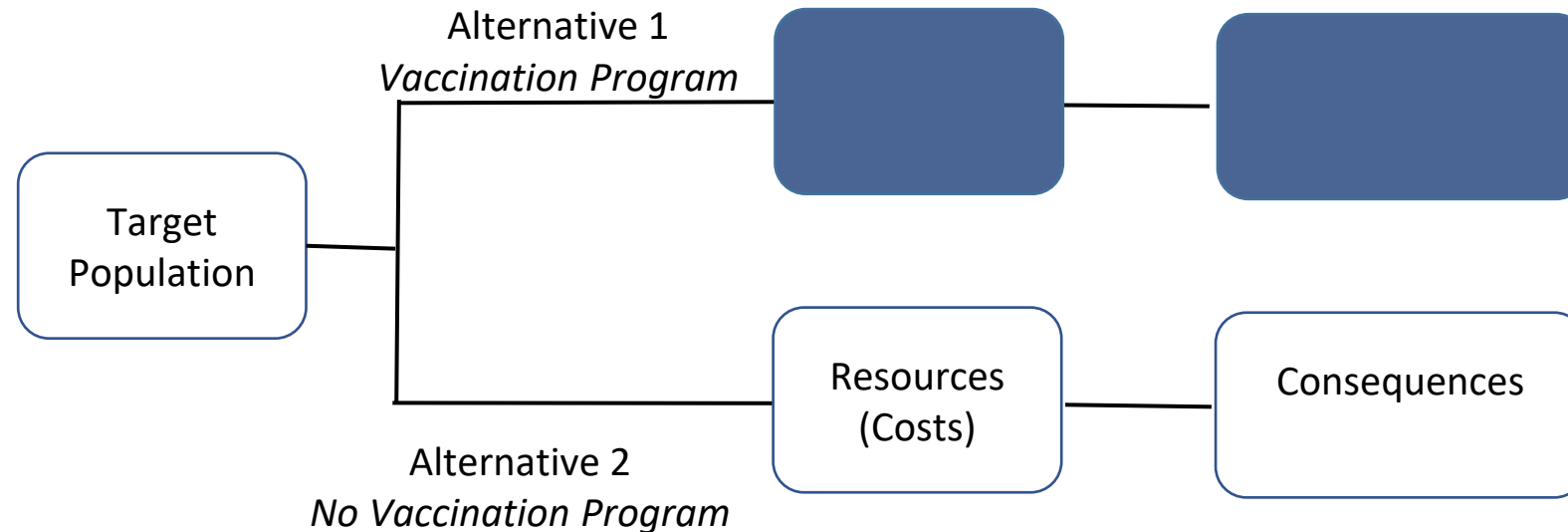


Objectives:

- Identify resources consumed in the provision of alternative interventions
- Estimate the monetary value of these resources
- Compare the cost of the alternative interventions
- ***Identify the least costly alternative***

Economic Evaluation Methods

Cost (Burden) of Illness Analysis (COI)

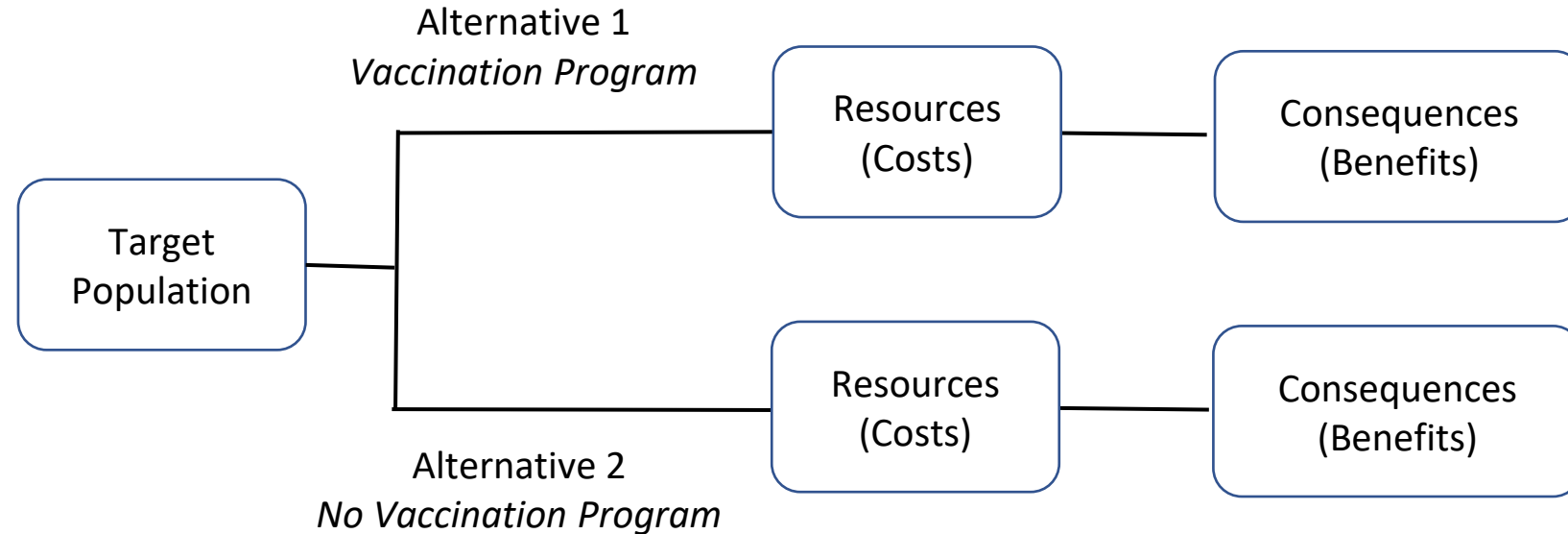


Objectives:

- Focus on current status of the target population without intervention
- Estimate health care resources consumed and associated costs
- Quantify “burden of illness” with metrics such as
 - Mortality (Years Of Life Lost)
 - Disability (Limitations On Daily Activity)
 - Lost Productivity

Economic Evaluation Methods

Cost – Consequence Analysis



Objectives:

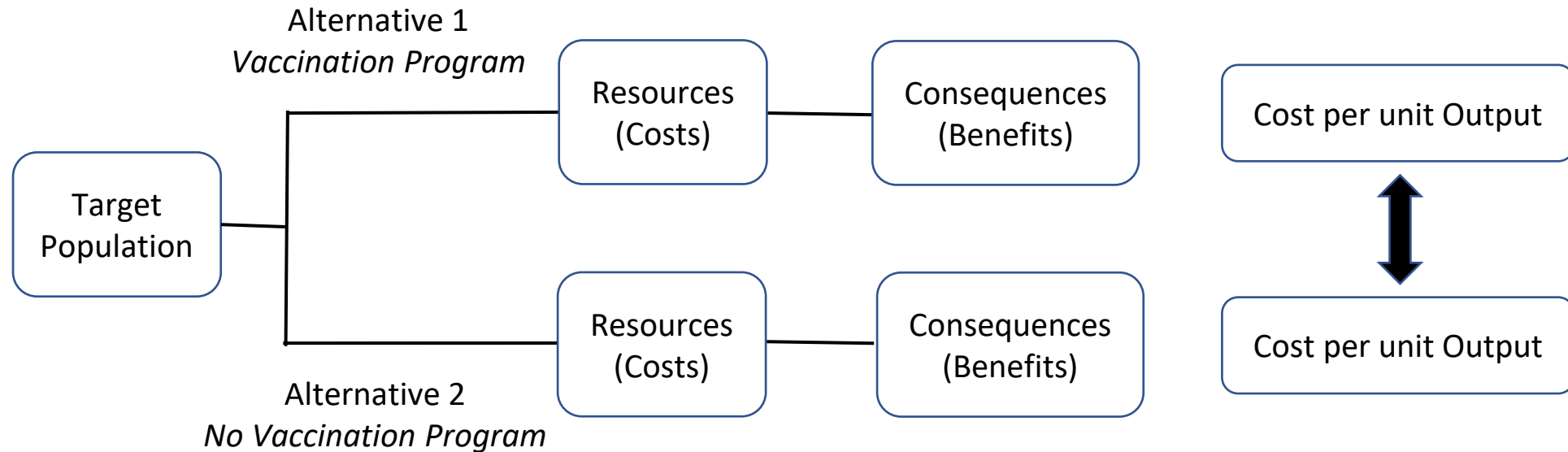
- Identify resources consumed in the provision of alternative interventions
- Estimate the cost of each alternative intervention
- Identify and quantify effects of each intervention
 - Patient and Family
 - Community
 - Health Care System
 - Nation

Potential Economic Consequences (Benefits) of A Vaccine Program

Benefit	Category	Definition
Health gains	Direct	Reduction in mortality/morbidity
Health care cost savings	Direct	Averted medical expenditures (outpatient visits, hospitalizations, diagnostics and treatments, transport to the facility)
Care related productivity gains	Indirect	Savings of parents' productive time and lost wages
Outcome-related productivity gains	Broader	Improves cognition and physical development, as well as school enrollment, attendance and educational attainment
Behavior-related productivity gains	Broader	Improves child health and survival and thereby changes household choices, such as fertility and consumption choices
Community externalities	Broader	Improves health among unvaccinated community members, general economic improvement

