Introduction to Costing of Immunization Programs

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TVEE
TEACHING VACCINE ECONOMICS EVERYWHERE

Outline

Section A – Definitions and Classifications of Costs

Section B – Costing Estimations

Section C – Using Costs in Economic Evaluations

Section D – Presenting Cost Data and Analysis

Section E - Adjustments to costs

Required Reading

How To Cost Immunization Programs: A Practical Guide On Primary Data Collection And Analysis

Link to access:
https://static1.squarespace.com/static/556deb8ee4b08a534b8360e7/t/5f861ef9b178d5473d7b4f17/1602625274339/How_to_Cost_Immunization_Programs_v10-2020.pdf

Section A
Definitions and Classifications of Costs

What do we mean by "cost“?

- Cost may be defined as the value of resources used to produce a good or health care service.

- However, the way these resources are measured can differ.

Financial Cost

- Financial cost represent actual expenditure on services purchased.

- Costs are thus described in terms of how much money has been paid for the resources used in the project or service. We need to know the price and quantity of the resources used.

Economic Cost (= Opportunity Cost)

- Costs are the alternative uses that have been foregone by using a resource in a particular way.
- Resources are then unavailable for productive use elsewhere.
  - If you do A, you cannot do B
  - Costs of doing A is the forgone value of doing B

The opportunity cost of eating a cake is the loss of the ability to look at it.

Which Cost Should be Used?

- The type of costs to be estimated are those that are relevant to the study question and the objective of the study. We also need to consider the **perspective** and the **time horizon** of the study.

- Possible questions and objectives are:

  - Explore affordability in Current Budget
  - Evaluating whether a new vaccine is economically beneficial
  - What will be the additional impact of a new vaccine on my budget?
  - Is immunization a better investment than a bed-net program for malaria prevention?

Perspective of the Cost Study

The study perspective essentially defines the basis of analysis and determines the relevant costs that need to be accounted for.

Generally, there are three main study perspectives in health economics evaluations:

- Health care provider (government, private or all providers):
  - Costs relevant to a specific provider

- Payer (government, donor funder, employer)
  - Costs relevant to a specific payer

- Societal
  - All costs regardless of where they are incurred
  - Includes patient and household related costs

Time Horizon

- When collecting primary data retrospectively, one *must set boundaries of the time horizon in which resource use occurred*

- If the costing exercise is using financial 7 transaction records as a data source, it will be important to reconcile the transaction dates with the service period of the time horizon.

- It is common in immunization costing exercises to combine information from different time periods. However, It is much easier to answer questions about what is happening ‘now’ and supplement this with some questions to confirm that no radical changes happened that would call into question the use of ‘now’ as a proxy for the time period of interest.

Classification of Costs

- Standard classifications of costs exist for evaluating immunization programs
- The classes or categories must not overlap
- The classes chosen must cover all the possibilities

- Classification by Inputs
- Classification by Function/Activity
- Classification by Level
- Classification by Source

Classification by Inputs

- Capital cost items: those that last longer than one year.

- Recurrent cost items: those that are used up in the course of a financial year and are usually purchased regularly.
  - Recurrent costs are the running costs of the program
  - Sometimes referred as operational costs of the program.

Capital Cost Items

- **Cold chain equipment**: Value of all cold chain equipment used to store and transport vaccines.
- **Vehicles:** Value of all vehicles and modes of transport (could include boats)
- **Lab equipment**: Value of any specific equipment used for laboratory testing and diagnosis related to surveillance. Note that most of these costs will be health system costs, and not specific to immunization.
- **Other equipment**: Value of other equipment, such as computers, printers, peripherals, furniture, other medical equipment used for immunization-related activities.
- **Buildings**: Value of building space used to delivery and store vaccines.
- **Other capital**: Any other capital investments (this category should be very small)

Recurrent Cost Items

• **Paid labor:** Labor for immunization-related activities

• **Volunteer labor:** Estimation of the market value of volunteer labor used for immunization-related activities.

• **Per diem and travel allowances:** Any allowances paid to paid or volunteer workers for immunization-related activities.

• **Vaccines:** Cost of traditional and new vaccines, including insurance, freight, wastage. There may be other services fees and transport costs. However, local customs duties/levies/taxes should usually be excluded, since these are transfer payments without true opportunity cost.

