Healthcare Interventions, Economic Value, and the Importance of Economic Evaluation

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Summary

- Interventions
- Value Assessment
- Example of Use of Economic Evaluation to Inform Health Policy

Healthcare Interventions vs. Instruments of Policy

- **Interventions**: actions taken by or for individuals to reduce the risk, duration, or severity of an adverse health condition
  - Divided into "personal" and "population-based"
  - e.g., smoking cessation
- **Instruments of policy:** encourage, discourage or undertake interventions
  - e.g., taxing tobacco products
- Economic evaluations are conducted to assess the value of different kinds of interventions

Jamison, Dean T. "Cost effectiveness analysis: concepts and applications." In R. Detels, J. McEwen, R. Beaglehole, H. Tanaka (eds.) Oxford Textbook of Public Health: Volume 2, The Methods of Public Health, Fifth edition. Oxford: Oxford University Press, 2009. Pp. 767-782.

Personal Interventions

Directed to individuals and provided at a wide range of facilities

Intervention Type	Definition	Example
Primary prevention	Reduce risk factors and reduce disease incidence	Smoking cessation
Cure	Remove cause and restore function to the status quo ante	Successful wedge resection for stage-1 non-small cell lung cancer (NSCLC)
Acute management	Decrease the severity of acute events	Surgery to repair a ruptured blood vessel in stage-3 NSCLC
Secondary prevention (or chronic care)	Decrease severity and frequency of recurrent events of chronic or episodic diseases	Low-dose lung CT scans among heavy smokers
Rehabilitation	Restore (or partially restore) function resulting from a previous condition	Physiotherapy after lobectomy for NSCLC
Palliation	Reduce pain and suffering from an incurable condition or one for which rehabilitation is unavailable	Thoracentesis to reduce fluid buildup and improve breathing in stage-4 NSCLC

Population-Based Primary Prevention

Directed to entire populations or sub-populations

Intervention Type	Example
Personal behavior change	TV anti-smoking campaign
Control of environmental hazards	Interventions to reduce inhalation of second-hand smoke
Population-oriented medical interventions	Immunization, mass chemoprophylaxis, screening **(might apply to lung cancer)**, referral

Instruments of Policy

Can (potentially) be undertaken by governments or other entities to encourage or discourage interventions or to expand the menu of potential intervention

Intervention Type	Goal	Example
IEC	Improve knowledge of individuals about the consequences of their choices	TV anti-smoking campaign by government
Taxes and Subsidies (on services, products and pollutants)	To effect behavioral responses	Increase in tobacco product taxes
Regulation and legislation	Limit availability of some commodities, curtail practices, define rules	Legislative ban on smoking in workplaces and buildings
Direct expenditure	Provide selected interventions or build infrastructure that facilitates a range of interventions or influences behavior	Building hospitals or medical schools
Research and development	Subsidizing these activities helps expand the range of interventions	Lung cancer prevention trials

3 ps: Intervention Packages, Platforms, Policies

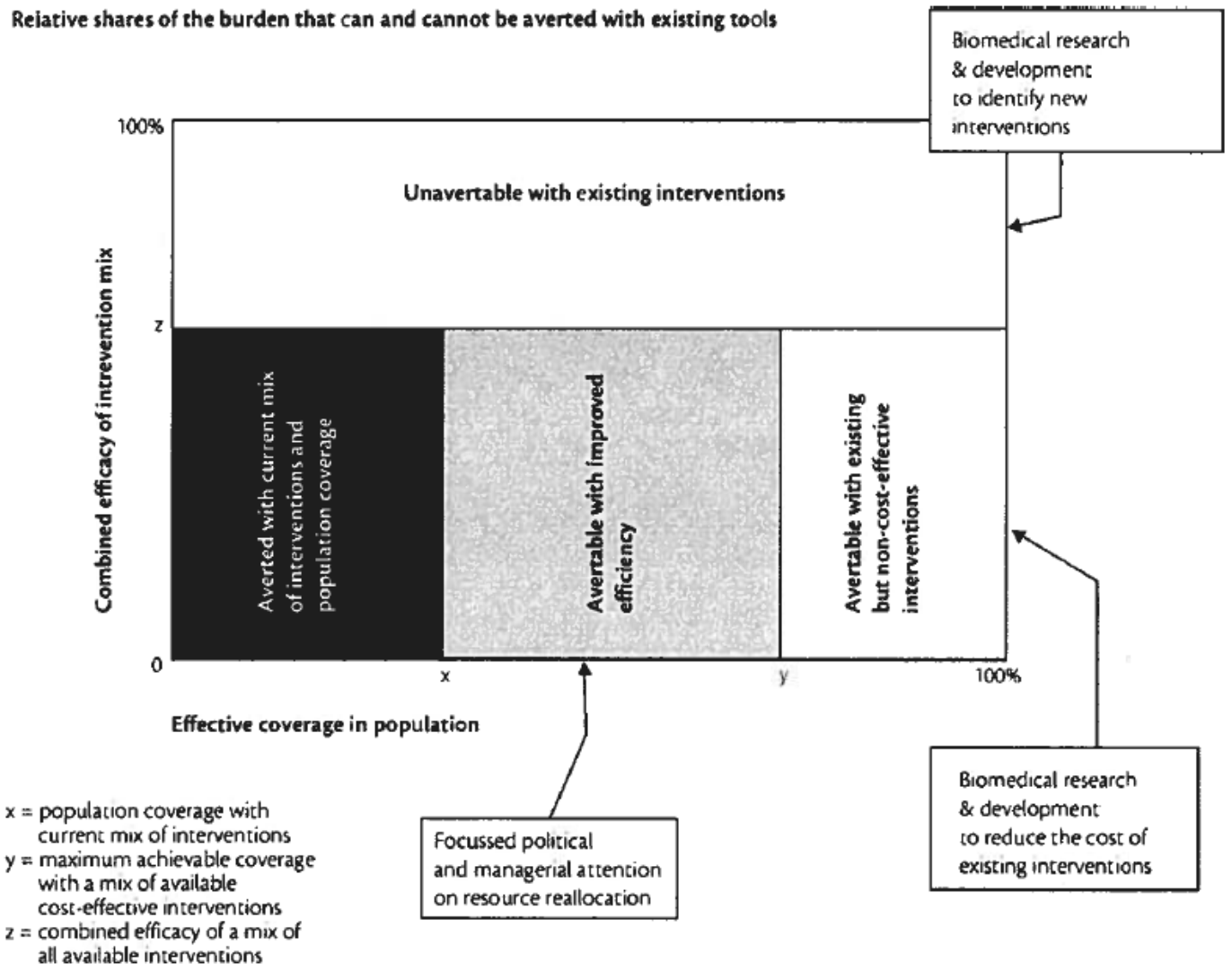
- **Policy makers don't (usually) choose interventions 1-by-1**
  - They usually think in packages (not like trialists who isolate one intervention (and hold everything constant)
- **Package of interventions**
  - Expanded Program on Immunization (EPI)
  - Not too useful to define the CE of the "pertussis" part of EPI but the CE of the EPI program package in general
- **Platforms**
  - Surgical suite at a primary health facility or district hospital
  - Costs (and effectiveness) of the entire suite — personnel, equipment, capital etc.
- **Policies**
  - As discussed under instruments of policy

