

Organized Session
**Applying Health Economics Principles to
Vaccine Programs**

iHEA 2023
Cape Town



TVEE
TEACHING VACCINE
ECONOMICS EVERYWHERE

Welcome & Introduction

Bill Padula, PhD

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www.stageanalytics.com



TVEE

TEACHING VACCINE ECONOMICS EVERYWHERE

Creating the Architecture for Sustainable Vaccine Financing

Website: www.immunizationeconomics.org/tvee

LinkedIn Group: <https://goo.gl/G5GVJw>



Leonard D. Schaeffer Center
for Health Policy & Economics



TVEE Overview

Vision

To contribute to preventing deaths and disabilities by optimizing links from immunization policymakers' decision-making to data on what it costs to deliver vaccines efficiently, equitably, and sustainably

Overview

To promote efficient use of resources by vaccine delivery programs in low- and middle-income countries through capacity building in vaccine economics and pharmacoconomics for program managers, policy & decision makers

The TVEE Project

Collaborators

1. Johns Hopkins University, USA
2. Makerere University, Uganda
3. Aga Khan University, Pakistan
4. IIHMR, India
5. WITS University, South Africa
6. University of Southern California, USA
7. University of Ouagadougou



Baltimore, USA
February, 2017

Pillars of TVEE Strategy

Developing Content

- Lectures
- Exercises and Case-studies
- Real-world examples
- Handbook Publication

Building Capacity

- Regional Hubs
- Frequent workshops
- Degree Programs
- Continuing Studies Courses

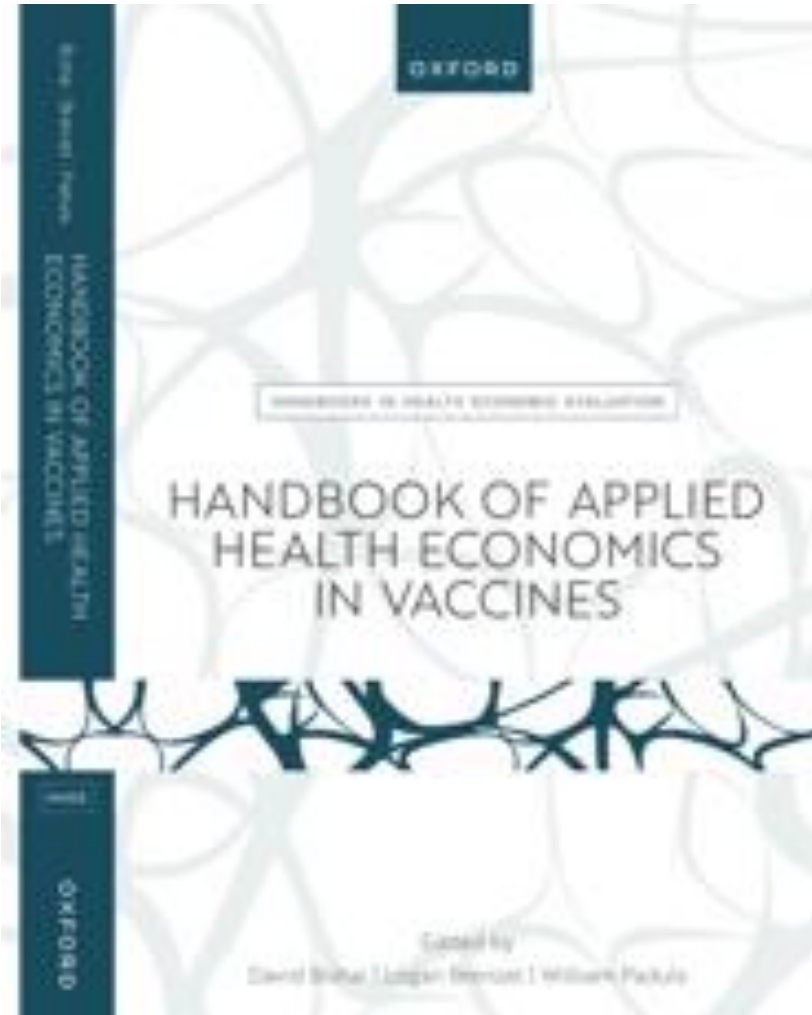
Establishing Sustainability

- Training of Trainers
- Capstone/Project Mentorship
- MOOCs
- Video Lectures
- Securing Funding Sources

Growing a Global Community

- LinkedIn Alumni Network
- Workshop Collaborations
- Global Conferences
- Global Webinars

The Book



- Comprehensive educational writing covering:
 - Microeconomic theory related to vaccines
 - Costing of Vaccines
 - Economic Evaluation
 - Advanced topics in Economic Evaluation
 - Financing, Supply Chain & Logistics
 - HTA case study: COVID19 Vaccine
- Online teaching material
 - Costing Exercises
 - Cost-effectiveness Analysis exercises
- **Open-access worldwide**
- Download a Free e-copy, or buy online

<https://global.oup.com/academic/product/handbook-of-applied-health-economics-in-vaccines-9780192896087?cc=za&lang=en&>



An incredible group of contributors to thank

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- Bill Padula

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- Elizabeth Watts
- Tommy Wilkinson

Our Presenters for today's Organized Session

Lecturers



- **David Bishai, MD, PhD:** University of Hong Kong



- **Susmita Chatterjee, PhD:** The George Institute for Global Health



- **Ijeoma Edoaka, PhD:** University of Witwatersrand



- **Emmanuel Drabo, PhD:** Johns Hopkins Bloomberg School of Public Health



- **Logan Brenzel, PhD:** *formerly* Bill & Melinda Gates Foundation

Host



- **Bill Padula, PhD:** Leonard D. Schaeffer Center for Health Policy & Economics, University of Southern California

Discussants



- **Ulla Griffiths, PhD:** London School of Hygiene & Tropical Medicine



- **Justice Novignon, PhD:** University of Ghana



- **Pete Baker, MD:** Center for Global Development



1.0

**Section introduction: principles
of vaccine economics**

David Bishai and Chrispus Mayora

Principles of Vaccine Economics: *The Relevance of Health Economics to Vaccines*

David Bishai, MD, PhD

Professor & Director, School of Public Health

The University of Hong Kong

Hong Kong

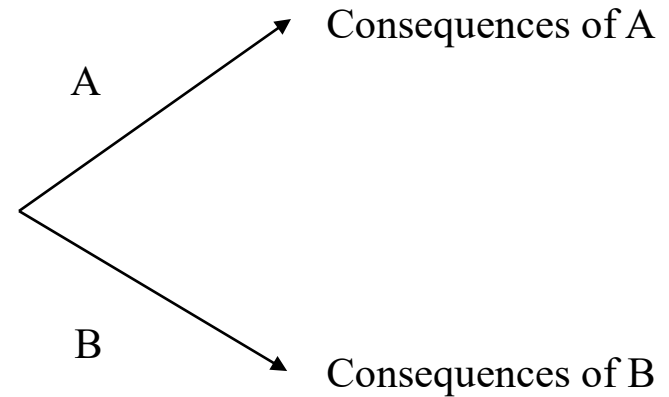
Outline

- Intro to a course on vaccine economics
- Basic definitions in “health systems”
- How the pieces fit together
- Dimensions of functioning
- Application to vaccines
- How to make health system stronger

Section A What is Health Economics

Health Economics Intro

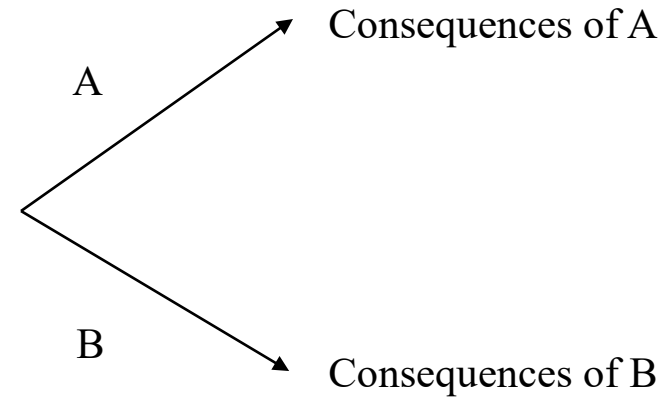
- Health economics is *the study of the choices that improve the health of individuals and population*
- A **choice** requires
 - A goal
 - Foreseen consequences