• **Vaccine injection and safety supplies:** Cost of auto-disabled syringes, reconstituting syringes, safety boxes and other supplies used for administration of vaccines.

• **Other supplies:** Cost of stationary and other supplies for the immunization program.

• **Transport and fuel:** Cost of bus fare, plane travel, and the cost of fuel for immunization-related transport.

Recurrent Cost Items

• **Vehicle maintenance:** Cost of maintaining vehicles (of all types) used for immunization-related activities.

• **Cold chain energy costs:** The cost of running the cold chain (fuel, electricity, etc), and the cost of ice.

• **Printing costs:** The cost of printing immunization cards, training and IEC (information education and communication) materials, and other immunization-related materials.

• **Utilities and communication:** Costs related to building overheads, including maintenance, utilities, telephone, internet connections with some portion of these costs allocated to immunization.

• **Other recurrent:** Other recurrent costs for immunization-related activities that are not included in the above line items. Normally, this category should be very small. For the financial cost analysis, this could include customs duties and taxes which are transfers

Classification by Function/Activity

This classification involves the kind of activity or function for which resources are used in the program.

• **Routine facility-based service delivery:** Time and resources spent on the act of administering the vaccine to children within the facility/compound.

• **Record-keeping, health management information systems (HMIS), monitoring and evaluation:** Time and resources spent on data entry and analysis, including maintaining stock registers, maintaining records of children vaccinated, completing reports and analyzing, monitoring, and evaluating immunization program data.

• **Supervision:** Time and resources spent by a facility (or district level) staff to supervise subordinate or peer health or community workers.

• **Outreach service delivery:** Time and resources spent traveling to and from a place with the express purpose of vaccinating children outside of the facility. [Note: feel free to add additional activities if your country differentiates between mobile service delivery, outreach service delivery, school-based service delivery, etc.]

• **Training:** Time and resources spent attending and/or providing immunization-related training. Initial training should be thought of as a capital cost, while ongoing, routine training is a recurrent cost. Training costs include the cost of venue, per diem for participants, cost of trainers, and reproduction of training materials.

Classification by Function/Activity

• **Social mobilization and advocacy**: Social mobilization includes holding community meetings, printing flyers and educational materials, conducting events, other sensitization of the community. Include any time and resources spent mobilizing the community and households, and advocating for vaccination (value of time, per diem, cost of materials, etc. Some of these costs may be one-time costs and should be thought of as capital investments to be depreciated over an estimated useful life.

• **Surveillance:** Time and resources spent following-up post-vaccination events and active cases of diseases that are prevented by vaccination.

• **Vaccine, collection, distribution and storage:** Time and resources spent collecting vaccines at the airport or other distribution points, storing vaccines in national or subnational cold stores, maintaining stock records of vaccines, and distributing vaccines down to the facility.

• **Program management:** Time and resources spent on planning, budgeting, managing the immunization program at various levels. This would include the cost of time and resources spent on forecasting vaccine needs and procuring vaccines. General management of the health system would not be allocated here.

• **Cold chain maintenance:** Time and resources spent maintaining the cold chain at the respective level of analysis.

• **Other:** Time and other resources spent on any other immunization-related activity not covered in the above categories. This category should be very small or not represented at all in the analysis

Direct and Indirect Costs

- **Direct costs** are those costs that can be traced to a specific unit or department or activity.
- **Indirect costs** are those costs that can not be specifically traced to a unit/department/activity.

- Examples are hospital administration, utilities, vehicles, OPD space for ANC or EPI programs.

Sources of costs

- The source of the resources (that is, who provides them) is an important characteristic. Source/contributors may include:
  - Central Government – Ministry of Health, other ministries
  - State / Provincial, District level government agencies
  - Donors
  - Civil society organizations and providers
  - Faith-based organizations and providers
  - Patients / Households
  - Private employers/providers
  - Health insurance agencies

Section B
Cost Estimation

Full and Incremental Costs

- A **full cost analysis** estimates the costs of all resources that are being employed in implementing an immunization program.

- **An incremental cost analysis** looks at the cost of adding a new dimension or element, such as a new vaccine to an existing immunization program.

Levels of Analysis of Costs

- National level
- District level
- Health Center level
- Patient level

Average and Marginal Costs

- The average cost is the total cost per unit of output, and is calculated by dividing total cost by the units of outputs or services.