Healthcare Interventions as Technologies

Technology is the practical application of knowledge

Healthcare Technology	Example
Drugs	Cisplatin for NSCLC
Biologics	Erlotinib (Tarceva) for NSCLC
Vaccines	HPV vaccine for oropharyngeal carcinoma
Medical devices	Pleurx-Denver catheter for fluid drainage in lung cancer
Diagnostics	CT scan (low dose) for NSCLC screening, X-rays, Endobronchial US
Procedures (medical)	Psychotherapy for (some) cancer patients, Radiotherapy, Proton therapy, Photodynamic therapy etc. for lung cancer
Procedures (surgical)	Laser surgery to unblock airway, cryosurgery (to freeze tumor), etc.
Support systems	Telemedicine, drug formularies, blood banks, electronic medical records
Health system innovations	Organizational and managerial e.g., clinical pathways, DRGs, alternative healthcare configuration
Health technology assessment (HTA)	HTA itself can be considered a technology

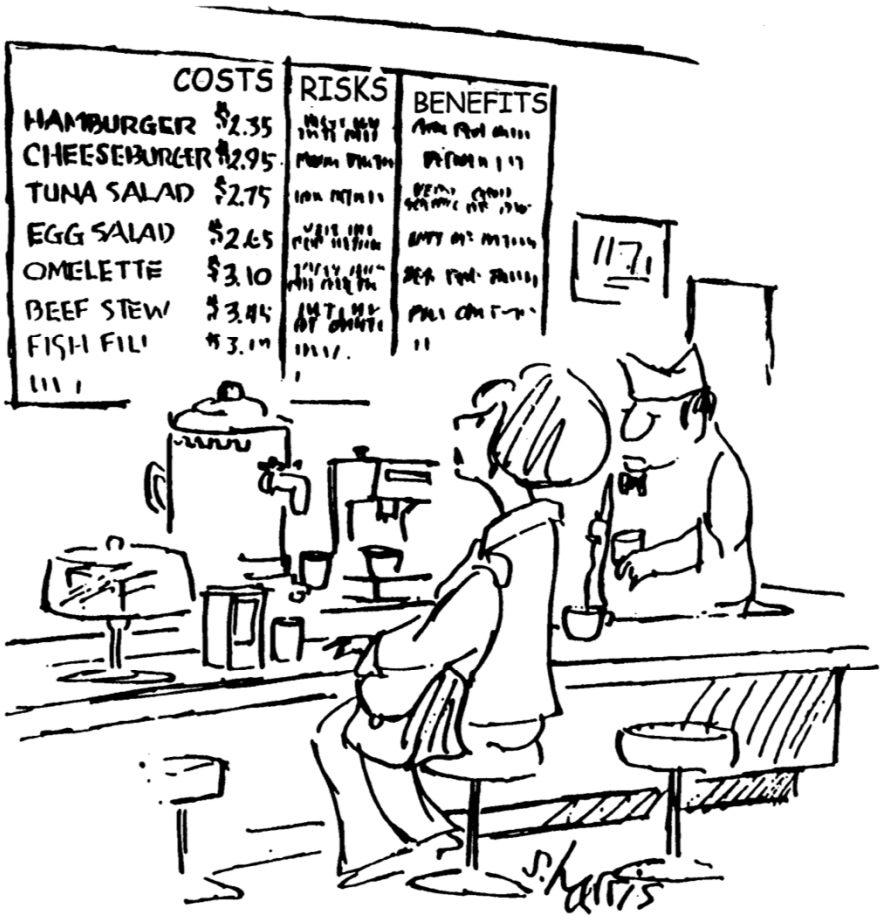
The Implementation Gap (Jamison (2009))



We all are (applied) economists!