Tradeoffs Money vs. Outcomes

Example:

- A) Multi dose vial
\$0.10 per dose Infection 1 per 10^6
- B) Single dose vial
\$1.00 per dose
Infection 1 per 10^9



Important Distinctions

- Choices about
 - How to stay healthy
 - How to stop being sick
 - How to get medicines and services to people
 - How to make medicines and services higher quality
 - How to pay for medicines and services
- For every choice there are goals and consequences

Problems arise

- Consequences of a choice affect others
 - Unvaccinated child infects other children
 - Workers who vaccinate could be treating the sick
 - Resources to do A cannot be used to do B
- Goals are not agreed on
 - Safety of services vs. Wide distribution
 - Preventing disease or Curing disease

Role of Economics

- Reveal the optimal choice
- Resolve conflicts

- Make explicit statements about goals
- Make explicit statements about consequences

- Conflicts easier to resolve if goals are agreed on and consequences are agreed on

- Consensus → Action → Results

Applying Economics lens to Vaccination problems

- **Uncertainty** – people fear side effects, unknown consequences, intrusion by health personnel into homes and neighborhoods (concentrated populations)
- **Information Asymmetry** – people don't know about the value of vaccines (widespread across Pakistan)
- **Externalities** - Vaccines behave like public goods: compulsion for govt to provide, little incentive for other providers, benefits more to the poor

SOLUTIONS

- **Marginal cost analysis** – Guide resourcing decisions: where can the extra dollar in Health go to provide extra benefits
- **Market failure correction**- appropriate pricing of vaccines, countering monopolies

Vaccines as a public good – Why public provision

- Infectious disease control and ensuring population level herd immunity requires high rates of immunization
- The social benefits of immunization exceeds the value that some individuals place on it
- Benefits extend beyond those who receive the vaccines

→ Need low prices

→ Need outreach to some areas

Vaccines as a public good – Why public provision

- Even when private providers play an important role, the ultimate responsibility of ensuring access to vaccines of public health importance lies with government.

Summary

- Economics is the study of choices
- Choices in health have uncertainty, asymmetric knowledge, and externalities
- Coherence can be increased by spreading information about the goals and consequences of policy



2.5

Costing new vaccine introduction

Susmita Chatterjee, Siriporn Pooripussarakul, and Logan Brenzel

Costing of Immunization Services

Susmita Chatterjee, PhD

Senior Health Economist

The George Institute for Global Health

India

Outline



Why costing studies are needed



Defining immunization costs



Designing a primary costing study



Costing new vaccine introduction

Why costing studies are needed

- Strategic planning and programme budgeting
- Assessing variation in service delivery costs and analysis of programme efficiency or quality
- Developing cost benchmarks
- Conducting cost-effectiveness, cost-benefit, and return on investment analysis to inform resource allocation decisions

Defining immunization costs

Cost definitions and categorizations

- *Economic cost*: Opportunity cost of investing in one programme relative to investing in other
- *Financial cost*: Cash outlays incurred for delivery of the programme
- *Fiscal cost*: Actual expenditure made for delivery of the programme

Designing a primary costing study

Scope:

- *Type of programme:* facility / outreach / supplementary
- *Perspective:* healthcare provider / payer / societal
- *Cost:* economic / financial
- *Time horizon:* retrospective / prospective

Data sources:

Retrospective study: administrative records supplemented with interview with key programme staff

Prospective study: direct observation

Addressing shared costs

Examples:

- A vehicle can be used to supervising an outreach session along with other administrative purposes
- A health worker spends time on immunization services along with family planning services

Allocating shared resources requires developing an “allocation key” or “tracing factor” that serves as the basis for allocation

Example:

- Allocating the use of a vehicle based on the share of mileage per week specific to immunization as proportion of total mileage

Sampling for immunization costing studies

- Sampling is required because of the heterogeneity of costs across geographical areas and between and within facility types
- Sample design should ensure representativeness and should be sufficiently large to generate estimates with acceptable precision.
- Random sampling is preferred when the goal is to have nationally or sub- nationally representative estimates.

Costing new vaccine introduction (NUVI)

Type of vaccine to be introduced:
monovalent, combination

Start-up costs

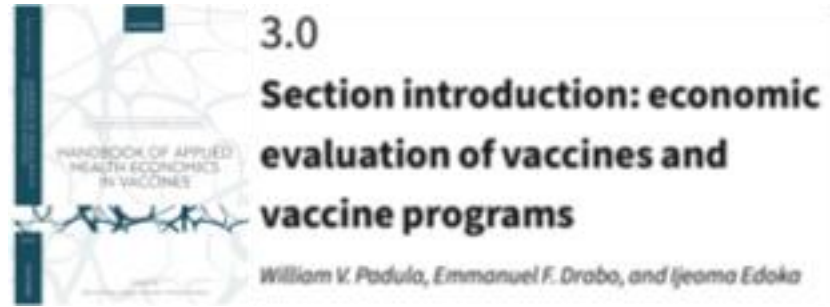
- Microplanning
- Training of staff
- Purchase of cold chain equipment
- Social mobilization and advocacy

Recurrent costs

- Vaccines and supplies
- Service delivery
- Supervision and monitoring
- Vaccine transport
- Waste management
- Ongoing cold chain expenses

Summary

- Immunization costing studies generate essential strategic information that is required for planning and budgeting, assessing technical efficiency, developing benchmarks, and economic evaluation to inform resource allocation decisions.
- For economic evaluations, economic costs should be estimated, financial cost is more relevant if budget impact is the main policy question.
- Costs for NUVI are incremental to the existing system and can be evaluated as fiscal, financial, or economic costs depending upon the use of the results by decision makers and both start-up and recurrent costs should be estimated.