- The marginal cost is the additional cost of producing one more unit of output.
  - Incremental cost is same as marginal cost but is used when “one more unit” is defined in large additions to the program
    - Marginal cost--”one more child received one dose”
    - Incremental cost--” additional vaccines”

Costing Approaches

- **Ingredients-based or Bottom-up:**
  - Detailed analysis of resource use due to a particular intervention (e.g. staff salary, staff time spent vaccinating)
  - Conducted through a survey of facilities or other units using pre-tested questionnaires

- **Top-down:**
  - Allocates a total budget to specific services (e.g. staff salary for vaccination)

- Choice depends on need for details
  - Bottom Up offers more precision but takes more time and effort
  - Top-Down is pragmatic, but sacrifices details and relies on financial records which may or may not be available

How Do We Estimate Costs?

An Ingredients-Based (Bottom Up) Approach defines costs as P (price) x Q (quantity) x Percent (Allocation to Immunization)

Step 1: **Identify** resources used
- What resources are used by the immunization program?

Step 2: **Measure** resources used
- What quantities of each resource was used by the program within the time period?

Step 3: **Value** resources used
- What are the unit prices of each input?
- What proportion of that input was used for immunization?

Allocating Shared Costs in Immunization Programs

- Immunization programs and strategies are often implemented in a vertical manner and it is easier to identify inputs that are specifically related to the program
  - Specific inputs include vaccines, syringes, cold chain
- However, some of the inputs into immunization service delivery are shared with other services.
  - Examples: health worker time, use of vehicles, use of buildings, facility overhead
- Shared costs must be allocated to be included in the cost estimates
- Allocations can be made using a set of 'allocation rules or tracing factors'
  - Example 1: Proportion of immunization visits to total outpatient visits might be used to allocate facility overhead costs
  - Example 2: Total kms travel for outreach services as a proportion of total kms traveled by a vehicle might be used to allocate vehicle costs to the program

Sources of Information on Quantities, Unit Prices and Allocations (Selected Line Items)

Input	Quantities	Prices	Allocations
Personnel Time	Staff register, observation, interviews	Ministry of Health Salary Payment Scale	Interviews, diaries, observation studies
Vaccines	Vaccine supply and administration records	Procurement documents	100%
Supplies/syringes	Supply records, interviews	Procurement documents	Interviews with staff
Per Diem	Facility records, travel logs	Ministry of Health or donor rates	Interviews with staff
Fuel	Vehicle log books	Market survey	Interviews with staff on proportion of mileage for immunization services
Overhead	Unit financial records	Expenses made	Interviews with staff, allocation based on other factors
Cold chain	Unit records, observation	Procurement documents	100% usually for immunization
Vehicles	Unit records, observation	Procurement documents	Same allocation as for fuel

Prospective and Retrospective Data Collection

Retrospective data collection: the investigator collects data relating to an earlier time period, such as the last calendar year.

Retrospective data collection method is most common in studies of immunization costs

- Past data are gathered from reports, registers, and through interviews with vaccine staff.

Prospective data collection: the investigator collects data over a future time period.

What prices to use in a cost analysis of immunization and vaccine programs?

- Replacement prices are preferred: what would the price be if you had to purchase the input today?
  - Market surveys can be a source of information

- Historical prices: reflects prices paid in the past
  - May be OK if the input is used up quickly, such as vaccines and supplies

How to value resource use?
Principles involved

- Opportunity cost
  - In a perfectly competitive market: price = opportunity cost
- However, in health sector, prices are often distorted
  - Actual wages for health workers artificially too high/too low
  - Actual prices for drugs artificially too high/too low

- From financial perspective distorted prices are OK.
  - Payer is still paying the distorted prices
- From economic perspective not OK
  - Society's opportunity cost is not reflected by the prices
  - Collect new data on opportunity cost of resources