- We evaluate costs and effects everyday
- We prioritize our choices
- We make resource allocation decisions with limited budgets

Comparative Analysis in Real Life

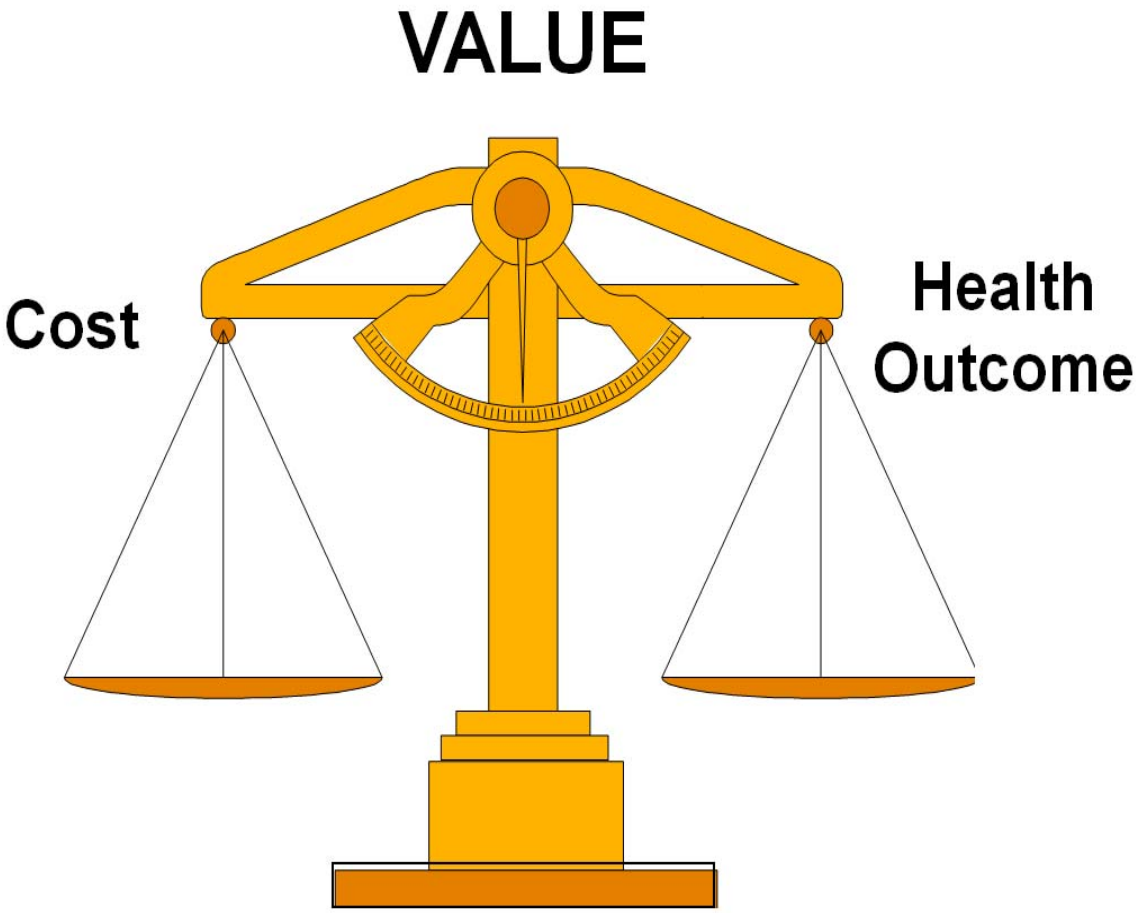


Defining Economic Evaluation

- **Comparison** of two or more alternative health interventions, treatments, or programs in terms of their **costs** and **effectiveness**—with effectiveness measured in the same units
  - Costs refer to the value of resources involved in providing a treatment or intervention
  - Consequences (health outcomes) are the health effects of the intervention

Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL, . Methods for the Economic Evaluation of Health Care Programmes (Oxford University Press, 2005)

Trade-offs and Balance



The Importance of Defining a Comparator

- Analysts need to define a comparator or "base case" and define both policy and specific interventions as changes from the base case
- For specific interventions e.g., clinical procedures, the natural base case is the status quo or standard of care
- The base case is less obvious for policy interventions
- Probably best to define policy base cases that are close to the current reality for policy makers—incremental CEAs from these bases provide more interpretable information
- Sometimes it is important to consider the impact of doing less than is being done in the base case thereby generating negative costs and effects
  - Such negative intervention may prove to be highly cost-effective

Comparative Analysis in Healthcare

- Assuming **two** health interventions for comparison in an health economic evaluation
  - Intervention A is the existing intervention
  - Intervention B is the new or novel intervention
- As an analyst, you would like to compare the value of intervention B (the new intervention) to intervention A (the old intervention)
  - The comparative analysis considers the costs and health outcomes (effectiveness) of A and B
  - Gold standard of effectiveness measures is quality-adjusted life-year (QALY) or disability-adjusted life-year (DALY), both measure that combine length and quality of life
    - Cost per DALY averted
    - Cost per QALY gained

Resources for Healthcare

- Monetary resources e.g., $, ¥, €, £, etc.
- Health system capacity e.g. human resources, infrastructure, etc.
- To implement an intervention, the system uses some of each resource
  - Some interventions need more of one or the other
- In poor countries with low health system capacity, it is important to select interventions that require relatively little health system capacity