Economic Evaluation Methods

Cost - Effectiveness Analysis

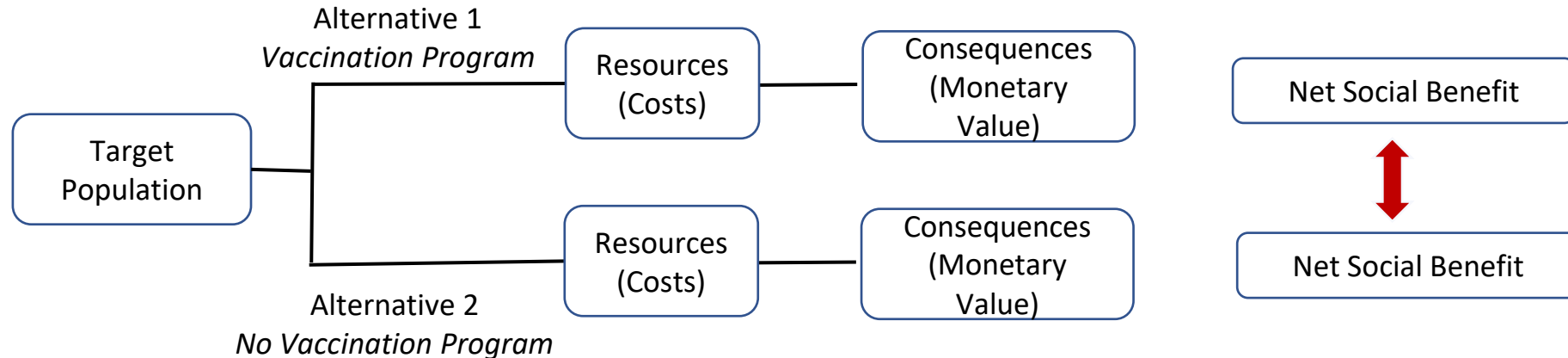


Objectives:

- Compare alternative programs in terms of efficiency
- "Benefit" is defined as units of output
 - Example: output for an intervention that reduces mortality could be specified as "years of survival"
 - Same metric must be used for each alternative to enable comparison
- Efficiency of each alternative calculated as "cost per unit of benefit"

Economic Evaluation Methods

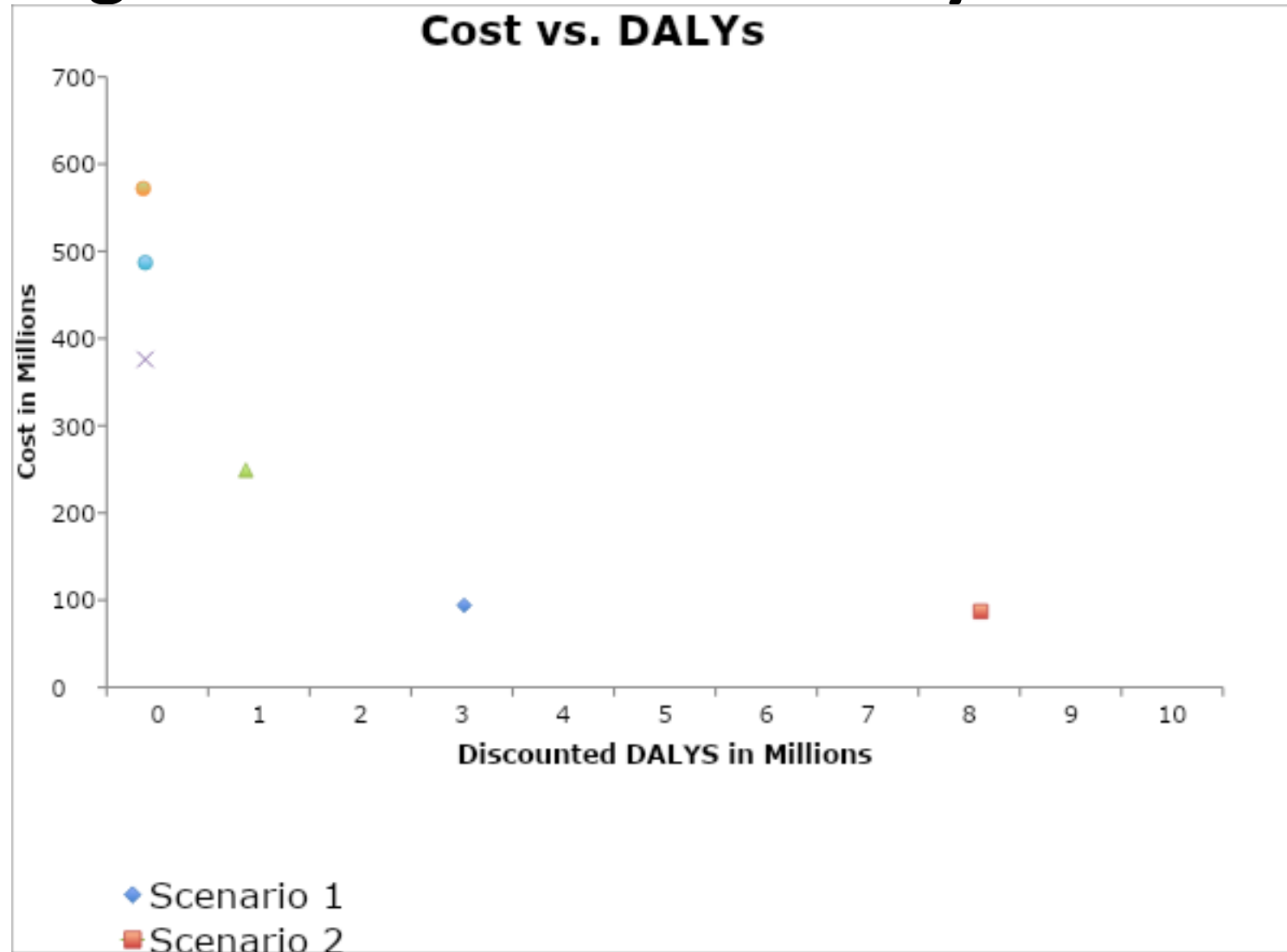
Cost - Benefit Analysis (CBA)



Objectives:

- Compare alternative programs in terms of net social cost
- "Benefit" is defined as the monetary value
 - All relevant consequences for each intervention must be given a specific monetary value
 - Requires assumptions for monetary value of years of survival gained, days of disability avoided
- Net social cost of a program = value of benefit – cost
- Assess a single program: worthwhile if net social benefit >0
- Compare alternative programs: which has greater net benefit?