Caution: Costs vs. Charges

If data came from asking what patients were charged---

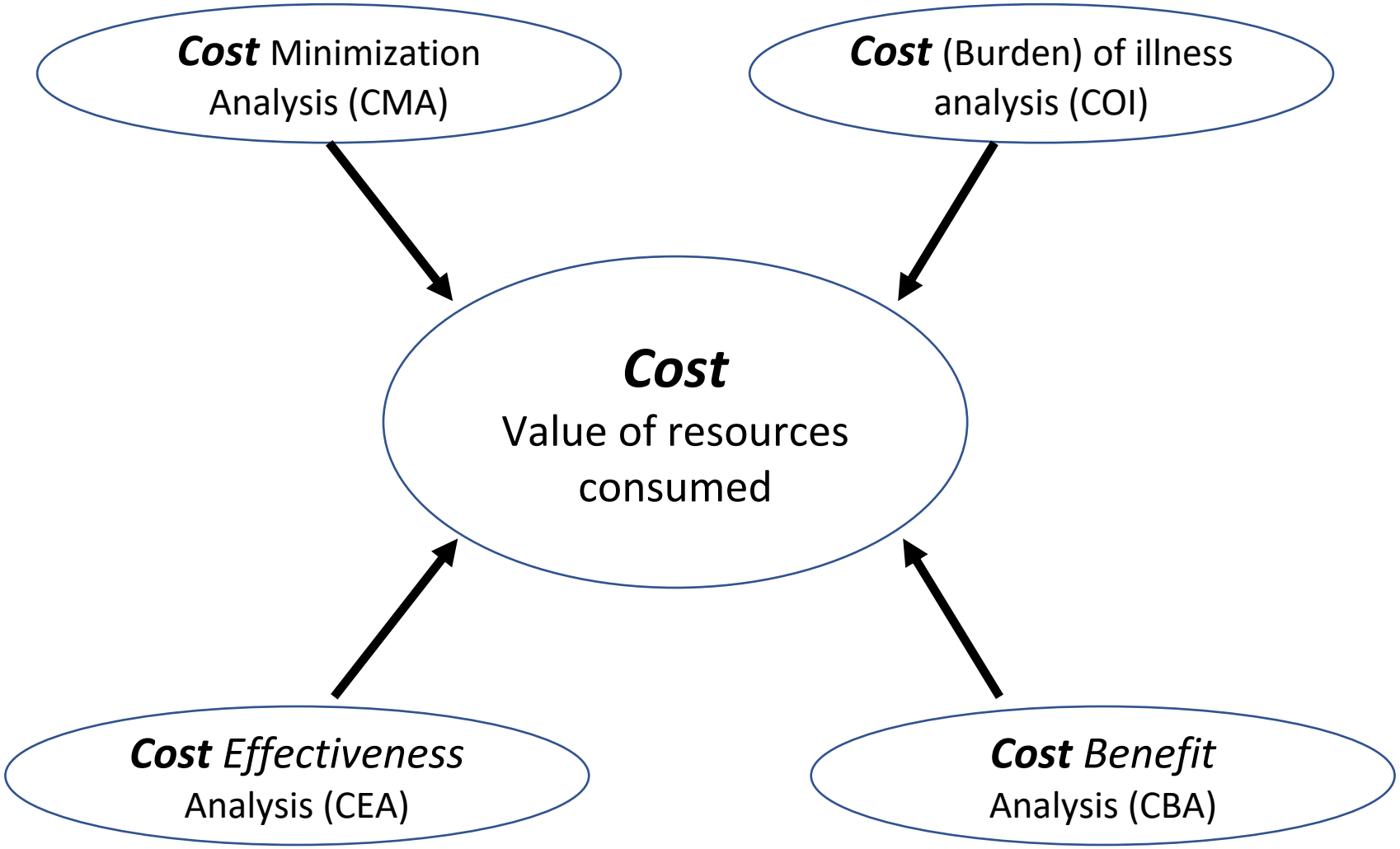
- Charges do not necessarily represent social opportunity costs
- In contrast, the amount paid by a payer does represent the cost from the payer's perspective.
- From financial cost perspective this doesn’t matter
    - People paid the charges they paid
- From economic cost perspective need to make adjust charges
    - Cost-to-charge ratio can be used

Useful Resources of Cost Estimates

- Immunization delivery costs: www.immunizationeconomics.org/EPIC
- Health System Costs (WHO CHOICE)www.who.int/choice/cost-effectiveness/en/index.html
- Global Health Costing Consortium, Unit Cost Repository (HIV/AIDS interventions) https://ghcosting.org/pages/data/ucsr/app/

Section C
Using Costs in Economic Evaluation

Role Of "Costs" In Economic Analysis



What is the Aim of Costing?