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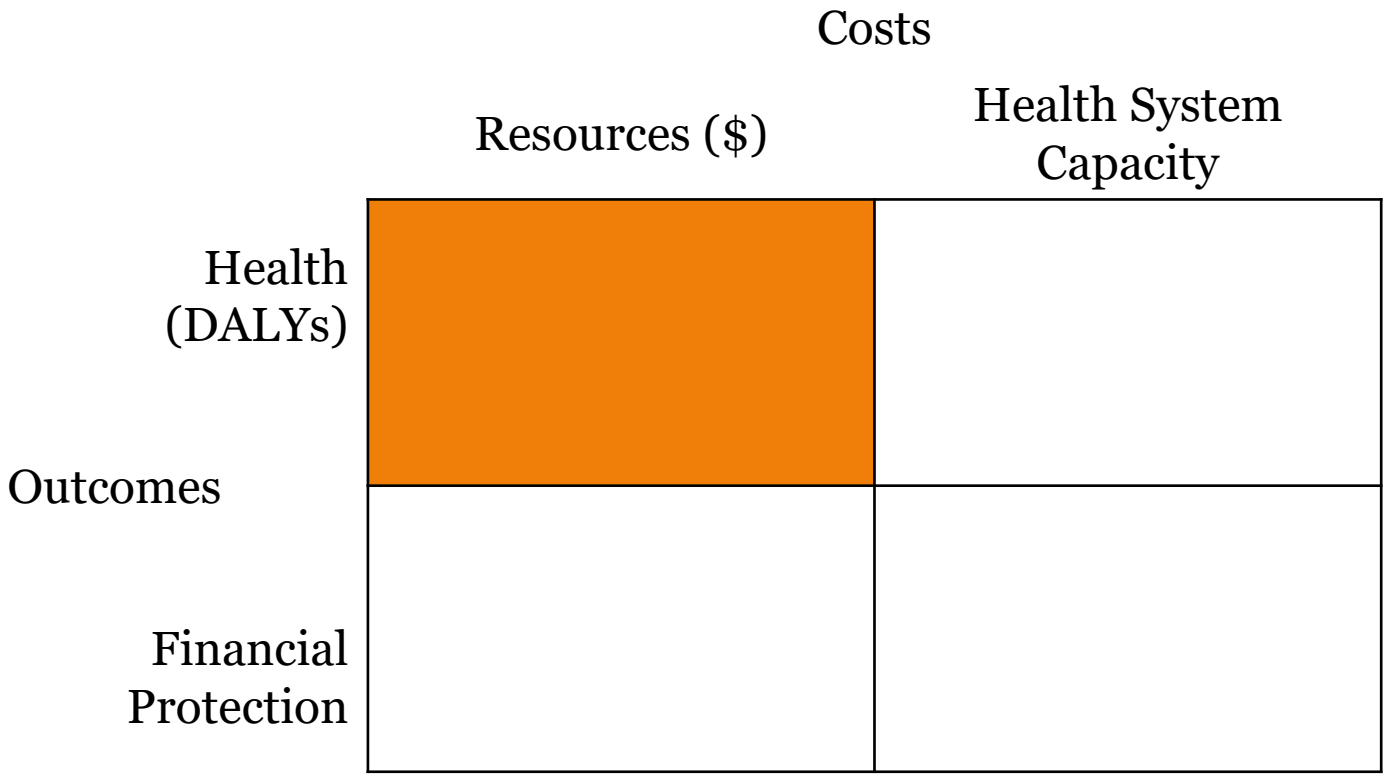
Intervention Costs and Effects

Adapted from Jamison (2009)



Shaded box represents the traditional domain of **Value Assessment** in healthcare which do not include Financial Risk Protection and Health System Capacity in their calculations

Rationale for Economic Evaluation in Healthcare

- Information on efficacy and effectiveness is necessary but not sufficient for making healthcare decisions
  - It is also necessary to consider the opportunity costs (benefits forgone) of alternative courses of action
- Healthcare does not have a typical market where supply and demand are brought together using a price mechanism
  - Governments intervene (to different extents) to deliver and finance healthcare
- Given scarce resources and the absence of a price signal, policy makers need a means to allocate resources between competing demands
  - Explicit consideration of the opportunity cost of alternative courses of action is necessary

Uses of Economic Evaluation in Healthcare

- To guide decision makers (usually public sector) on whether/when to change intervention mix or whether/when to change intervention coverage levels.
  - Often the questions asked pertain to specific health problems.
- To inform health policy.
  - Health policy can be defined as the "decisions, plans, and actions that are undertaken to achieve specific health care goals within a society. [WHO]
- To generate cost-effectiveness generalizations to support or undermine broad generalizations in healthcare policy options.

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Use of Economic Evaluations by Policy Makers

- Policy makers need evidence
  - They don't do stuff because of divine intervention but because evidence was generated and synthesized
- Estimates of costs, effectiveness and cost-effectiveness provide clear guidance to policy-makers when:
  - The **effectiveness target is clear** and the economic evaluation seeks to minimize the expenditure needed to achieve the target
  - The **budget constraint is clear** and the aim is to maximize health benefits within the given budget
  - The acceptable **threshold cost-effectiveness is clear** and explicitly stated

Value for Money in Healthcare is Important in Rich and Poor Countries

- Poor countries spend very little annually per capita on health and achieve poor outcomes
  - With a high burden of treatable and preventable diseases, a few extra dollars, used without formal assessment of value i.e. misspent, would mean a lost opportunity to postpone many deaths and prevent substantial disability.
- Rich countries spend large amounts annually per capita on health and achieve good outcomes.
  - With the high (and rising) cost of healthcare, an improved intervention mix might reduce healthcare spending (or at least reduce the rate of growth of healthcare spending).
  - Many new and expensive interventions are approved every year; which of these should payers reimburse?