Uganda Vaccine Case Study

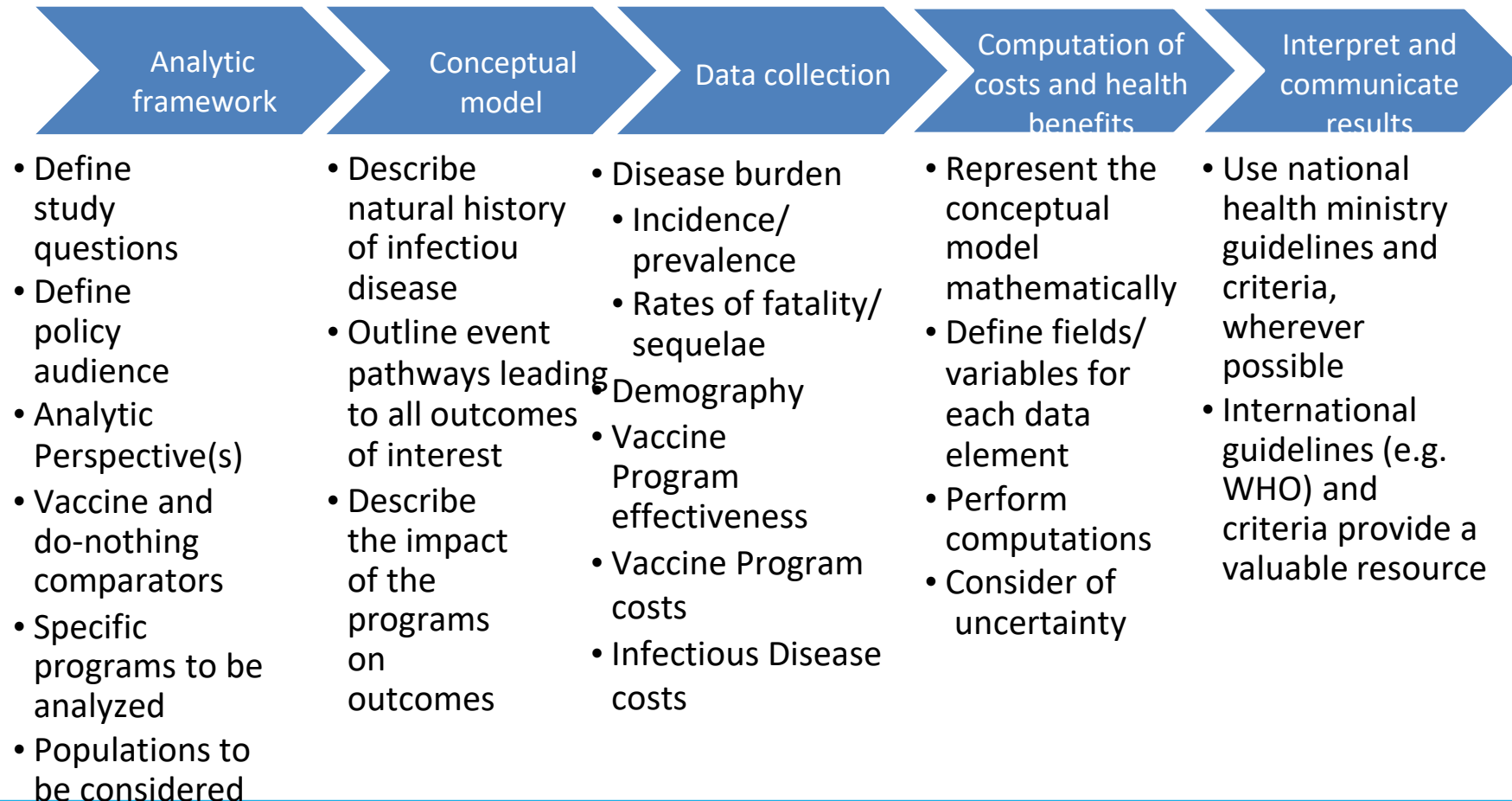


Economic Evaluation Methods

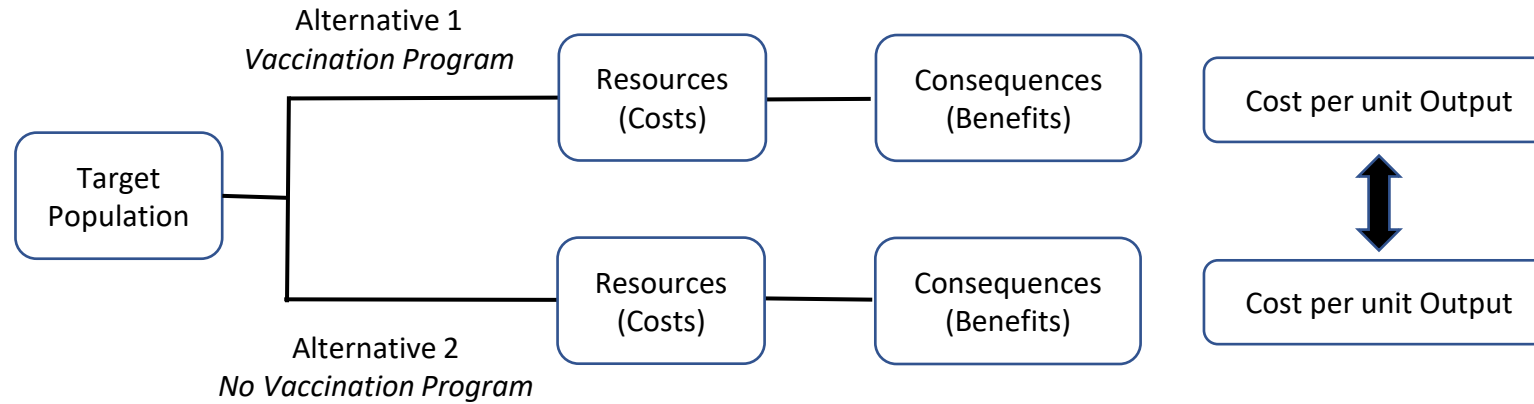
Other Methods

- Budget Impact
 - Cost of a Vaccine absorbed over a pooled risk
 - Commonly interpreted by government or vaccine payers
 - Measure of cost of intervention for all those in need to entire population in terms of “Per member per month” or “Per member per year”
- Return on Investment (ROI)
 - Long-term outlook of costs recouped from benefit
 - Vaccine cost tradeoff to medical expenses
 - Generally measured over: 5 or 10 years

What are the Components of Vaccine Cost-Effectiveness Analysis?



Measuring the “Output” of a Vaccine Program or Intervention



- Ideal metric combines both the *quantity* and *quality of life* as a result of the program or intervention
- **Quality adjusted life-year (QALY)** - duration of survival weighted by a factor representing consumer strength of preference for state of health during this period – more common in Western countries, recommended by U.S. cost-effectiveness panel
- **Disability-adjusted life-year (DALY)** - years lost relative to optimum survival weighted by a factor representing level of impairment – more commonly used in Vaccine economics, recommended by WHO

Study Perspective Examples

- Healthcare Sector perspective: Healthcare costs (drug, hospital costs, analytic procedures) including costs arising from the consequences of treatment to patients, providers and payers
- Government perspective: Healthcare costs & other publicly provided services (community services, social services) where taxpayer funds are financed
- Societal perspective: Healthcare and other public sector costs incurred for the management of disease from all perspectives involved in care (e.g. patient, provider, public/private payers, government, family caregivers, etc.)

Standard Vaccine Cost-Effectiveness Analysis Scenario: Infant/Child Malaria Vaccine

Intervention(s)	Cost	Benefits
New malaria vaccine	<ul style="list-style-type: none"> Vaccine costs Administration costs 	<ul style="list-style-type: none"> # malaria cases averted # infant deaths averted DALYs averted
Long-lasting, insecticide-treated nets (LLITN)	<ul style="list-style-type: none"> LLITN costs 	<ul style="list-style-type: none"> # malaria cases averted # infant deaths averted DALYs averted
Do nothing: treat acute malaria cases	Medical cost Non-medical direct cost Indirect costs	<ul style="list-style-type: none"> # malaria cases averted # infant deaths averted DALYs averted

Time Horizon

- The analytic horizon may often be short (i.e. one year or less), e.g. vaccination campaigns, particularly if herd immunity can be ignored and only one (birth) cohort is modelled.
- When using a dynamic model, and if the indirect effects change non-linearly with the number of (birth) cohorts vaccinated, the analytic horizon should be long enough for the modelled infection to attain a new endemic equilibrium, as the current epidemiology is altered after the start or change in the vaccination programme.

Time Horizon Examples

Study	Analytical horizon
CEA of HIV/AIDS	Lifetime
CEA of Hib vaccine in India	20 years
CEA of 7vPCV in Hong Kong	10 years
CEA of rotavirus vaccine in Hong Kong	5 years
CEA of rotavirus vaccine in Mexico	5 years
CEA of seasonal influenza vaccine (many countries)	1 year

Cost-Effectiveness Analysis: “ICER”

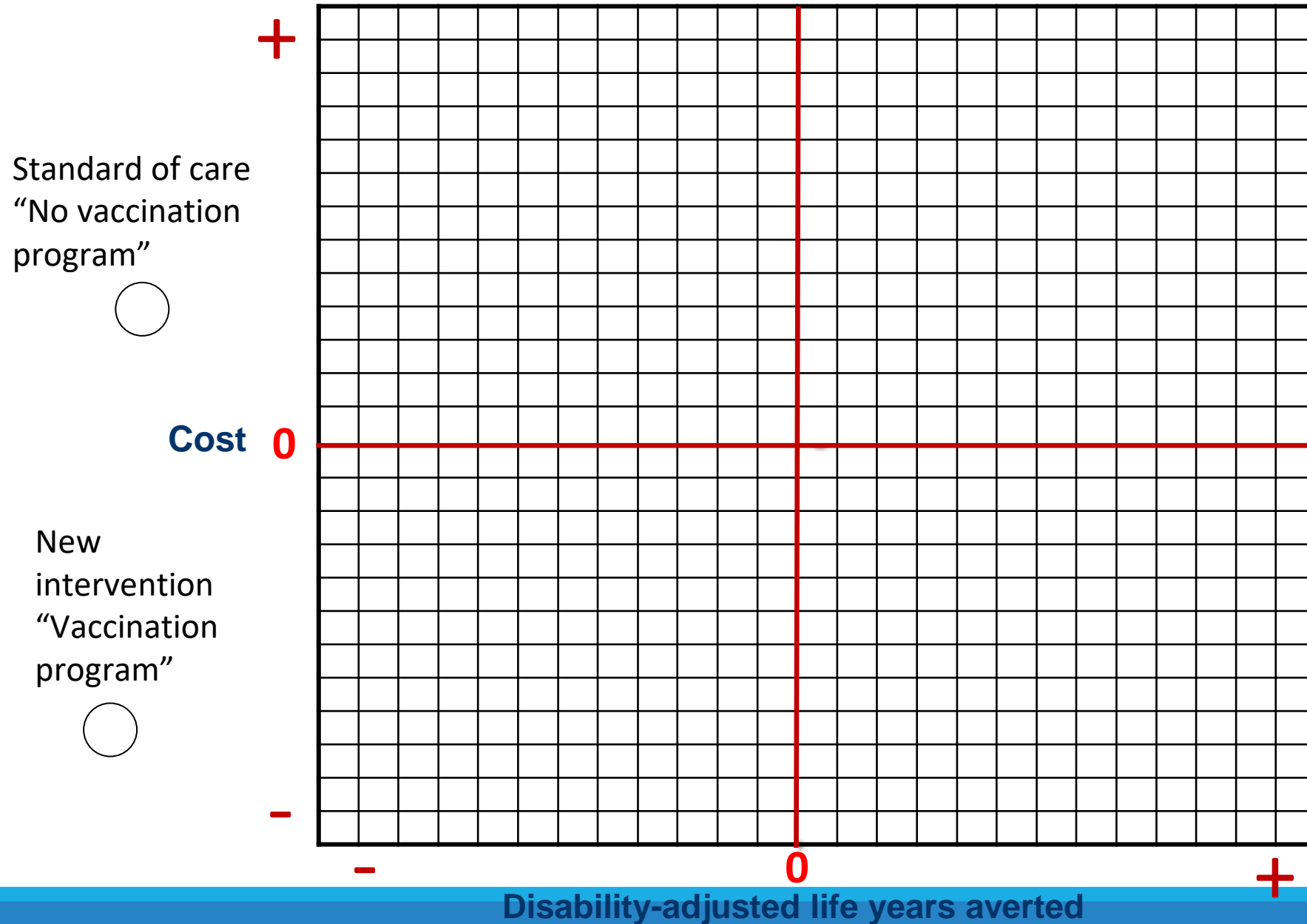
“ICER” – Incremental Cost-effectiveness Ratio

$$\text{ICER} = \frac{\text{Cost}_{\text{NEW PROGRAM}} - \text{Cost}_{\text{ALTERNATIVE}}}{\text{Output}_{\text{NEW PROGRAM}} - \text{Output}_{\text{ALTERNATIVE}}}$$