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

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

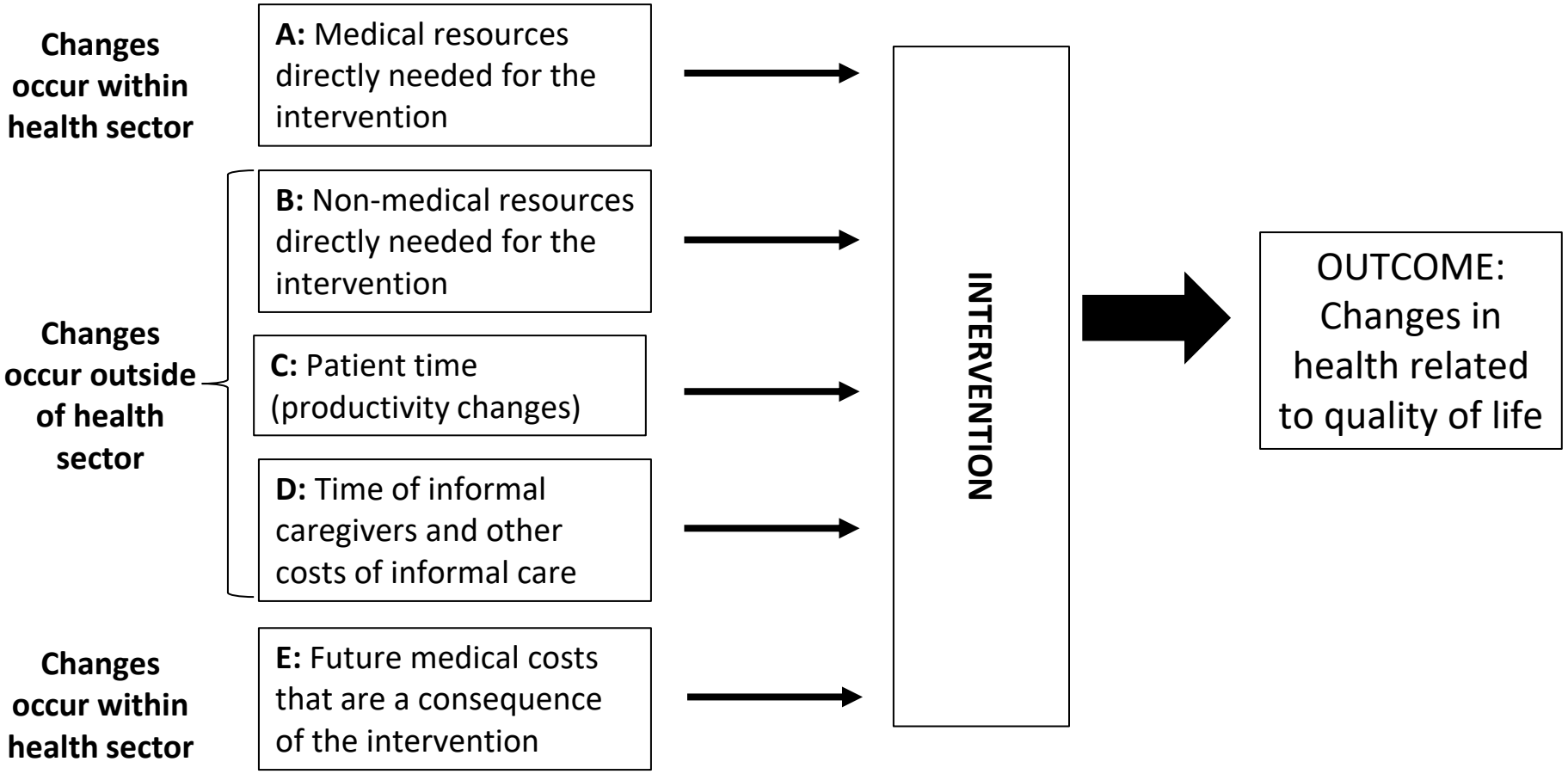
Weighing the sacrifices against the gains of the intervention to determine the relative desirability of such intervention

Source: Neumann 2017

Examples Of Different Types Of Costs

Category of Cost	Examples
Health care resources	• 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	• Childcare • Transportation
Patient time for treatment	• Patient time waiting for medical care • Patient time receiving medical care
Family caregiver time	• Family time • Uncompensated caregiver time
Patient productivity	• Patient's lost or impaired ability to work due to morbidity • Patient's lost productivity due to premature mortality

Which Resource Changes Need to be Identified, Measured and Valued?