Economic Evaluation of Vaccines and Vaccine Programs

Ijeoma Edoke, PhD

Health Economist, Health Economics & Epidemiology Research Office

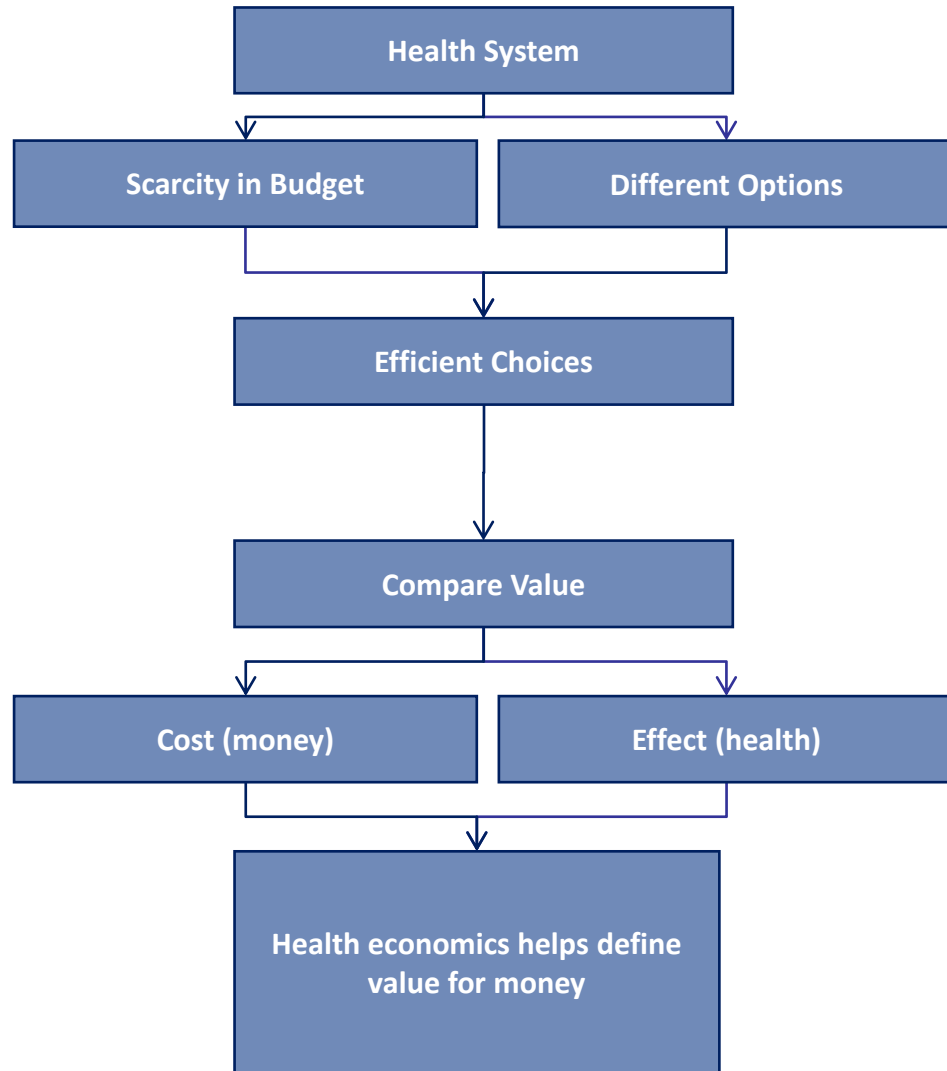
University of the Witwatersrand

Johannesburg, South Africa

Economics and New Vaccine Introductions

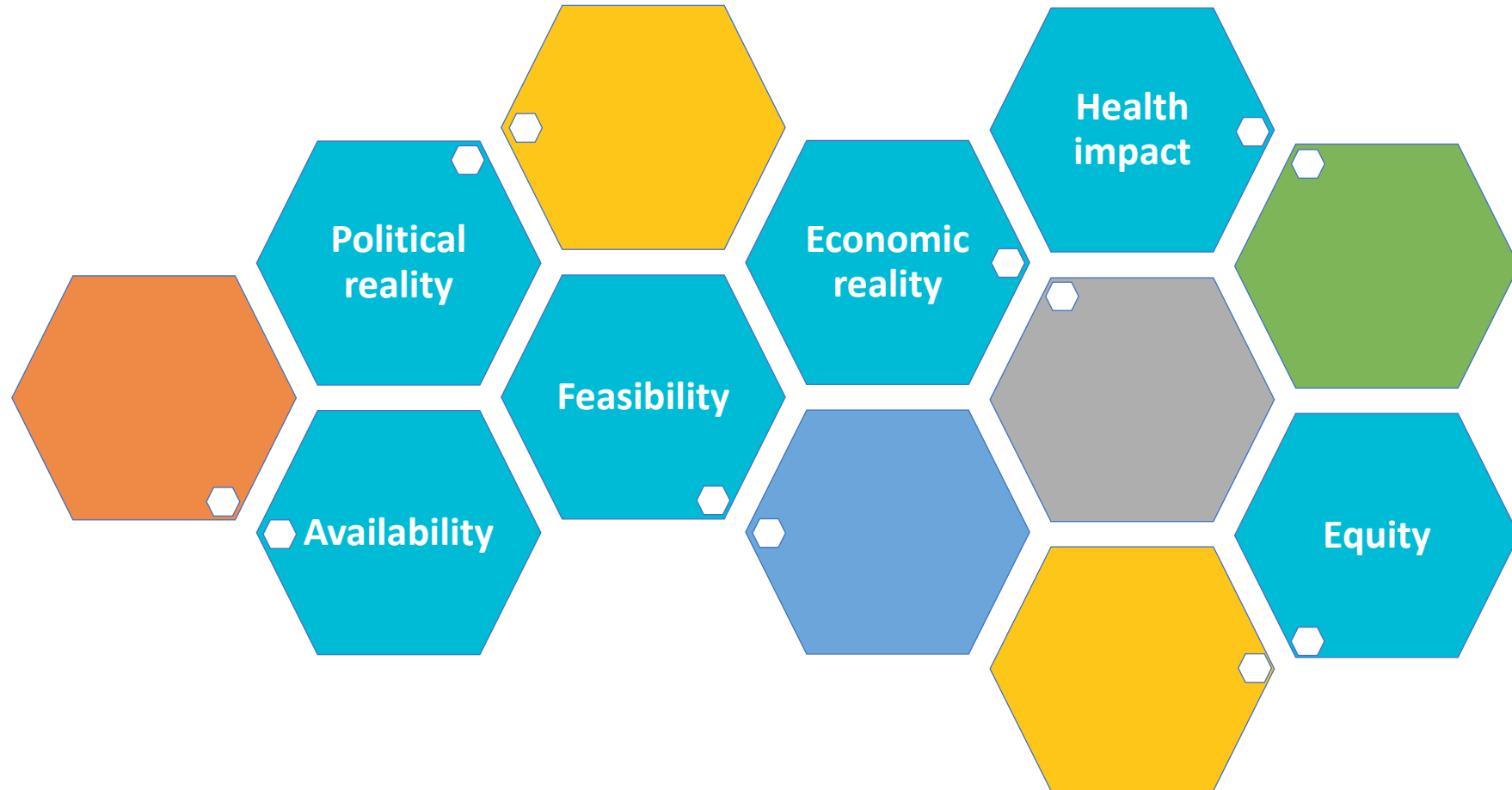
- Economics plays important role in policy decisions to provide vaccines in the EPI
- Program managers want to know what investments would be needed for introducing a vaccine as against the benefits to be had.

Introduction



- Health systems are confronted with *scarce/limited resources*
- But potentially unlimited *options* for managing infectious diseases (prevention vs treatment)
- So *choices* have to be made between options because of limited resources
- How to choose efficiently ?
- Can be done by comparing the COSTS and CONSEQUENCES of competing alternatives
- Health Economics is therefore a **tool for decision makers** to make their selection explicit and consistent

Choice of Whether to Invest In Vaccines is a Complex Dynamic

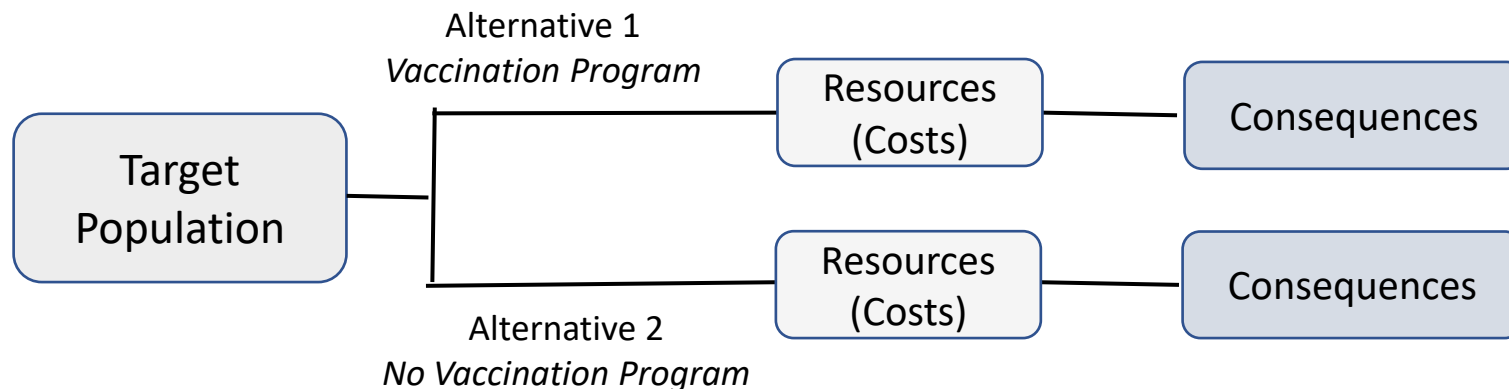


Common Economic Tools

- **Economic Evaluation:** Assesses whether an intervention represents good “value for money” relative to an alternative
- **Budget impact:** Assesses change in flow of funds due to the substitution of the alternative (current) intervention with a new interventions

Economic evaluation is a *comparative analysis*

Economic evaluation is the comparative analysis of **costs and consequences** of alternative courses of action in order to *assist* in policy decisions (Drummond *et al*, 1997).