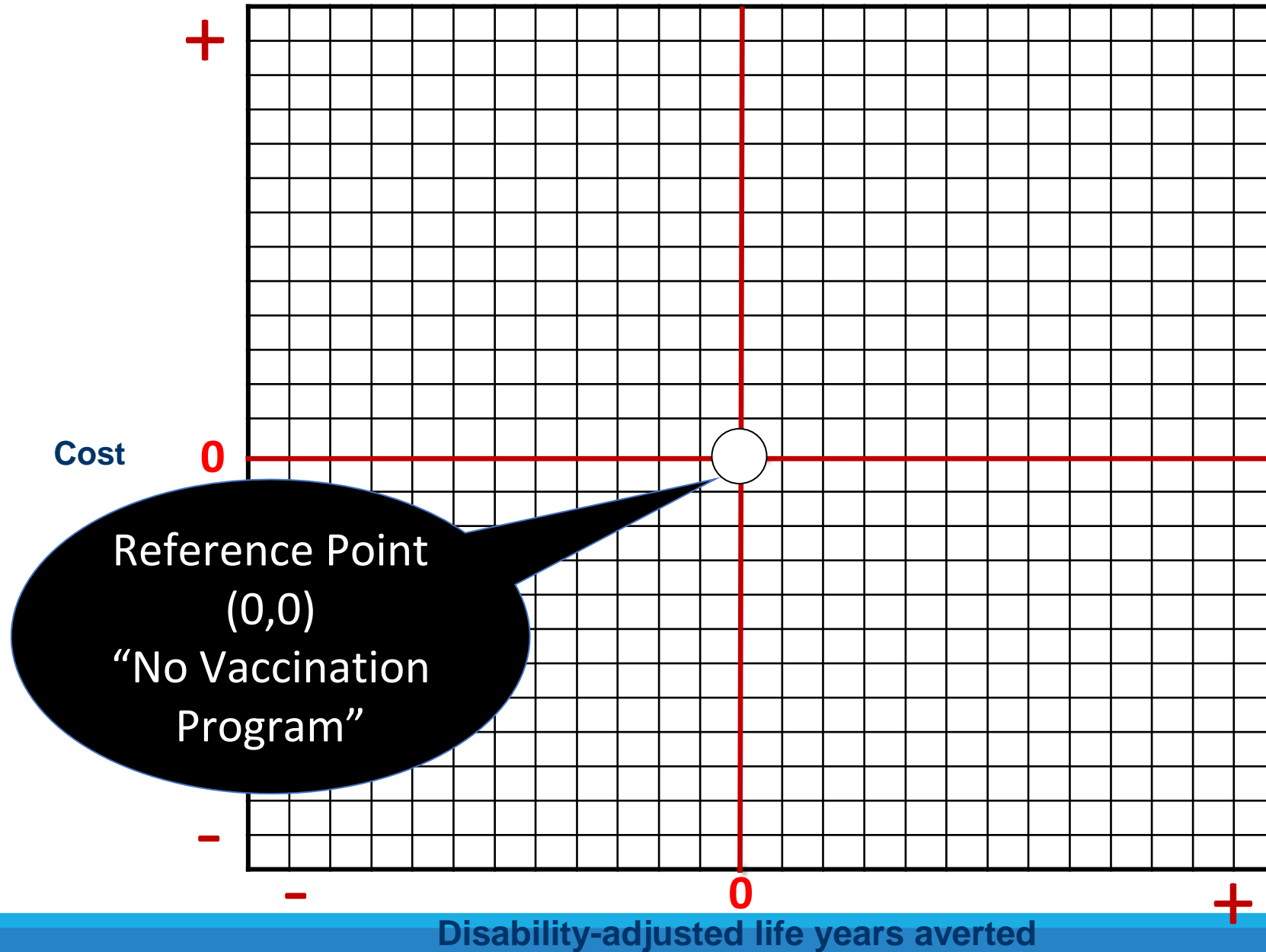
Example - Hib conjugate vaccination in India (versus no vaccination)

“From a government perspective, cost-effectiveness ranged from \$192 to \$1033 per discounted DALY averted. With the inclusion of household healthcare costs, cost-effectiveness ranged from \$155 to \$939 per discounted DALY averted.”