Assessment of an intervention requires an examination of all costs (and consequences) regardless of who bears the burden or where they occur in society.

Source: Brower et al. 2001

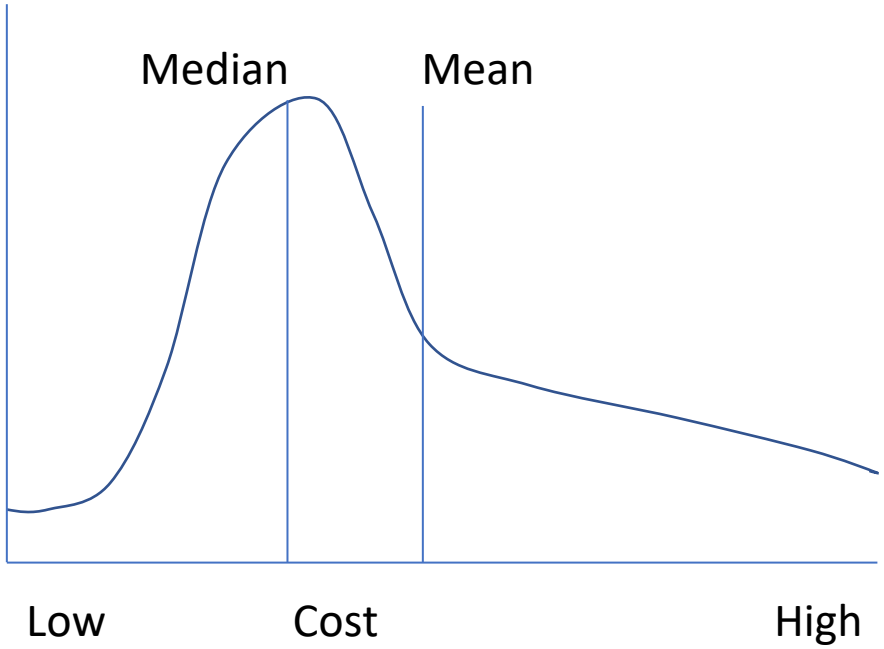
Examples of Costs Incurred and Offset

Costs incurred	Costs offset
• Attributable to cases (e.g. hospitalized cases, outbreak cases) that fail to be averted	• Attributable to cases (e.g. hospitalized cases, outbreak cases) that are averted due to vaccine
• Attributable to adverse events resulting from disease or vaccine	• In some circumstances can be very influential on the incremental cost-effectiveness ratio
• Attributable to intervention or vaccine program implemented	
• [Potentially, attributable to health care received because a premature death was averted]	

Section D
Presenting Cost Data and Analysis

Issues in analysis of costs

- Costs may not be normally distributed across facilities or regions
- So:
  - Summarize with means, medians, quartiles



How to analyse and present cost data?

- Present resource use separately from unit cost
- Describe the variation and distribution of costs
  - If there are cost outliers describe how often this happens
  - Show mean, median and quartiles or quintiles of costs
- The arithmetic mean (average cost) will be the measure most people use for reference

Presenting Cost Data

Resource List	Number of Units	Unit Price	Cost
Nurses	A	B	A x B
Refrigerators			
Vaccines			
Etc.			

Quality Assessment and Quality Control

- **Quality of data may be affected at various stages**
  - Interviewers can make errors in recording information
  - Information can be missing or not reported

- Data entry
  - Data entry can mis-enter data from survey tool

Ways to improve quality

- Meet stakeholders to discuss design – purpose and direction of the study
- Use standard questionnaires for various levels – facility, district, national
- Pre-test to customize and contextualize the tool
- Send notification in advance to facilities, district, regions to allow them to organize logbooks, registers and be present during interviews
- Do a quick review of the tool with the in-charge of the facility to facilitate data collection and availability of information
- Take stock of data collection process after a batch of questionnaire completed
- To identify trends of missing data, understanding of data collectors
- Undertake quick check calculations to make sure items adds to 100% - staff time
- Revisit facility to do ‘mop-up’ of missing information and to double check information
- Obtain contact information of facility ‘’in-charge to follow-up on any data queries

Quality Control – Minimizing Errors During Data Entry

- **Use tablets for primary data collection**

- **If using paper**
  - **Incorporate validation checks into any database entry tool**
    - To catch missing cells, inconsistent numbers
    - To specify texts compared to numeric
    - To capture differences in size of numeric values

Assess Quality – Use Global Health Cost Consortium (GHCC) Reporting Checklist

GHCC Reference Case checklist excellent for immunization cost reporting

Checklist structured into 17 sections

1. Define purpose of study
2. Define perspective of study
3. State whether economic costs or financial costs or both
4. Define units of unit costs

etc.