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Types of (Full) Economic Evaluations

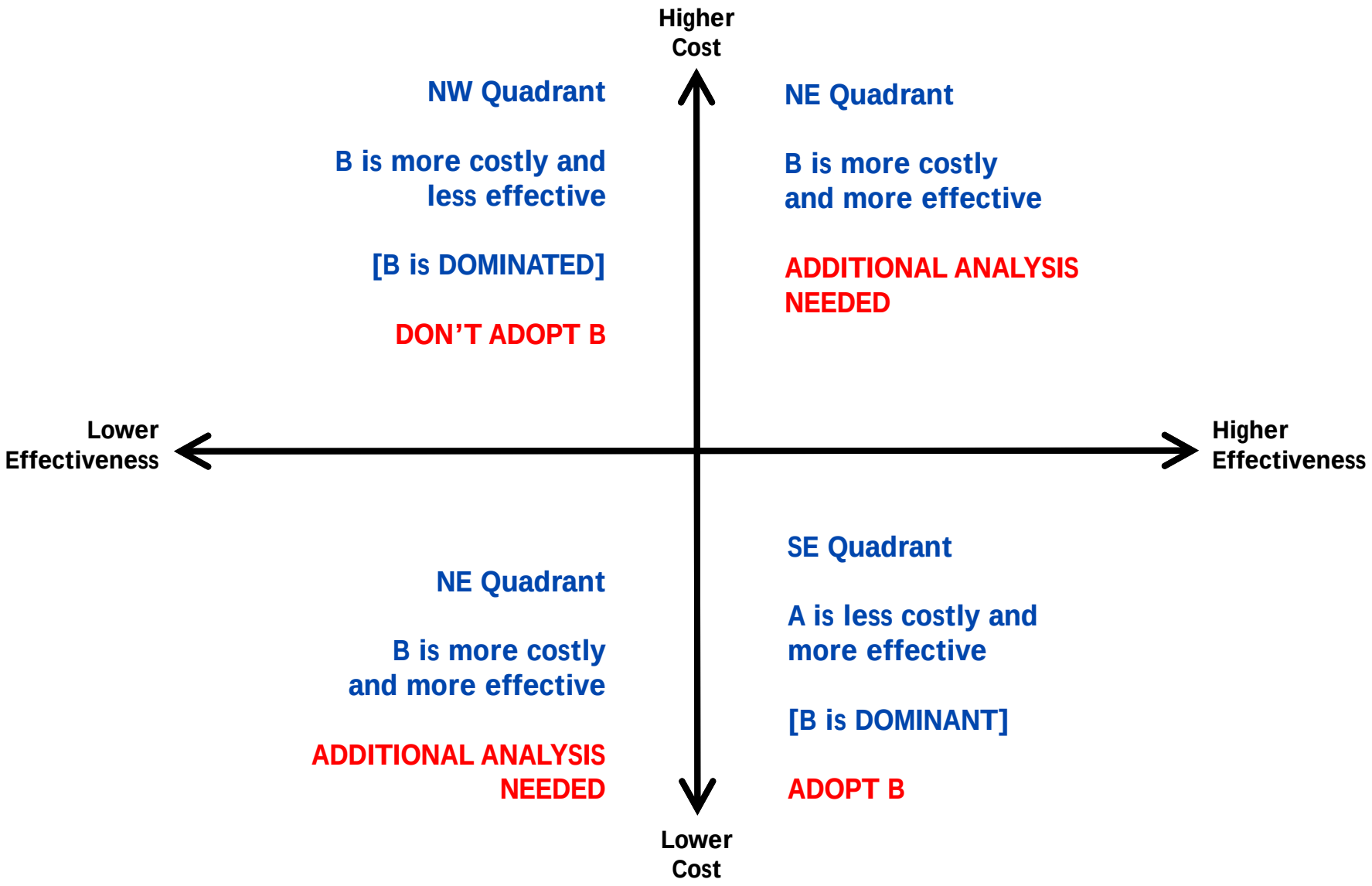
Method of Analysis	Cost Measurement	Outcome Measurement
Cost-Consequences Analysis	$	Multi-dimensional listing of outcomes
Cost-Minimization Analysis	$	Equivalence demonstrated or assumed in comparative groups
Cost-Effectiveness Analysis	$	Single “natural” unit outcome measure
Cost-Utility Analysis	$	Multiple outcomes—life-years adjusted for quality-of-life
Cost-Benefit Analysis	$	$

Application of Economic Evaluation Methods

	Applicability for assessing			
Method of Analysis	Options to achieve a specific objective	Options across health sector	Options inside and outside health sector	Intrinsic value
Cost-Consequences Analysis	Yes	?	No	No
Cost-Minimization Analysis	Yes	No	No	No
Cost-Effectiveness Analysis	Yes	No	No	No
Cost-Utility Analysis	Yes	Yes	No	No
Cost-Benefit Analysis	Yes	Yes	Yes	Yes

Adapted from Jamison. Cost effectiveness analysis: concepts and applications." In R. Detels, J. McEwen, R. Beaglehole, H. Tanaka (eds.) Oxford Textbook of Public Health: Volume 2, The Methods of Public Health, fifth edition. Oxford: Oxford University Press, 2009. Pp 767-782.