Resources are scarce – choices must be made!

Potential costs to consider in an Economic Evaluation

Category	Cost	Definition
Direct	<u>Medical costs:</u> <ul style="list-style-type: none">• Vaccine cost• Physician consultation fee• Medications & Diagnostic tests etc.	Refers to all costs incurred as a direct consequence of medical resource utilisation
Direct	<u>Non-medical costs:</u> <ul style="list-style-type: none">• Transportation• Food• Accommodation	Refers to all others costs incurred as a direct consequence of accessing the intervention or treating an illness.
Broad	<u>Indirect costs:</u> <ul style="list-style-type: none">• Time loss from work• Informal caregiving	Quantifiable costs incurred as a consequence of the illness or the intervention
Broad	<u>Intangible cost:</u> <ul style="list-style-type: none">• Pain• suffering	Unquantifiable costs incurred as a consequence of the illness or the intervention

Potential Benefits to Consider in an Economic Evaluation

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

Types of Economic Evaluation

Type of analysis	Costs		Outcomes		Comparison of interventions
	Inclusion	Valuation	Inclusion	Valuation	
Partial economic evaluation					
Cost of illness analysis (COI)	Yes	Monetary units	No	–	None (disease-level analysis)
Budget impact analysis (BIA)	Yes	Monetary units	Yes	None or maximize various	Yes
Return on investment (ROI) analysis	Yes	Monetary units	Yes	Monetary units	Yes, ROI
Cost comparison analysis	Yes	Monetary units	No	–	Yes
Full economic evaluation					
Cost-minimization analysis (CMA)	Yes	Monetary units	Yes	None (assume unchanged)	Yes
Cost–consequence analysis (CCA)	Yes	Monetary units	Yes	Natural units	Yes
Cost-effectiveness analysis (CEA)	Yes	Monetary units	Yes	Natural units	Yes, ICER or NMB
Cost–utility analysis (CUA)	Yes	Monetary units	Yes	Utilities: QALY, DALY, healthy year equivalent	Yes, ICER or NMB
Cost–benefit analysis (CBA)	Yes	Monetary units	Yes	Monetary units	Yes, cost–benefit ratio or net benefit



4.0

**Section introduction: advanced
methods in economic evaluation**

Emmanuel F. Drabo and William V. Padula

Advanced Methods in Economic Evaluation of Vaccines and Vaccine Programs

Emmanuel Drabo, PhD

Assistant Professor, Department of Health Policy & Management

Johns Hopkins Bloomberg School of Public Health

Baltimore, USA

What Are Health Economic Models?

- **Computer-based simulations** which focus on the population-level impacts of diseases and disease mitigation strategies
- Good models combine the best available data (e.g., epidemiological, clinical, economic) from multiple sources
- Permit comparisons of the current and future epidemiological, clinical, and economic impacts of alternative disease-related interventions
- Can measure the economic and health consequences associated with an intervention

Decision Tree Modeling

- Decision tree models are the simplest type of health economic model
- They are useful for modeling instantaneous or one-time probabilistic events

HepB_CEA-Tree_PartA

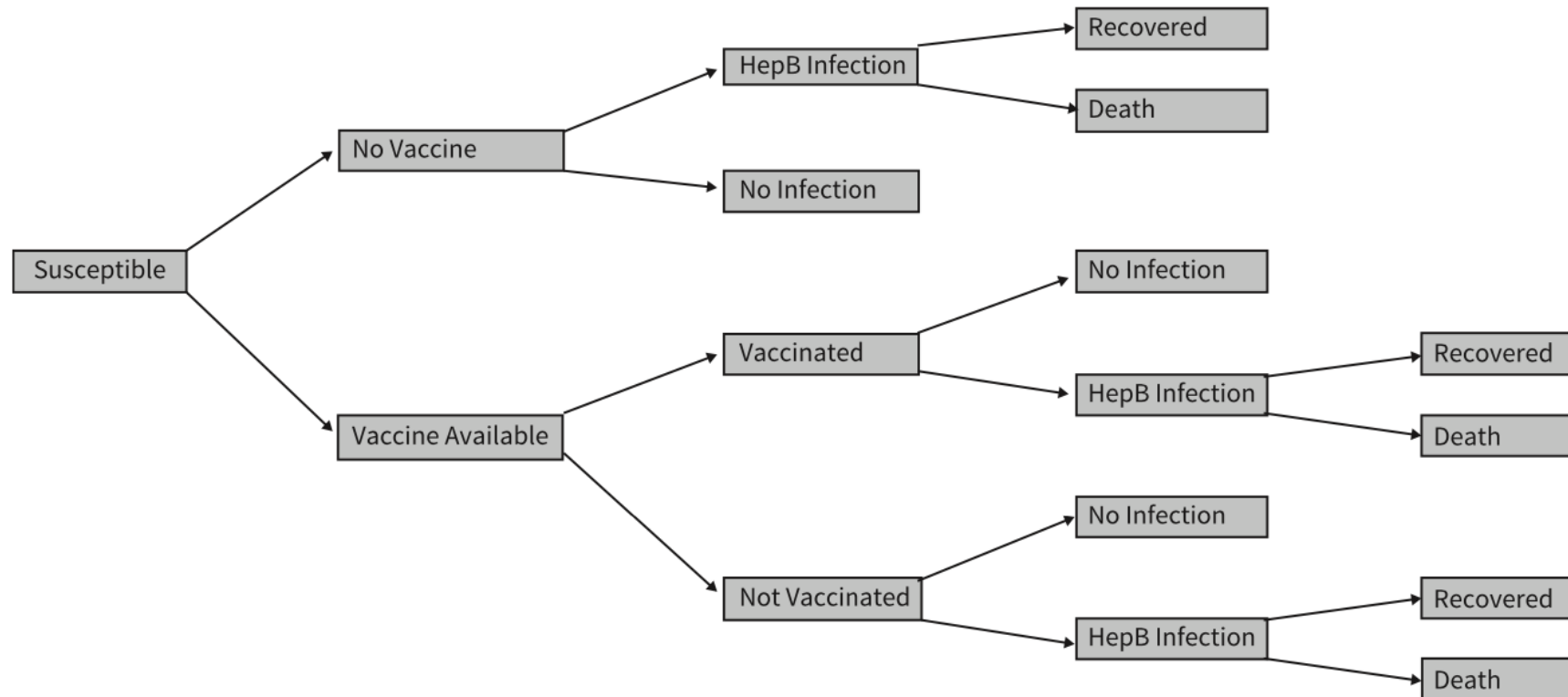


Fig. 3.7.1 Example hepatitis B vaccine decision tree for conducting economic evaluation.