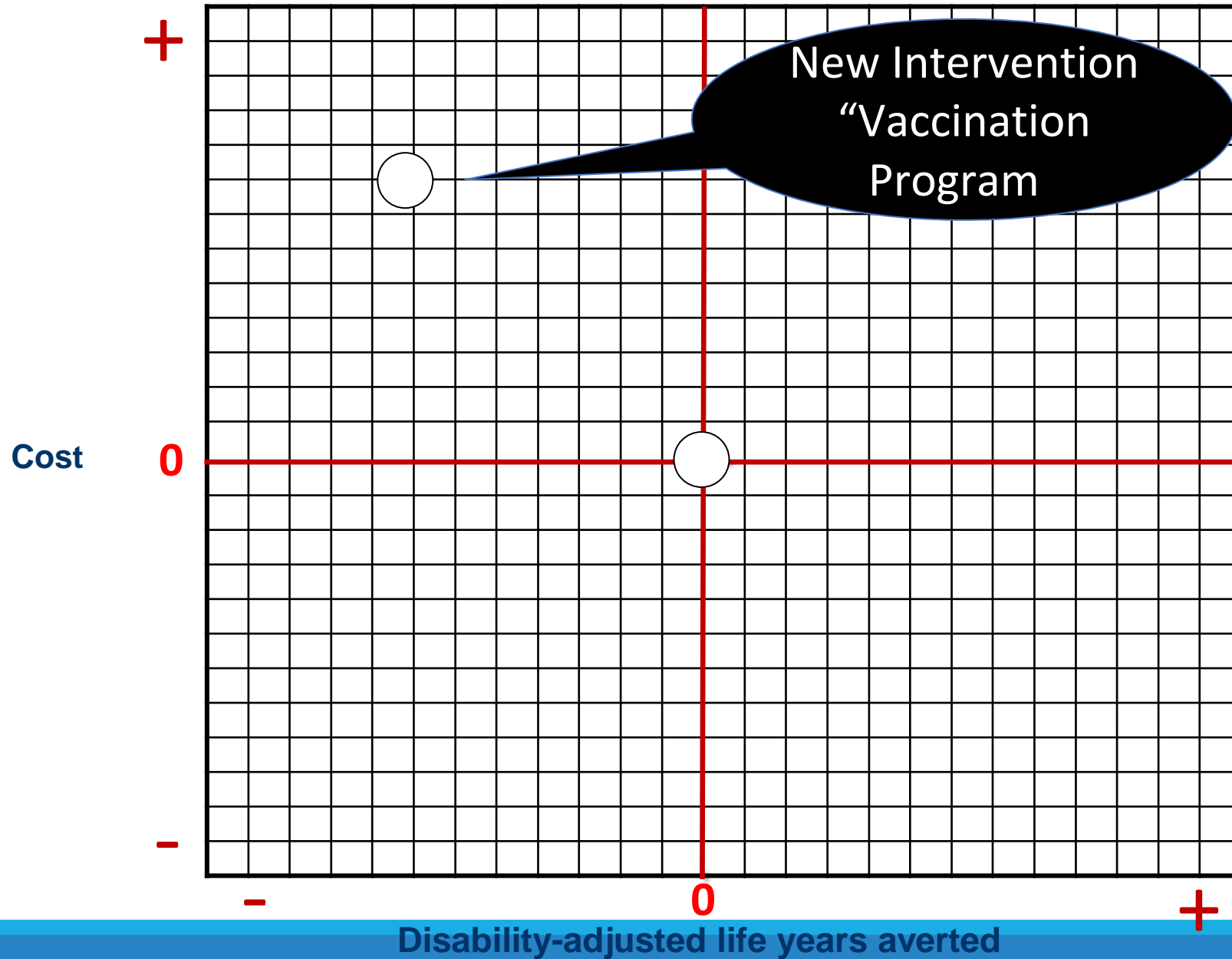
Cost-Effectiveness Plane



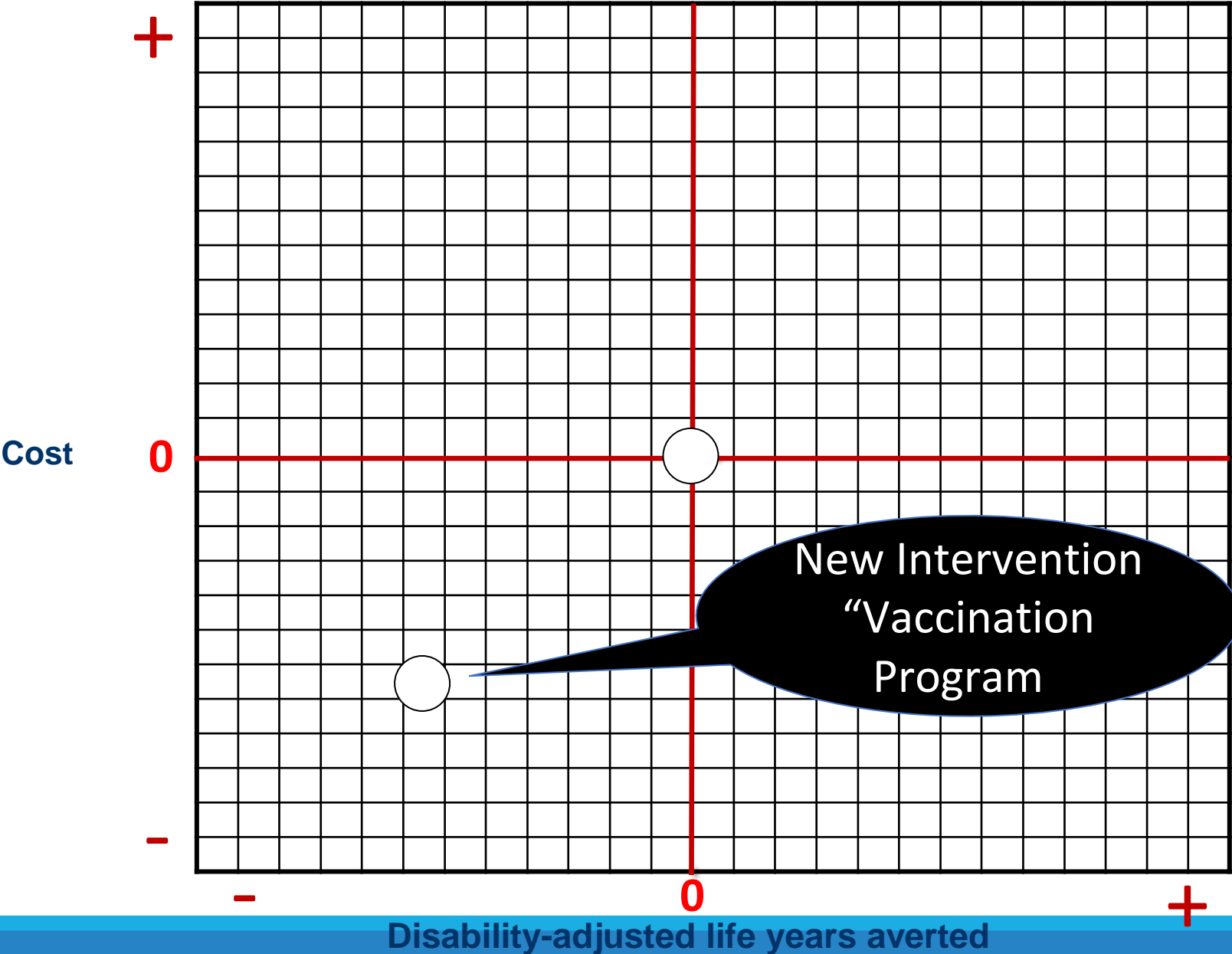
Cost-Effectiveness Plane



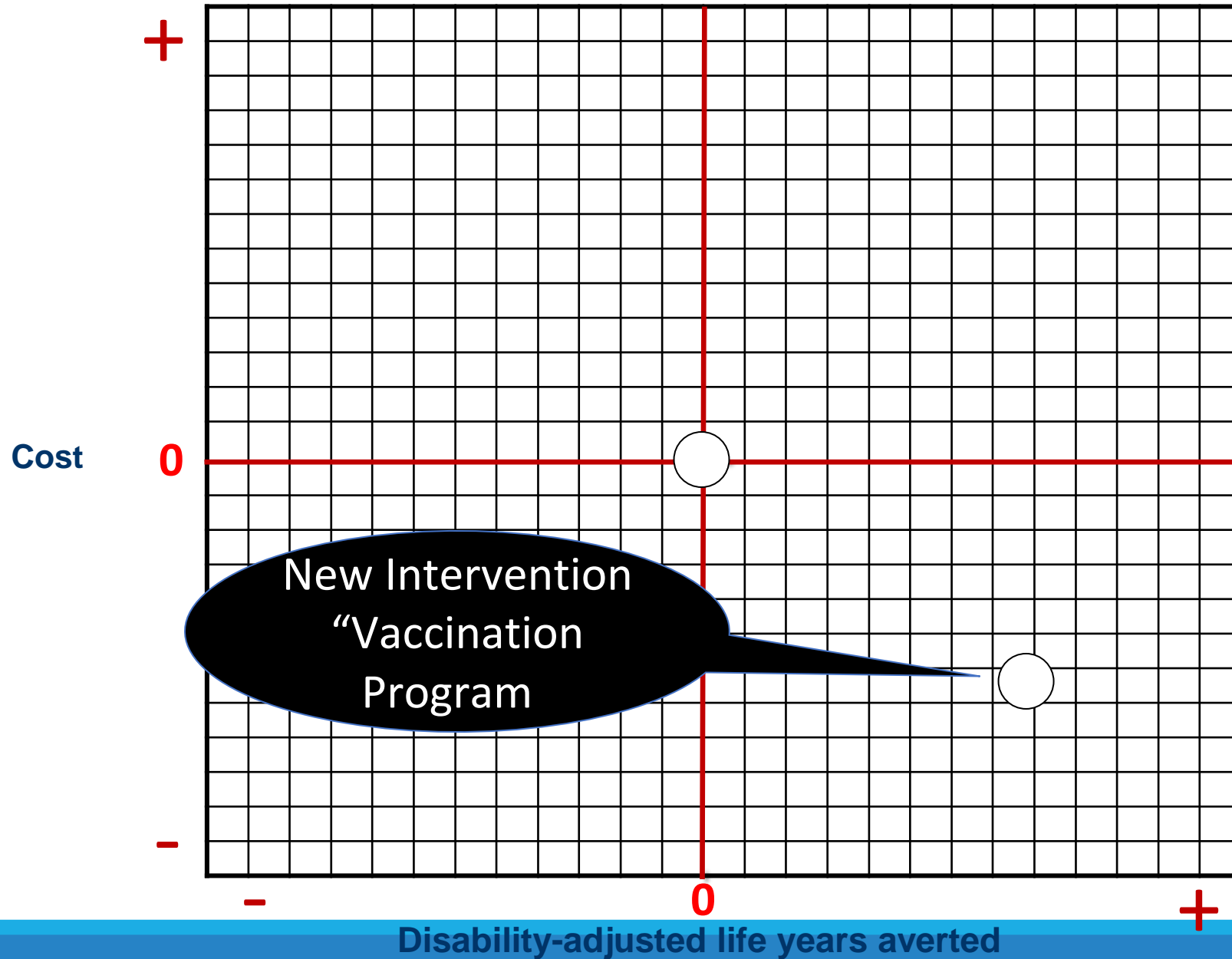
Interpreting the ICER (1)



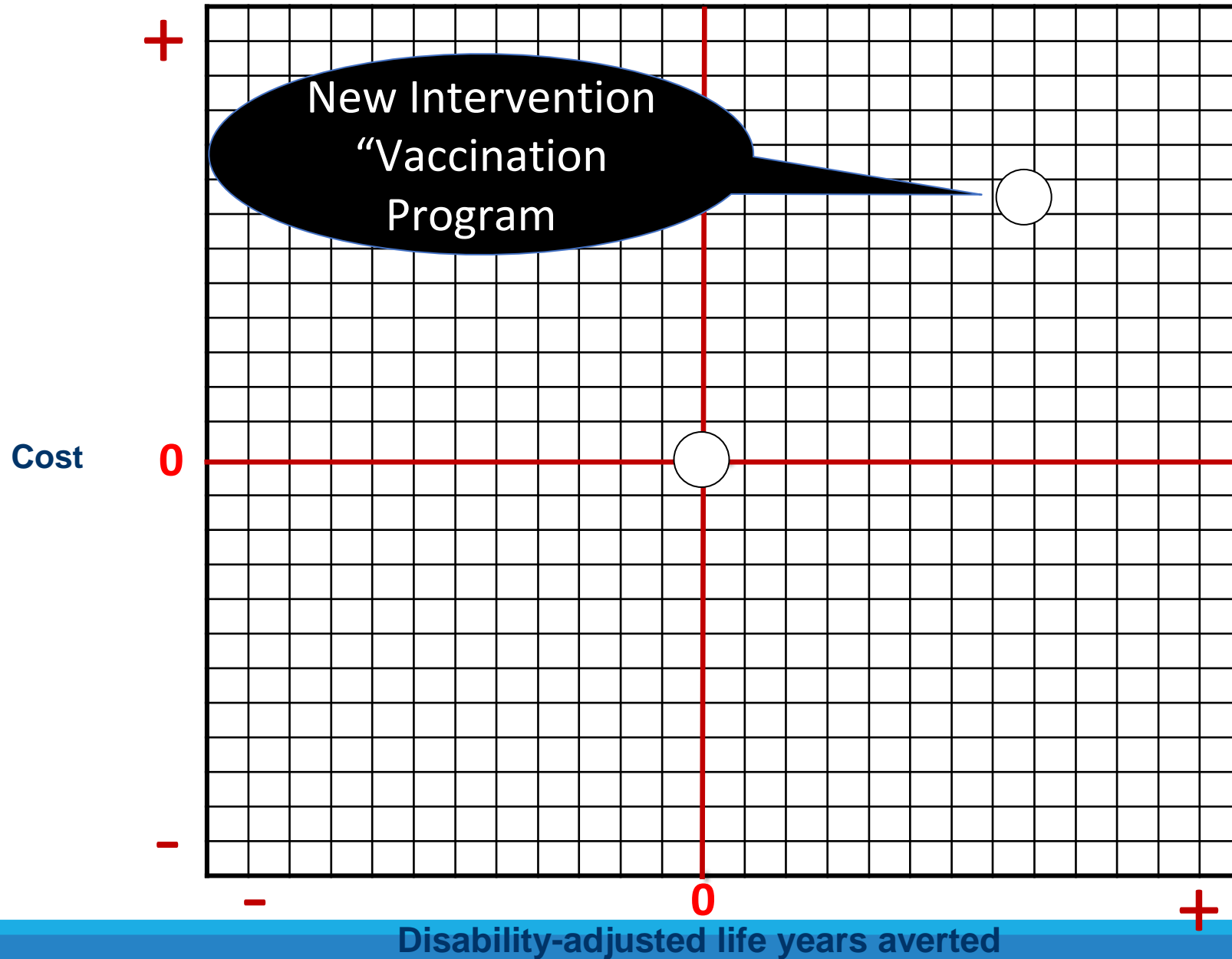
Interpreting the ICER (2)