Comparing A and B: The Cost-Effectiveness Plane



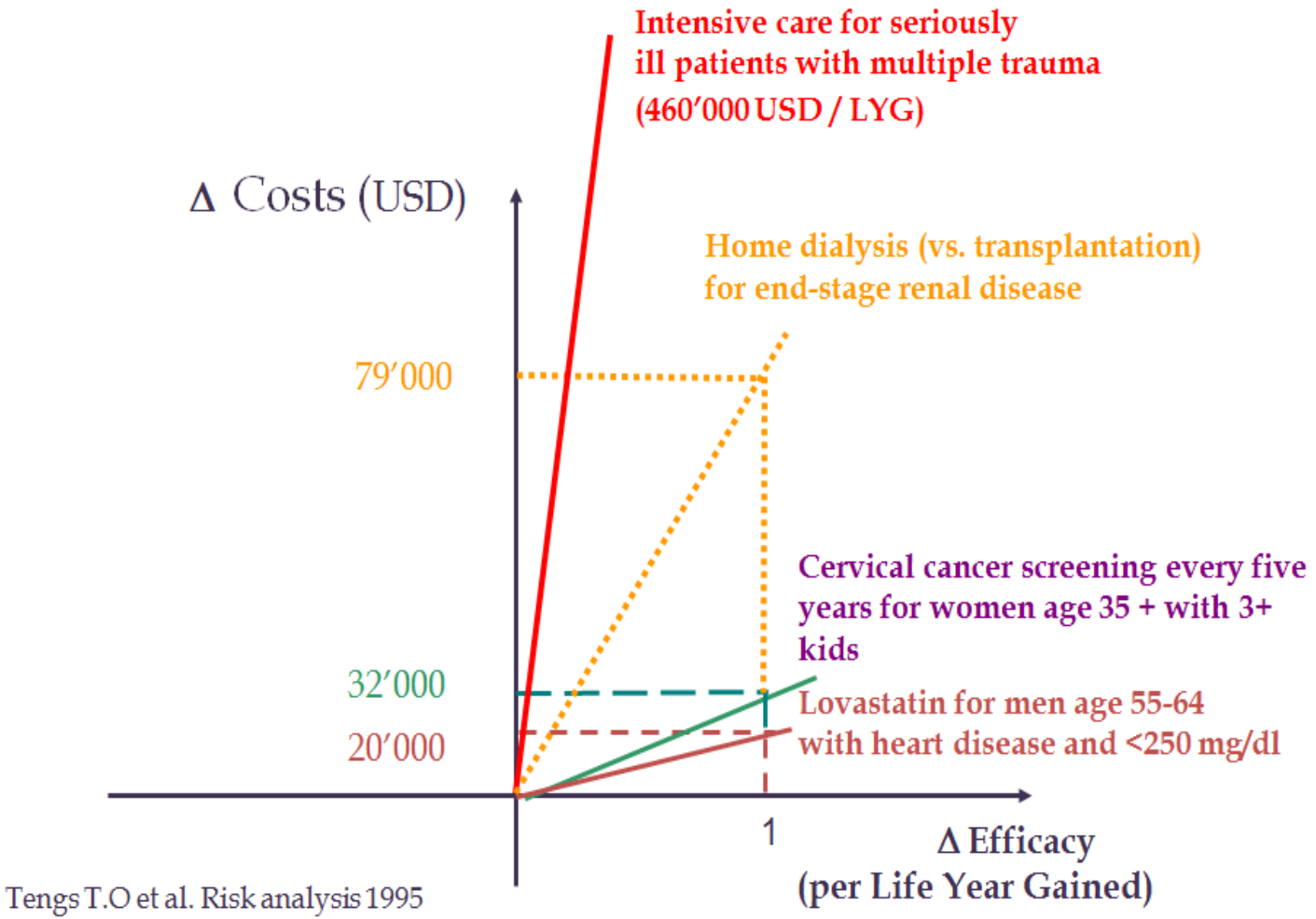
NE Quadrant — The ICER

- Intervention B is both more costly and more effective than intervention A
- This situation is the most common
  - Innovative technologies tend to increase effectiveness relative to standard of care at an added cost (a premium on innovation)

$$\text{ICER} = \frac{\text{Mean Cost (B)} - \text{Mean Cost (A)}}{\text{Mean Outcome (B)} - \text{Mean Outcome (A)}}$$

- Costs are always measured and presented in currency units ($, £, €, UGX, etc.)
- Outcomes are measured in a variety of ways but must be in the same units for comparators A and B

Some Examples of ICERs



Tengs T.O et al. Risk analysis 1995

ICERs and Cost-Effectiveness

- Three approaches to determine if an ICER ($/DALY averted or $/QALY saved) represents value for money in a given society.
  - Thresholds
  - Benchmark interventions
  - League tables

Thresholds

- Most common threshold in LMICs is GDP-based
  - Highly cost-effective — ICER < GDP per capita
  - Cost-effective — ICER between GDP per capita and 3 X GDP per capita
- Limitations of GDP-based threshold
  - Obscures important comparisons
  - Thresholds are easily attained
  - Based on untested assumptions and no empirical data
  - Affordability not adequately appraised
- High-income country thresholds vary but tend to be higher
  - UK (NICE) — £20,000 to £30,000 per QALY
    - Recent study suggests that this is too high and that £13,000/ QALY is more accurate (£13,000 of NHS resources adds one QALY to the lives of NHS patients)
  - US — $50,000 to $200,000 per QALY