Then, Why Do We Need Advanced Modeling Approaches? 43

- But decision trees are limited in capturing the effects of time spent in various health states characterizing a disease process (e.g., healthy, sick, or dead)
- Advanced modeling approaches are needed to account for **long-term consequences** of vaccination programs
- Allow extrapolation of clinical evidence over a short time frame to a longer time frame to capture **time-dependency**

Types of Health Economic Models

- Health economic models can be classified based on:
 - **Type of change of the state variables**
 - Discrete
 - Continuous
 - **How the system is being observed**
 - Static
 - Dynamic
 - **Aggregation level**
 - Aggregate level (i.e., compartmental or cohort)
 - Individual level
 - **Degree of randomness**
 - Deterministic
 - Stochastic

Markov Modeling

- Markov assumption (Andrey Markov, 1906): *All future states are independent of all past states*
 - No “memory” of the past – ***memoryless property***
- A Markov model depicts transitions between health statuses over time, based on prior probabilities of assumed outcomes
- Health statuses are represented as a series of finite, discrete health states
- Can be used to keep track of the costs and effectiveness outcomes associated with time spent in a particular health status



Andrey Andreyevich Markov
06/14/1856 – 07/20/1922

Example of a Markov Model: Hep B Vaccination Transitions

- Ovals represent health states
- Directed arrows connecting the health states represent the directions of the transitions between states
- Each arrow is associated with a state transition probability, $T(s, s')$

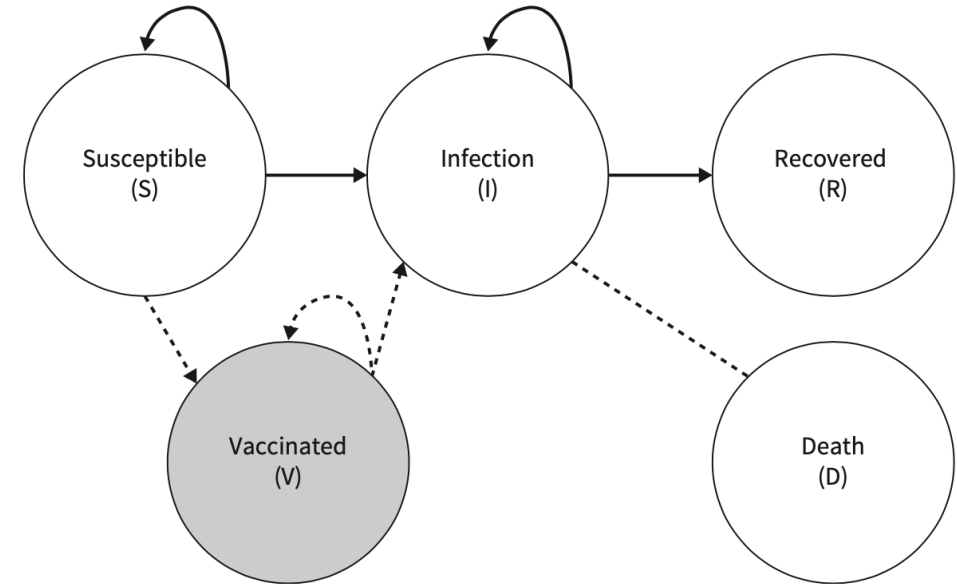


Fig. 4.1.1 State transition diagram of the hepatitis B vaccine Markov model. The states of the model are represented by the circles; the transitions between health states are represented by the arrows.

Table 4.1.1 Illustrative state transition probabilities for the vaccination scenario

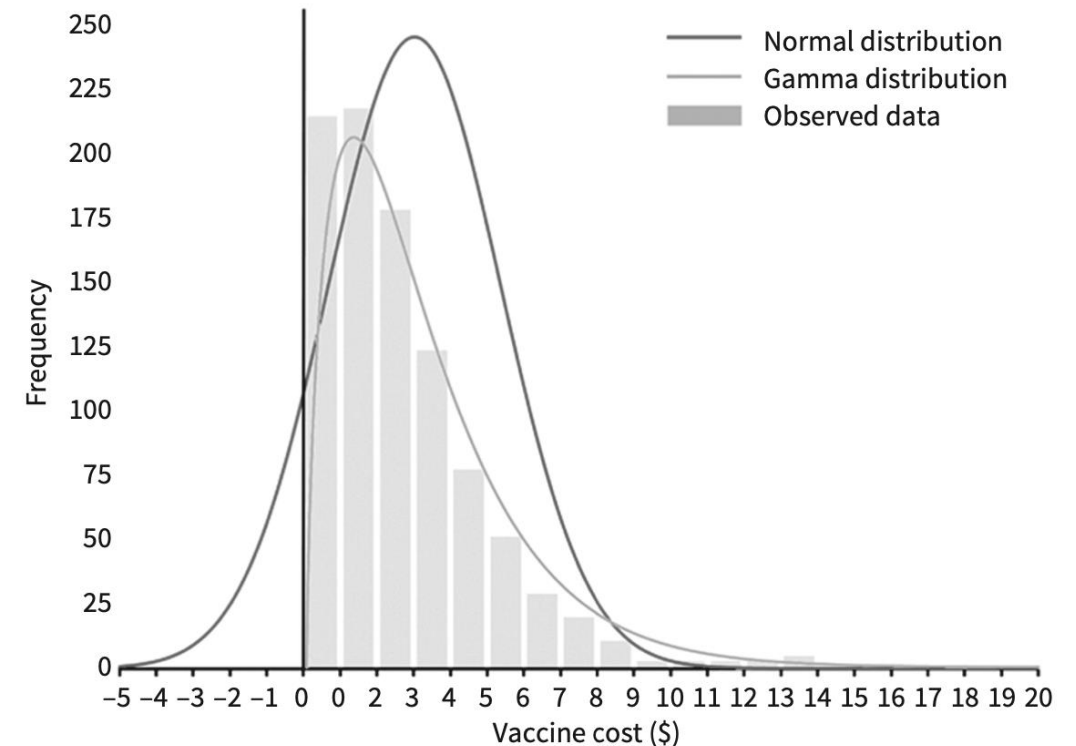
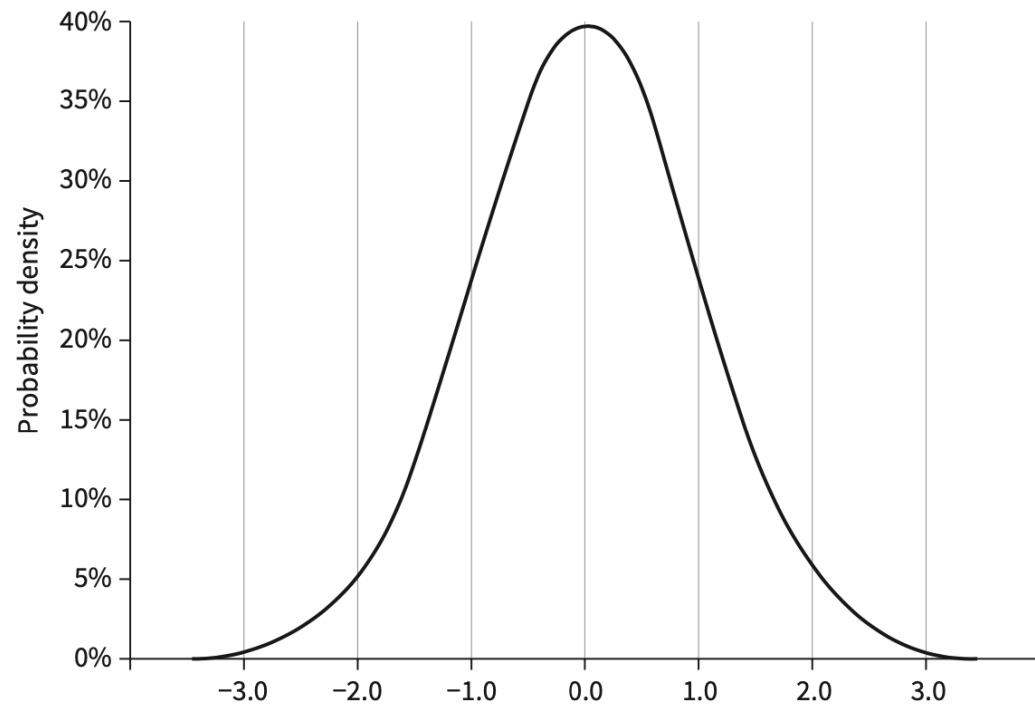
	S	V	I	R	D	Check
Susceptible (S)	0.198	0.100	0.700	0.000	0.002	1.000
Vaccinated (V)	0.000	0.998	0.000045	0.000	0.002	1.000
Infected (I)	0.000	0.000	0.129	0.865	0.006	1.000
Recovered (R)	0.000	0.000	0.000	0.998	0.002	1.000
Deaths (D)	0.000	0.000	0.000	0.000	1.000	1.000