- Checklist can be found at GHCC website or at : Vaughan, Kelsey, et al. "Reporting gaps in immunization costing studies: Recommendations for improving the practice." Vaccine: X 5 (2020): 100069.

Summary: Measurement of Cost

- Costing process
  - Describe the scope of the immunization program or intervention
  - Be explicit about assumptions and define the perspective adopted
  - Identify and quantify resources used
  - Assign unit cost to each type of resource

- Common approaches to cost measurement
  - Observe market prices (with caution!)
  - Micro-costing (“ingredients”)
  - Standard costs (WHO CHOICE or GHCC)

- Once program costs have been determined, adjustments may be necessary (discounting, inflation, currency)

Section E
Adjustments to Costs

Objectives

- Discounting
- Annualization
- Time preference, inflation and exchange rates in costing

Discounting

Time Preference
Pick A or B

- A. You receive 100 dollars today
- B. You receive 103 dollars after 365 days

Time preference

- Would you prefer to have $100 now or in the future?
- Positive rate of time preference
- Why?
  - ‘live now, pay later’ attitude
  - future is uncertain
  - might expect to be wealthier in the future

When do I discount?

- When you have costs/benefits for more than 1 year (into the future)
    - Ex 1: Vaccine requires one dose now and boosters next year
    - Ex 2: Immunity offers benefits next year. Benefits must be discounted too.

What's the formula?

- Discounted costs= (Cost in year t) x $1 / (1+r)^t$

  - In Excel: can use "NPV" function

Discount factors for present value: discount rate (r) = 5%

Year	$(1+r)^n$	Discount factor $1 / (1+r)^n$
1	$(1 + 0.05)^1 = 1.050$	0.952
2	$(1 + 0.05)^2 = 1.103$	0.907
3	$(1 + 0.05)^3 = 1.158$	0.864
4	$(1 + 0.05)^4 = 1.216$	0.823
5	$(1 + 0.05)^5 = 1.276$	0.784

Example

- If cost was the only deciding factor, which project would you invest in?
- Assume a 5% discount rate
- Also assume costs are incurred at the beginning of each time period

	Y1	Y2	Y3	Y4	Y5	Total
Project A	$100	$100	$100	$100	$100	$500
Project B	$500	-	-	-	-	$500
Project C	-	-	-	-	$500	$500

Example

	Y1	Y2	Y3	Y4	Y5	Total
Discount factor (5%)	1.000	0.952	0.907	0.864	0.823	
Project A	$100	$95	$91	$86	$82	$455
Project B	$500	-	-	-	-	$500
Project C	-	-	-	-	$412	$412

- Project C has the lowest cost in terms of present value
- For example, you need $500 today for Project B. Alternatively, you could put $412 in a bank today and receive the $500 you need in year 5 for Project C
- Economists contend you are better off with Project C because you can do something else with the $88 you did not put in the bank

Which discount rate?

- Interest rate on a risk-free investment
- Rate used by a particular country or agency when it has to borrow
- Rate used in literature: range 3-10%
- Rate recommended by guidelines
- Always carry out sensitivity analysis

Annualization

‘Annual equivalent costs’

Annualization

- Capital items purchased in previous years have a cost today
- Annualization permits capital costs to be converted to their annual equivalent, and thus added to annual recurrent costs
- It involves spreading the cost of the capital item over its life, and accounting for opportunity cost of the money that was locked up in the asset

When do I annualize?

- Capital items – things you use for more than 1 year
  - Computers
  - Microscopes
  - Lab machines
  - Buildings
  - Cars
- Buying these things means you lost the chance to invest those funds in the stock market and earn “r” every year

How do I annualize?

1. Use rental costs or if cannot find rental cost
2. Calculate annual equivalent cost

Need:

- Purchase price
- Useful life
- Discount rate

Formula:

- Annualization factor = ((1+r)^(n-1)/(r*(1+r)^n)
  - Where r is discount rate and n is number of years of useful life
- Annualized Cost=(Purchase price) / $(1 / (1 + r)^{Useful\ Life})$

How do I know the useful life?