Benchmark Interventions

- Citation of the cost-effectiveness of a benchmark intervention that has already been adopted
  - Example is dialysis as the basis of (traditional) $50,000 per QALY in the US
- Suggests that willingness to pay has already been decided
- Therefore overall health benefits will increase by transferring funds from interventions that cost more to interventions that cost less than benchmark
- Approach exhibits better local relevance
- Limitations of benchmark interventions
  - ICER for benchmark may be a high or low outlier
  - Benchmarks don't take affordability into account
  - There might be available options that have a better ICER than either the benchmark intervention or the intervention under evaluation

League Tables

- With league table approach, no need for thresholds; all interventions that have potential for scale are ranked in league table according to ICERs
- Assumes that health outcomes are maximized if implementation starts with interventions with the smallest ICER (at top of league table)
- Different kinds of league tables, big and small
  - WHO league tables
  - TUFTs CEA registry
- Limitation of league tables
  - ICERs may not be available for many relevant options or settings
- Advantages of league tables
  - Consider affordability
  - Need not be comprehensive to support improved resource allocation
    - Can indicate benefit of cancelling some programs and funding new ones

League Table Example

Table 1. **A cost–effectiveness league table for malaria interventions: Africa D region**[a]

Intervention (description)	Annual cost (million I$) per million people	Annual no. of DALYs averted per million people	Incremental no. of DALYs averted per million people	Incremental cost	
				Million I$ per million people	I$ per DALY averted
MAL-27 (case management with ACT, 80% coverage)[b]	0.25	26 426	26 426	0.25	9
MAL-7 (MAL-27 but 95% coverage)	0.33	31 470	5 044	0.08	16
MAL-17 (combination of ACT, IPTP and ITNs, 95% coverage)	1.07	44 115	12 645	0.74	59
MAL-20 (MAL-17 plus IRS)	1.59	49 518	5 403	0.52	96

ACT: artemisinin-based combination therapy; DALY: disability-adjusted life-year; I$: international dollars; IPTP: intermittent preventive therapy for pregnant women; IRS: indoor residual spraying; ITNs: insecticide-treated nets.

[a] A list of countries in the Africa D region is available from: http://www.who.int/choice/demography/african_region.

[b] The costs and DALYs averted by MAL-27 were compared with no intervention. Each of the other three options was compared with the next cheapest intervention, i.e. the intervention in the row above.

Data source: World Health Organization.[6]

Marseille et al. (Bull World Health Organ 2015)

SW Quadrant — The "Decremental" CER (DCER)

- In theory, limited benefits could be sacrificed for substantial resource savings, permitting reallocation of resources to higher-value alternative
- In the SW quadrant, the CER is a measure of savings per outcome loss
  - A **higher** DCER is better
- Decrementally cost-effective innovations have potential for maximizing health benefits while minimizing costs.
  - May be especially attractive in poor countries
- Examples in the literature
  - Watchful waiting in inguinal hernia (Stroupe et al, 2006)—DCER=$194,300/QALY
  - Percutaneous coronary intervention for multi-vessel coronary artery disease (Weintraub et al, 2004)—DCER=$3,210,000/QALY
  - Pharmacy refill compared to physician follow-up for HIV care (Babigumira et al, 2011)—DCER=$13,500/favorable immune response

Average vs. Incremental Cost-Effectiveness

(ACERs vs. ICERs)