Dealing with Uncertainty and Heterogeneity – Probabilistic Sensitivity Analysis (PSA) 27

- Different types of uncertainties:
 - Methodological uncertainty
 - Structural uncertainty
 - **Parametric uncertainty** – uncertainty in model input parameters
- Parametric uncertainty is best handled via probabilistic sensitivity analyses
 - PSA involves running a decision model multiple times
 - Each run of the model can be referred to as an iteration
 - Key parameters are included as draws from probability distributions

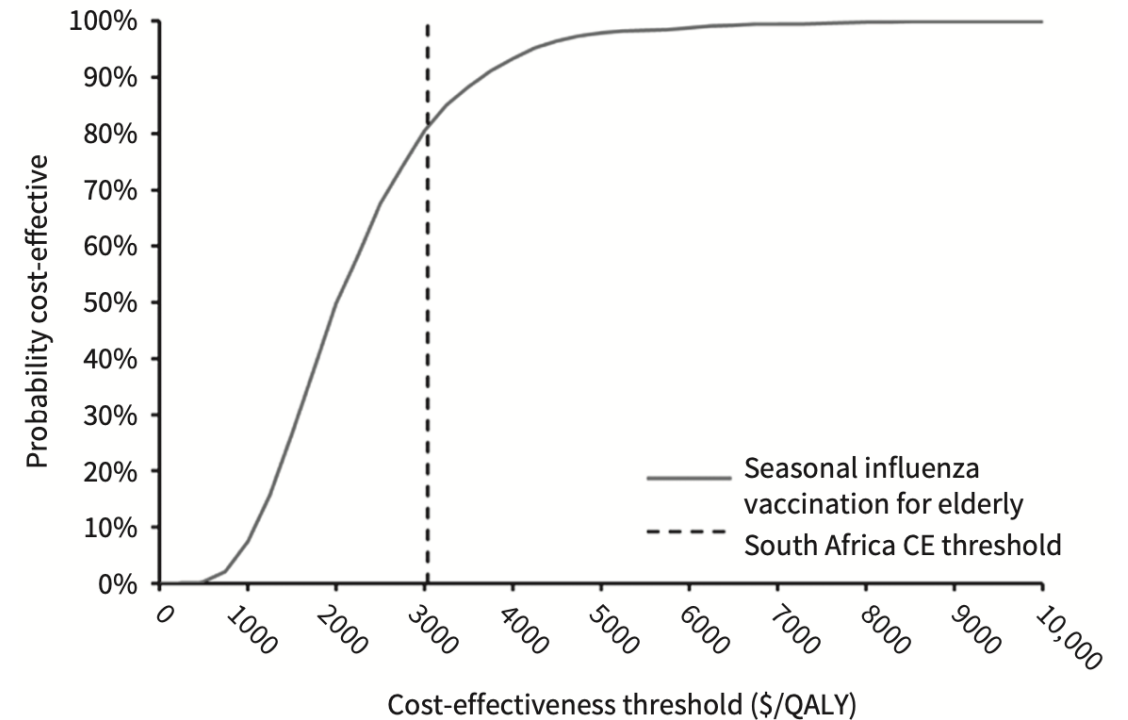
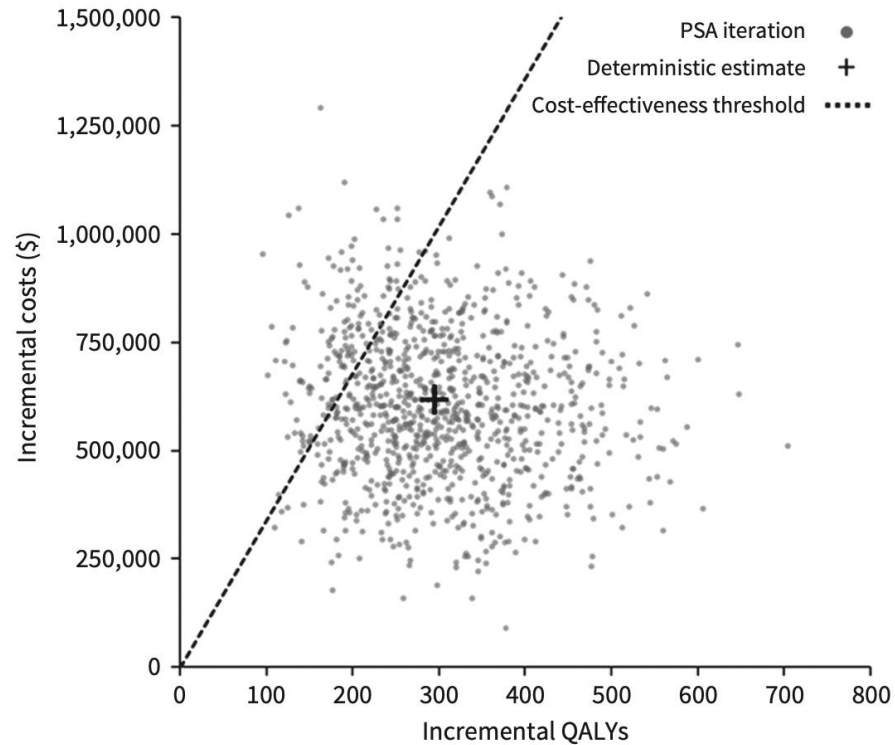
Which Distributional Assumptions to Use?

- Distributional assumptions should reflect the data generating process of the parameter, as reported by the supporting evidence
- Costs generally are best fitted by Gamma or Log-normal distributions
- Health utilities are best characterized by the Beta distribution



Representation of PSA Results

- PSA results can be depicted in the CEA plane and the cost-effectiveness acceptability curve (CEAC)



Value of Information (VOI) Analysis

- Results from a PSA can be used to estimate the value of further research
- VOI analysis quantifies the gains in expected health benefit associated with reducing uncertainty in model input parameters