- Manufacturer specifications
- Accounting rules
- Assumptions:
  - Electrical: 4-5 years
  - Mechanical (e.g., cold chain): 8-10 years
  - Furniture: 7-10 years (depends on material)
  - Precision/glass (lab): 3-5 years
  - Buildings: 20-50 years
  - Vehicles: 3-5 years depending upon terrain

Question

Single $10,000 piece of capital equipment (no re-sale value)

- useful life of 10 years
- discount rate of 5%

1. Cost estimate: $10,000
2. Discount rate: 5%
3. Years of useful life: 10
4. Annualization factor = ((1+0.05)^(10-1)/(0.05*(1+0.05)^10) = 7.7217
5. Annualized cost = $10,000/7.7217 = $1,295.05

Excel: =- PMT (0.05;10;$10000) = $1,295.05.

Inflation

Adjusting for inflation

- Inflation: process by which general prices increase and money loses value
- When comparing data from different years adjust to constant / real terms
- Inflate / deflate prices by inflation adjustment factor (IAF)
- IAF = indicator of inflation in base year / indicator of inflation in past year
- Examples: CPI (www.bls.gov/cpi/), GDP deflator

  www.imf.org/external/pubs/ft/weo/2008/02/weodata/index.aspx, both and more

When do I use inflation?

- To adjust costs observed in the past to the year of your study
  - Paper in literature reports costs for year 2003 but I want to present results for year 2009
  - (For primary data collection: items purchased in past years)

How do I adjust for inflation?

Multiple items: ‘Adjust for inflation’

- Price in past year * (indicator of inflation in base year / indicator of inflation in past year)
- Inflate in local currency unit, then use currency conversion rates

Example

- Cost per bed-day in 2003 costs = $45
- How much is this in 2006 costs?
- CPI in 2003 = 160.8
- CPI in 2006 = 181.2

- Cost per bed-day in 2006 = ($45/160.8) * 181.2 = $50.71

Adjusting costs across both time and space

Purchasing Power Parity

Concept of purchasing power parity

- Captures the notion that a dollar should buy the same amount in all countries
- Exchange rate should move towards the rate that equalizes the prices of an identical basket of goods and services in each country
- The Economist uses a McDonald's Big Mac, and more recently a Starbucks tall-latte, is their 'basket'
  - the Big Mac PPP is the exchange rate that would mean Big Macs cost the same in America as abroad
  - comparing official exchange rates with PPPs indicates whether a currency is under- or over-valued

Converting costs into IUS$

- WHO has developed PPPs
- www.who.int/choice/costs/ppp/en/
- An international dollar has the same purchasing power as the US$ has in the United States
- To convert local currency units to international dollars, divide the local currency unit by the PPP conversion factor

When do I need to do this?

- I have data from the past and from a different country…

- Example:
  - I have a great paper which says that training psychiatrists cost $200 per doctor in year 2004 in Zambia.
  - My study is set in Tanzania for the year 2009.

How do I do this?

1. Convert to local currency unit of the country where the data originated (e.g., Zambia) using official exchange rate of year of study (e.g., 2004)
2. Inflate from 2004 (year of study) to 2009 (year of your study)
    - Why?
3. Divide by the purchasing power parity rate for Zambia (country of paper) in 2009 (your year)
4. Multiply by the purchasing power parity rate of Tanzania (your country) in 2009 (your year)
5. Divide by the official exchange rate of Tanzania
    - Result: Cost of training psychiatrist in Tanzania (in US$), accounting for differences in purchasing power between Zambia and Tanzania

Summary

- **Discounting**
  - Costs should be discounted
  - Benefits less clear
  - No consensus regarding appropriate discount rate, so use sensitivity analysis to assess robustness of findings to changes in the rate
- **Capital costs**
  - Should be annualised to spread value of item over its lifetime and to capture opportunity cost of tying-up funds in the purchase of the item

Summary

- **Inflation**
  - CPI or GDP deflators can be used to adjust prices for inflation

- **Purchasing power parity**
  - IUS$ is a hypothetical currency that has the same purchasing power that the US$ has in the US at a given point in time
  - It is used to make comparisons both between countries and over time

Suggested Readings

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