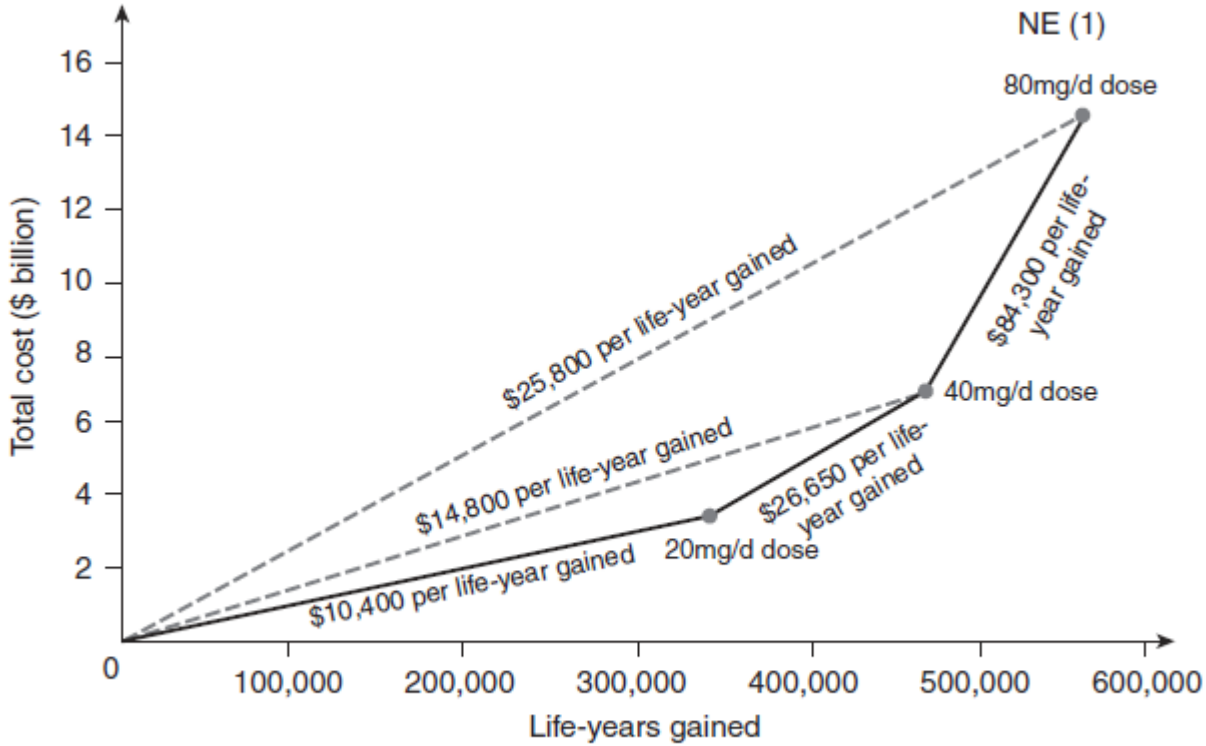


Fig. 2.3 Cost-effectiveness of three different statin doses to reduce cholesterol. Derived from Goldman *et al.* (1991).

Average Analysis — Average CE Ratio (ACER)

Cases of colon cancer detected per 10,000 population with six sequential tests

No. of tests	Total cases detected	Total costs	Calculation	ACER
1	65.0465	$77,511	$77,511/65.0456	$1,192
2	71.4424	$107,690	$107,690/71.4424	$1,507
3	71.9003	$130,199	$130,199/71.9003	$1,811
4	71.9385	$148,116	$148,116/71.9385	$2,059
5	71.9417	$163,141	$163,141/71.9417	$2,268
6	71.9420	$176,331	$176,331/71.9420	$2,451

Incremental Analysis — Incremental CE Ratio (ICER)

Incremental cases detected and incremental costs with six sequential tests

No. of tests	Total cases detected	Inc. cases	Costs	Inc. costs	ICER
1	65.0465		$77,511		
2	71.4424	6.3959	$107,690	$30,179	$4,718
3	71.9003	0.4579	$130,199	$22,509	$49,157
4	71.9385	0.0382	$148,116	$17,917	$469,031
5	71.9417	0.0032	$163,141	$15,025	$4,695,313
6	71.9420	0.0003	$176,331	$13,190	$43,966,667

Policy Example: Lung Volume Reduction Surgery (LVRS) for Chronic Emphysema

- Procedure developed by a surgeon to treat end stage lung disease.
  - 1998-1999 – 3,000+ procedures performed and reimbursed, some indication of high death rates
  - 2003 – Large RCT showed no benefit with the exception of a small sub-group of patients and the potential for great harm.
  - 2003 – CEA showed the procedure was not cost-effective.

Cost-Effectiveness Results: Trial-Based

Table 3. Total Health Care–Related Costs, Quality-Adjusted Life-Years Gained, and Estimated Cost-Effectiveness Ratios at Three Years.*

Variable	Surgery Group		Medical-Therapy Group		P Value	Incremental Cost-Effectiveness Ratio for Surgery ($)
	No. of Patients	Mean (95% CI)	No. of Patients	Mean (95% CI)		
All patients	531		535			190,000
Total costs ($)		98,952 (91,694–106,210)		62,560 (56,572–68,547)	<0.001	
Quality-adjusted life-years gained		1.46 (1.46–1.47)		1.27 (1.27–1.28)	<0.001	
Patients with predominantly upper-lobe emphysema and low exercise capacity	137		148			98,000
Total costs ($)		110,815 (93,404–128,226)		61,804 (50,248–73,359)	<0.001	
Quality-adjusted life-years gained		1.54 (1.53–1.55)		1.04 (1.03–1.05)	<0.001	
Patients with predominantly upper-lobe emphysema and high exercise capacity	204		212			240,000
Total costs ($)		84,331 (73,699–94,962)		55,858 (47,161–64,555)	<0.001	
Quality-adjusted life-years gained		1.54 (1.54–1.55)		1.42 (1.42–1.43)	<0.001	
Patients with non–upper-lobe emphysema and low exercise capacity	82		65			330,000
Total costs ($)		111,986 (93,944–130,027)		65,655 (52,075–79,236)	<0.001	
Quality-adjusted life-years gained		1.25 (1.23–1.26)		1.10 (1.09–1.12)	<0.001	

* Upper-lobe predominance of emphysema was defined according to the results on computed tomography. Exercise capacity was defined as the maximal workload on bicycle ergometry. Low exercise capacity was defined as a workload of 25 W or less for women and 40 W or less for men; a workload above these thresholds was considered to represent high exercise capacity. P values were derived by two-sided t-tests for equality of means. The results for the overall cohort exclude 140 patients previously found to be at high risk for death, 3 patients who were not enrolled in Medicare, 8 patients who were enrolled in Medicare+Choice plans, and 1 patient whose claims records were missing. Total costs include direct medical costs (Medicare reimbursements and pharmacy costs) plus the value of the time spent by caregivers, the value of the time spent by the patient, and travel costs. After year 1, costs were discounted by 3 percent per year. The incremental cost-effectiveness ratio is the cost per additional quality-adjusted life-year gained with lung-volume–reduction surgery. The subgroup of patients with non–upper-lobe emphysema and high exercise capacity is not included, because in this subgroup, surgery was associated with higher total costs and fewer quality-adjusted life-years gained than was medical therapy. CI denotes confidence interval.

Large drop in use of procedure

- “Since the report of the trial, use of LVRS among Medicare patients nationally has been modest, limiting the financial impact of the procedure.”

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