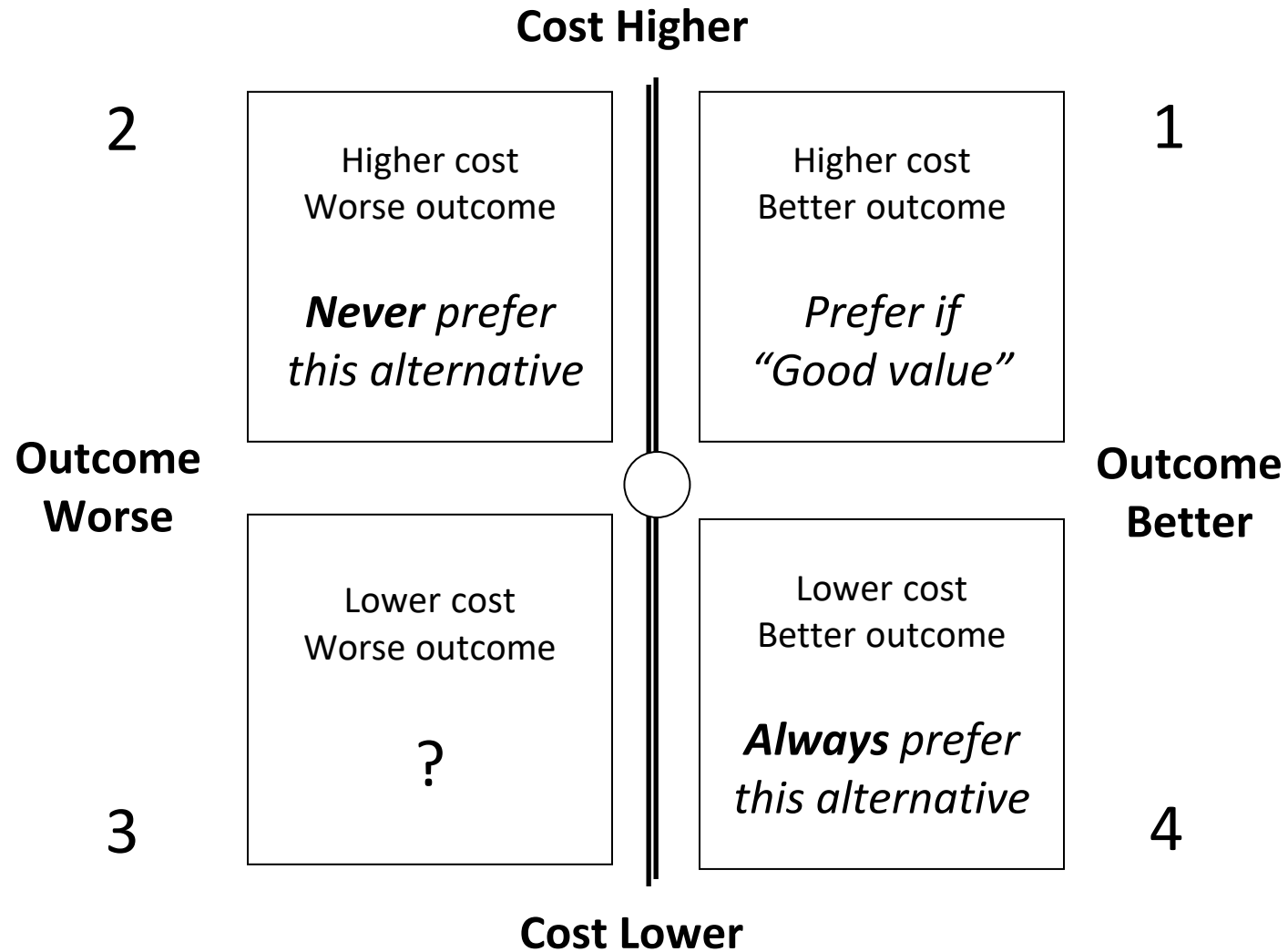
Interpreting the ICER (3)



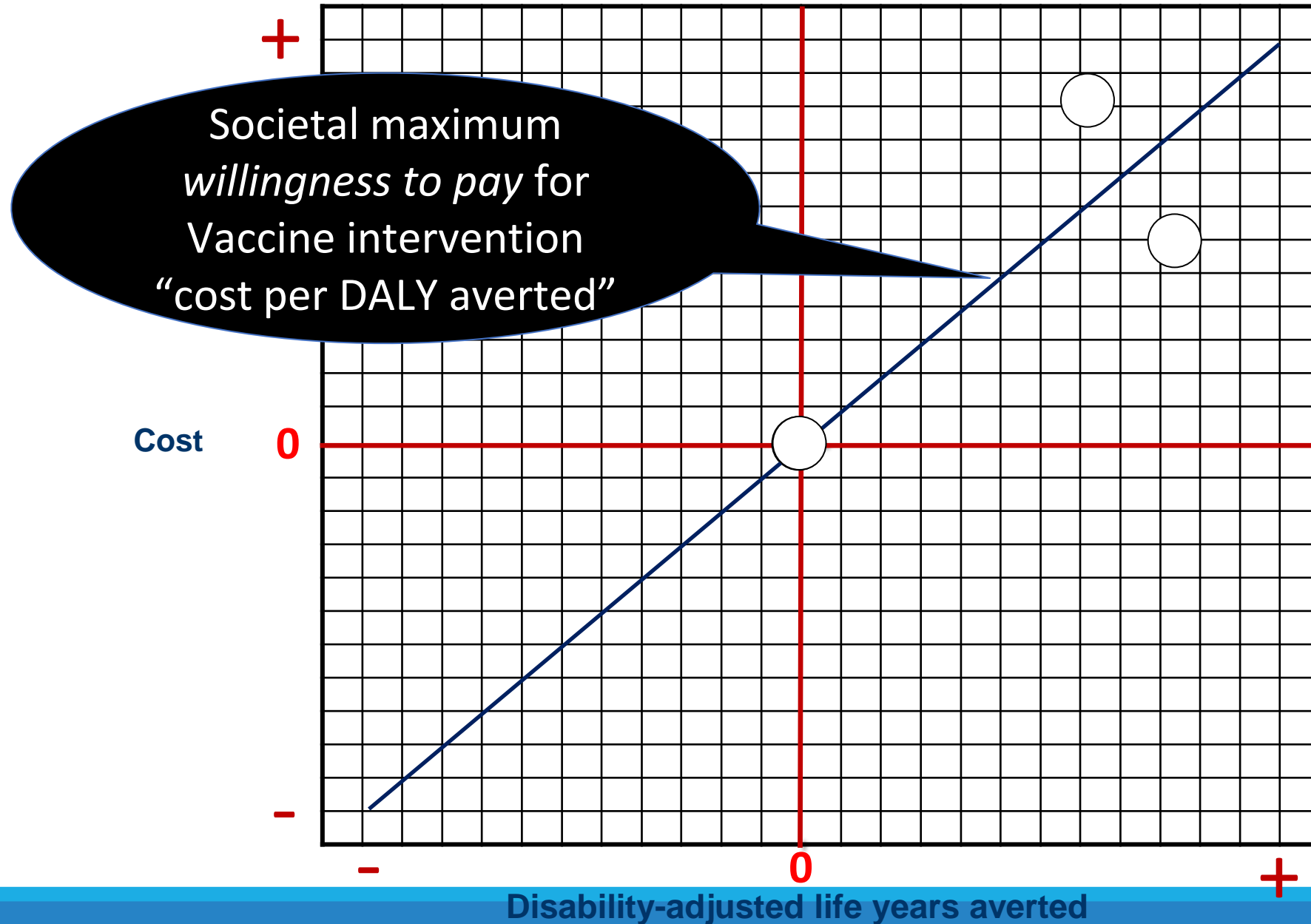
Interpreting the ICER (4)