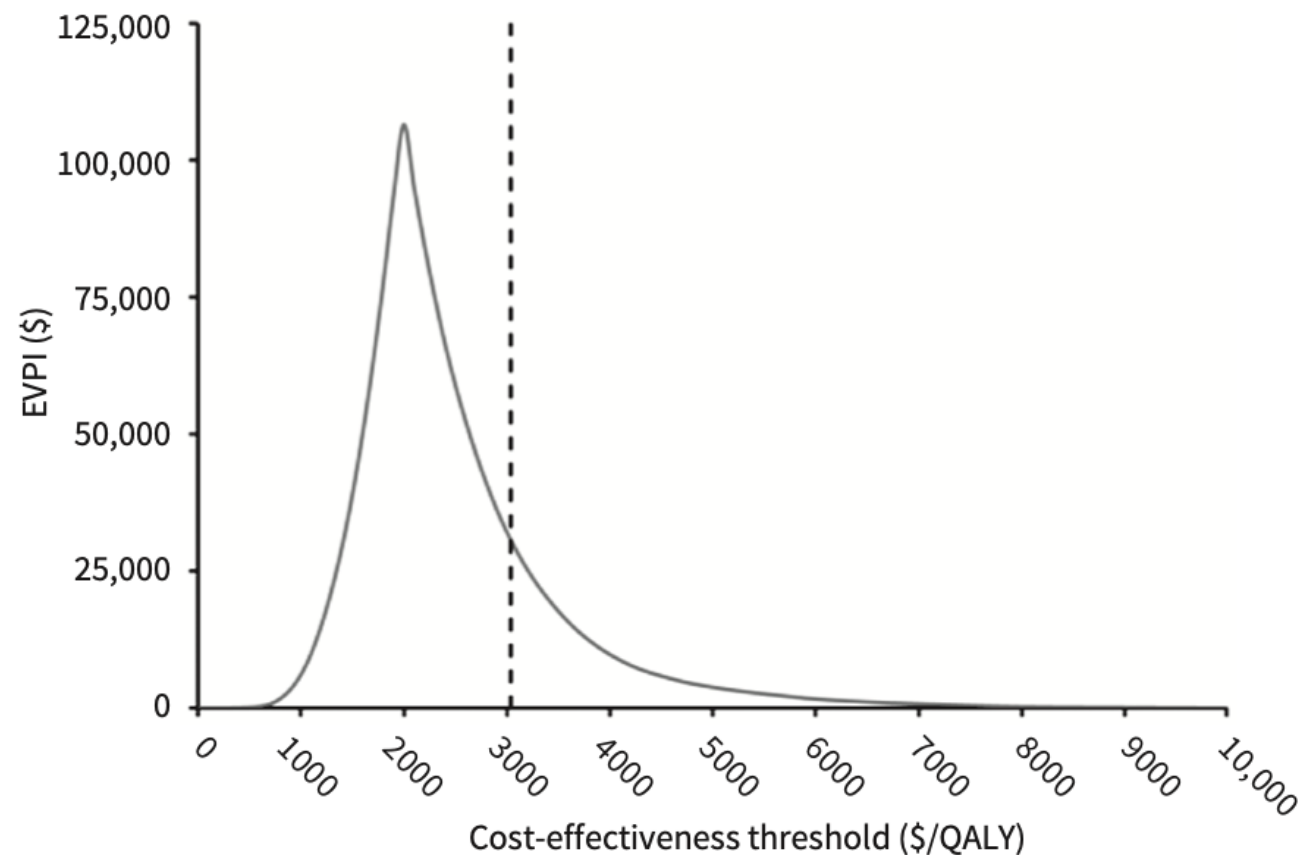
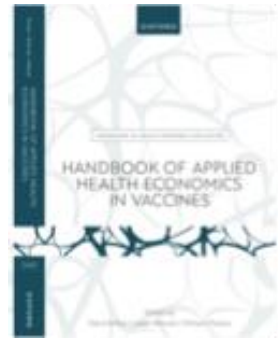


Fig. 4.3.6 Expected value of perfect information versus cost-effectiveness threshold.



5.0

**Section introduction: financing
and resource tracking of
vaccination programs**

Logan Brenzel and Shreena Malaviya

Financing and Resource Tracking of Immunization Programs

Logan Brenzel, PhD

Independent Consultant

Paris, France

(formerly Bill & Melinda Gates Foundation)

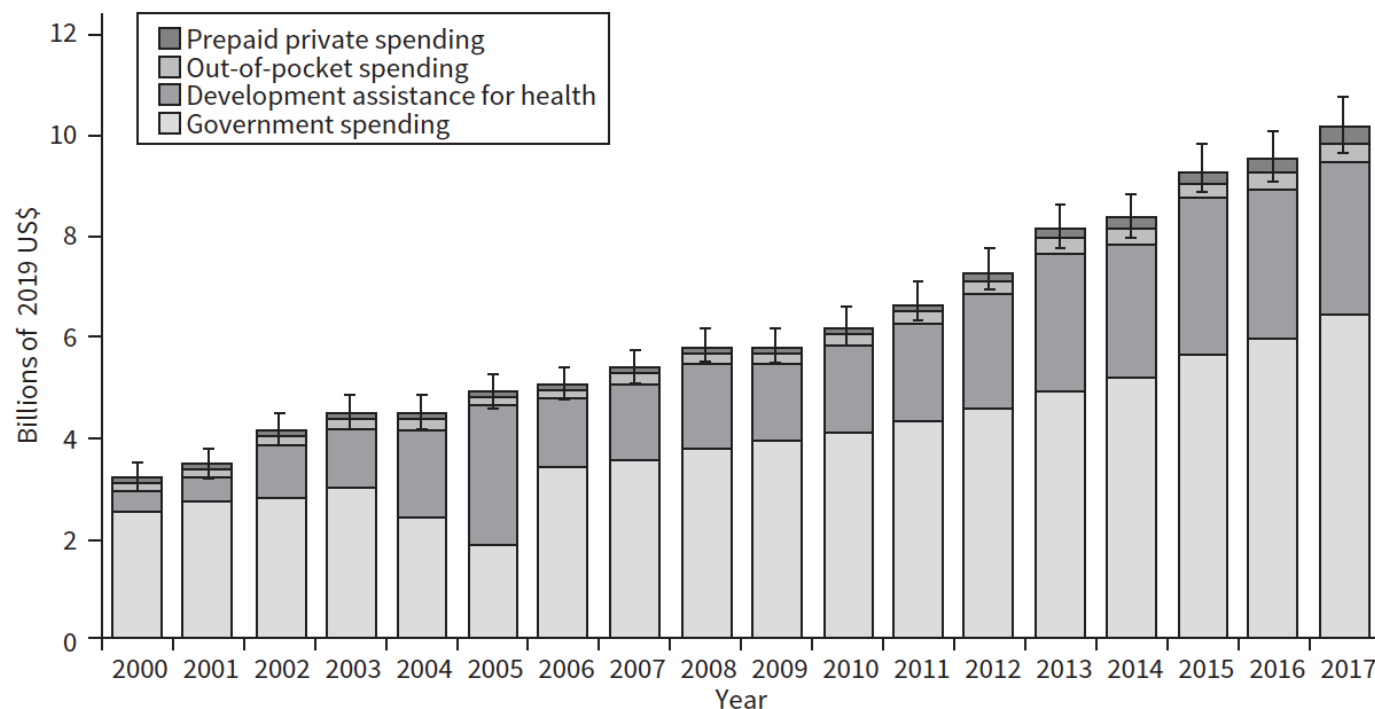
Pervasive issues in immunization financing?

- Budgets are historically based and don't take into account new vaccines, growing populations, and alternative delivery strategies
- Delivery costs are chronically underfunded
- In federated countries, delivery is often to be financed by local governments not the federal level
- Multiple and fragmented sources of financing
- Budgets are underspent
- Tracking and reporting on expenditures is relatively weak

Aims of the Handbook

- Present and analyze trends in immunization spending by source, component, and delivery strategy
- Discuss range of sources of financing and how they may improve efficiency, equity, and sustainability of the program
- Focus on the development partner landscape, highlighting the role of Gavi, the Vaccine Alliance and innovative financing mechanisms
- Provide resources for further, in-depth learning

Immunization spending by source



Source: Ikilezi, et al (2021).