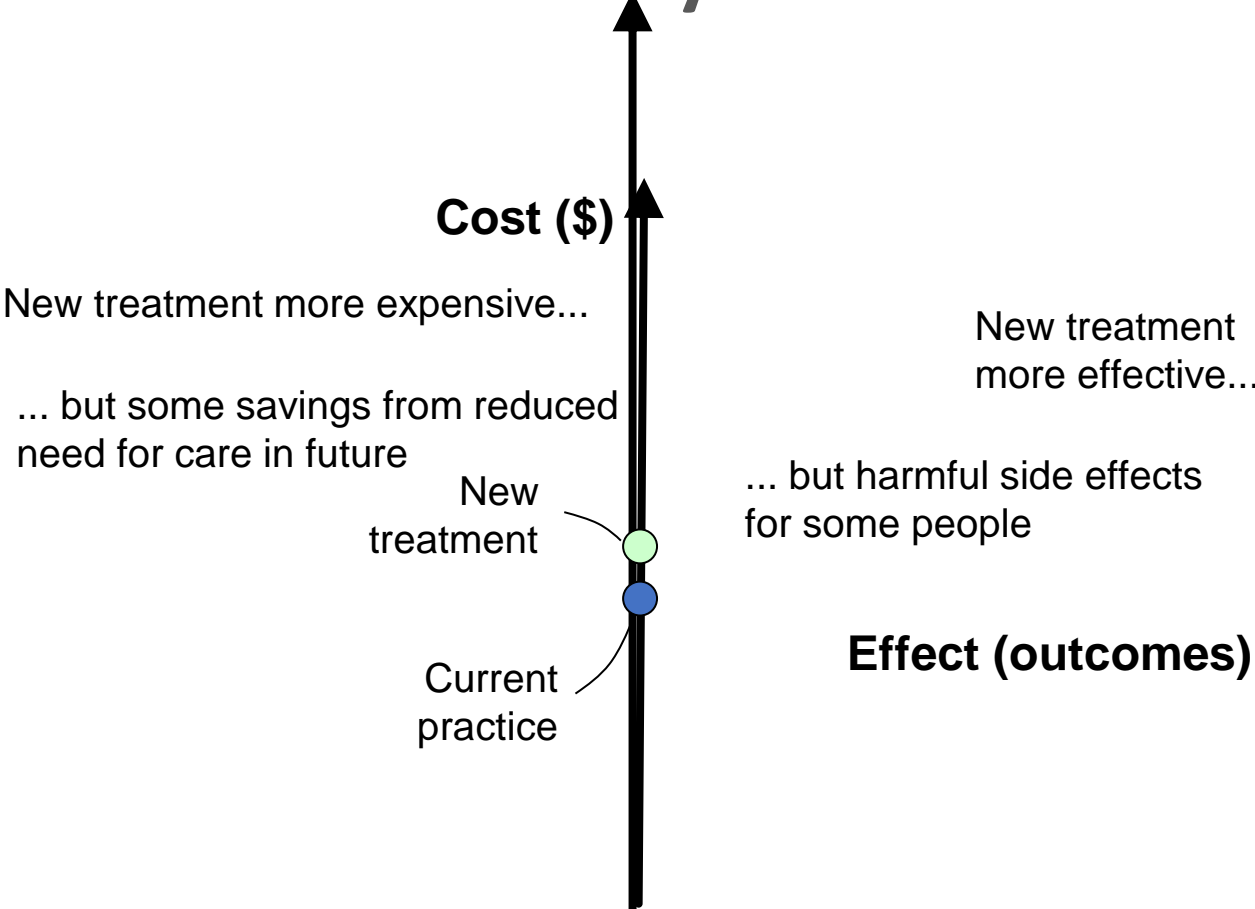
Decision Rules for Vaccine CEA



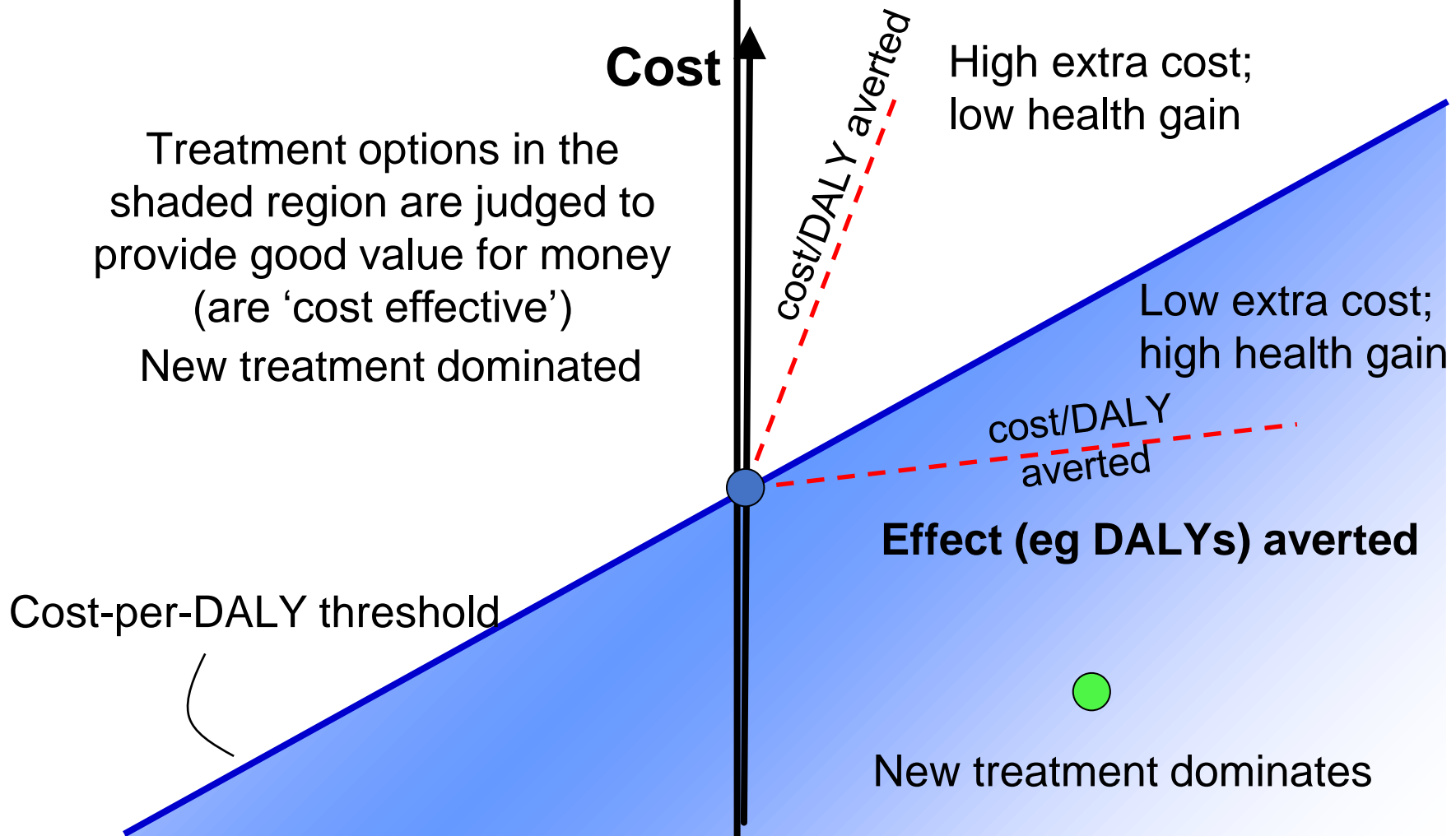
When is an intervention “cost-effective”?



How do we use the ICER to assess value for money?



How do we use the ICER to assess value for money?

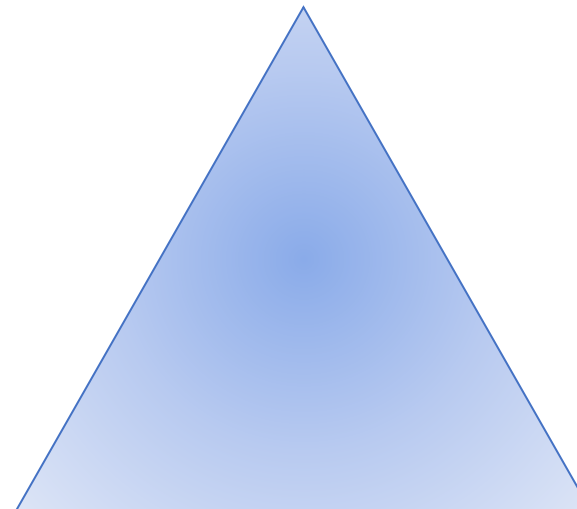


Summary

Role Of Economic Evaluation Of Vaccines In Health Policy

Efficiency

Cost-effectiveness



Affordability

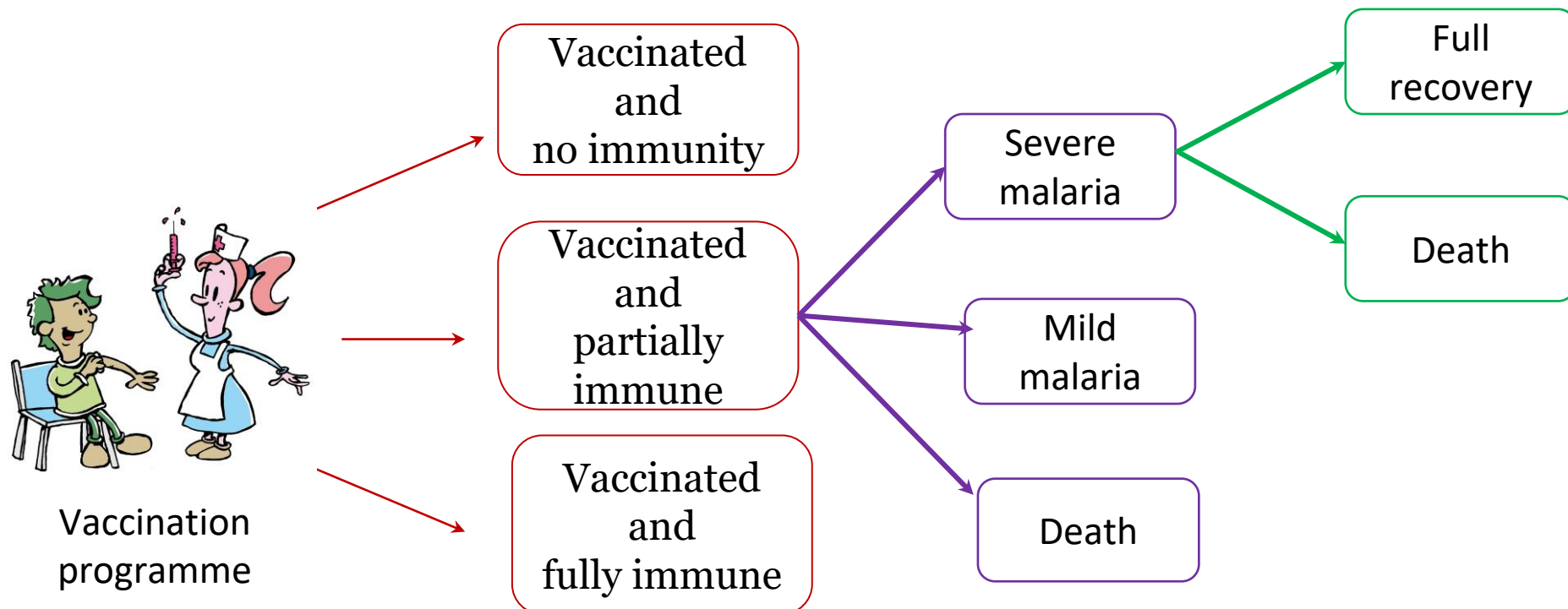
Budget Impact

Equity

Return on Investment

Creating a Decision Analysis Framework

- Points to consider in framework construction:
 - Not every infant receiving an intervention will have similar outcomes/respond equally
 - Possible outcomes following vaccination:



Decision Analysis

- Uses mathematical relationships to describe a series of possible infection consequences that could flow from a vaccine program, or lack thereof
- Is a systematic approach to decision-making that accounts for *variability* and *uncertainty* in Vaccine outcomes
- Variability
 - is the likelihood of responding differently to a Vaccine intervention
 - probability of disease infection with or without vaccine
- Uncertainty
 - estimation of probabilities are uncertain
 - Unintended consequences of vaccine use and investment
 - accounted for using sensitivity analyses

Decision Analytical Models

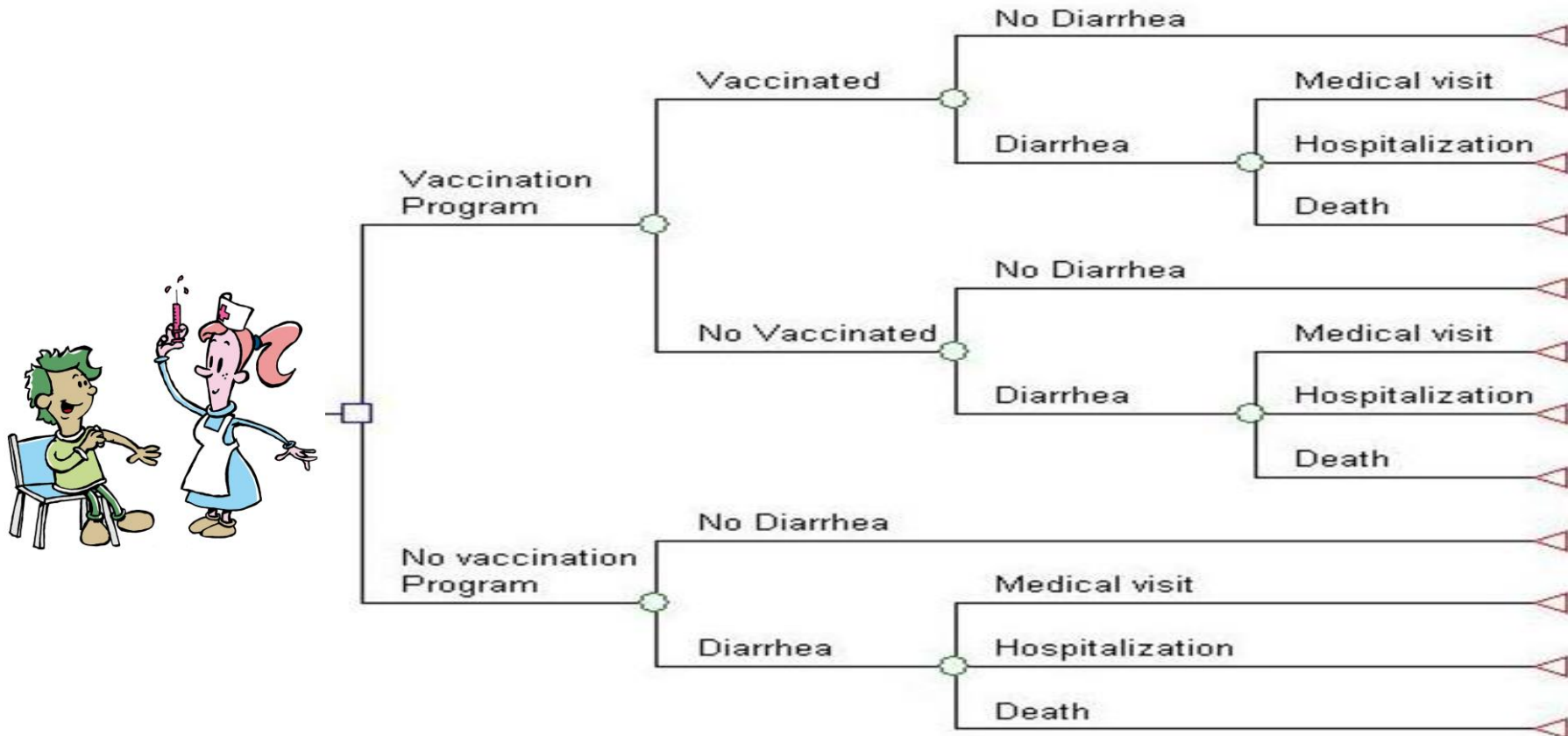
- Decision analytical models are structured
 - to characterize outcomes of vaccines and alternative options
 - is done in a way that is appropriate for the infectious disease condition and vaccine usage
 - to represent clinical/disease pathways that are pertinent to the infection, or pathways avoided with vaccine use
- Allows the synthesis of evidence from a variety of sources to estimate vaccine costs, safety and effectiveness

Decision Analytical Models

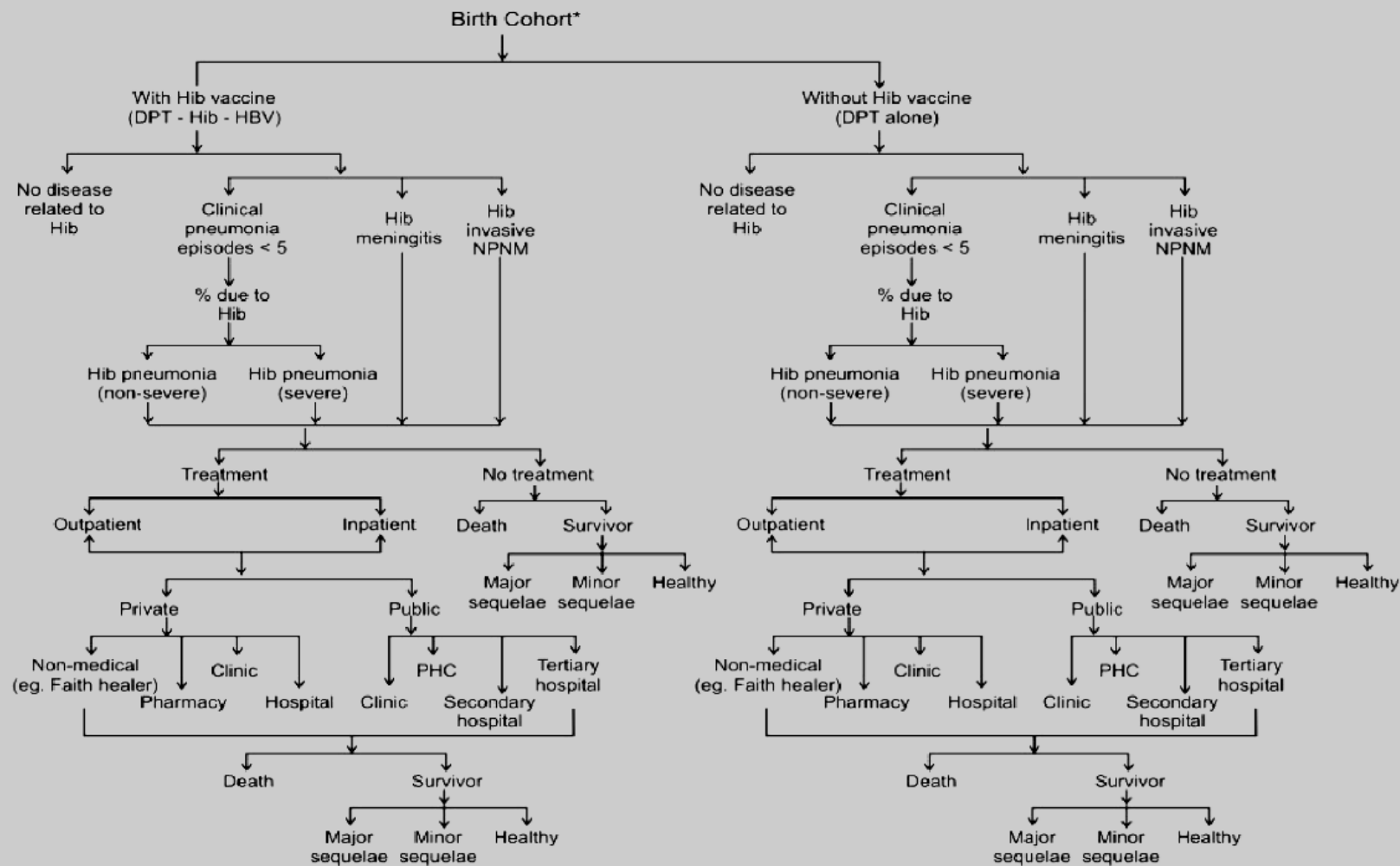
- Can allow for events reoccurring over time
 - Reinfection
 - Disease progression
 - Vaccine program completion
- Allows an assessment of different types of uncertainty
 - Unintended consequences of vaccine use
 - Unknown vaccine effectiveness
- Examples of decision analytical models include:
 - Decision tree
 - Markov model

Decision Tree

Possible pathways for a vaccination program against rotavirus compared to no vaccination



Decision Tree : Hib Vaccine



* Cycle repeated for 15 birth cohorts (2010-2024)

Figure 1 Model structure for cost-effectiveness of Hib vaccine in Haryana State, India

Notes: NPNM=non-pneumonia, non-meningitis; PHC=primary health centre