- 2% of total health spending is for immunization
- Spending increased 3x from \$3.2b to \$10.4b
- Governments represent >60% of total spending
- Governments allocate 90% of their spending to routine service delivery.
- Spending on vaccines tripled, while delivery spending remained the same
- DAH represents a third of spending, with \$13b channeled through Gavi
- Approximately \$4b was spent out of pocket

Immunization resource tracking

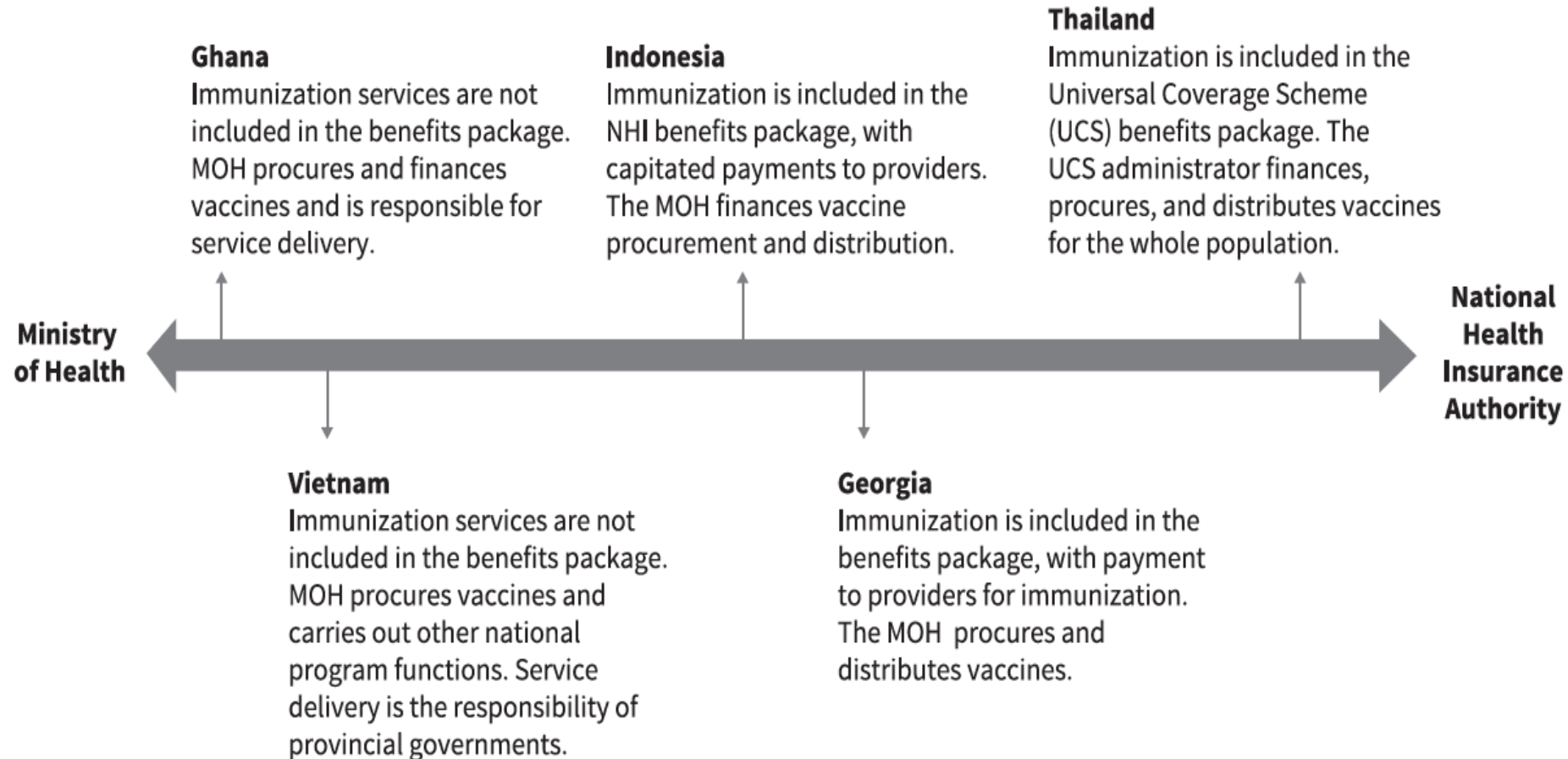
- Main sources:
 - WHO-UNICEF Joint Reporting Form
 - National Health Accounts (Global Health Expenditure Database)
 - Government analysis (Comprehensive Multi-Year Plans; National Immunization Strategy)
 - Donor records
- Main uses:
 - Monitor trends at country, regional and global levels
 - Evaluate spending per capita, per surviving infant- value for money
 - Identify gaps and inconsistencies for key components

Sources of immunization financing

- Immunization is a public good
- Sustainable financing for immunization connected to health financing
- Sustainability related to the reliability and adequacy of all sources of financing and how well those resources are programmed and spent
- Focus on improving budgetary space for immunization can ensure greater adequacy
- Governments
 - Government budgets (tax-funded)
 - Sector and program budgeting
 - Earmarking
 - World Bank loans and grants
 - Social insurance
 - Subnational level
 - Health-specific taxes on alcohol, tobacco
- Development partners
 - Multilateral: WHO, UN, EU
 - Bilateral: USAID, FCDO, JICA
- Non-governmental organizations
 - Medecins sans frontiers
- Households & private sector
 - Trust Funds

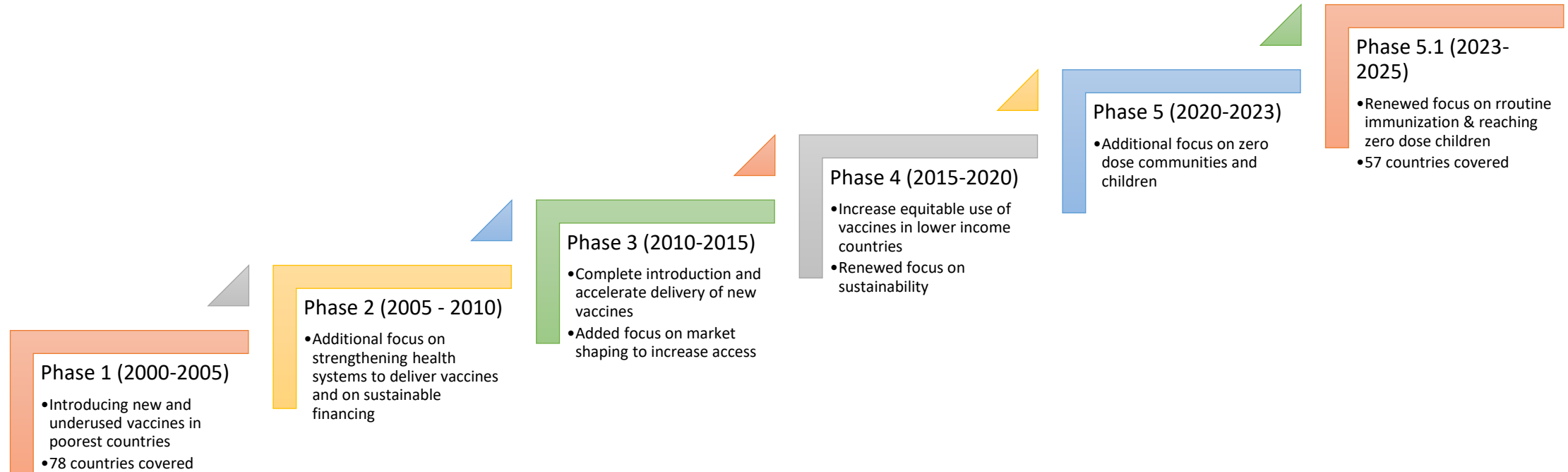
Funding of vaccines and immunization through NHI schemes

MOH, Ministry of Health



Source: LNCT/Linked Action Network, 2020.

Gavi, the Vaccine Alliance



- Established in 2000 by WHO, UNICEF, World Bank, BMGF
- Alliance of partners, countries, industry, NGOs with funding focus (no country presence)
- Early focus sustainable financing
 - Innovative financing: Pneumonia AMC, IFFIm
 - Eligibility, co-financing & transition



TVEE
TEACHING VACCINE
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Distinguished Global Health Panel



MODERATOR

David Bishai
University of
Hong Kong
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Witwatersrand



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University



Logan Brenzel
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Melinda Gates
Foundation

The Handbook of Applied Health Economics in Vaccines



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