DISEASE CONTROL PRIORITIES PROJECT

The How and Why of Cost-Effectiveness Analysis (CEA) in Disease Control Priorities in Developing Countries

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“Best buys” and “Bad buys” defined by Cost-effectiveness ratios (CER)

- CERs apply to *interventions*, so DCP2 is organized around them. That means not starting with or emphasizing either:
- Diseases (which interventions combat) or
- Population groups (even if “vulnerable”)

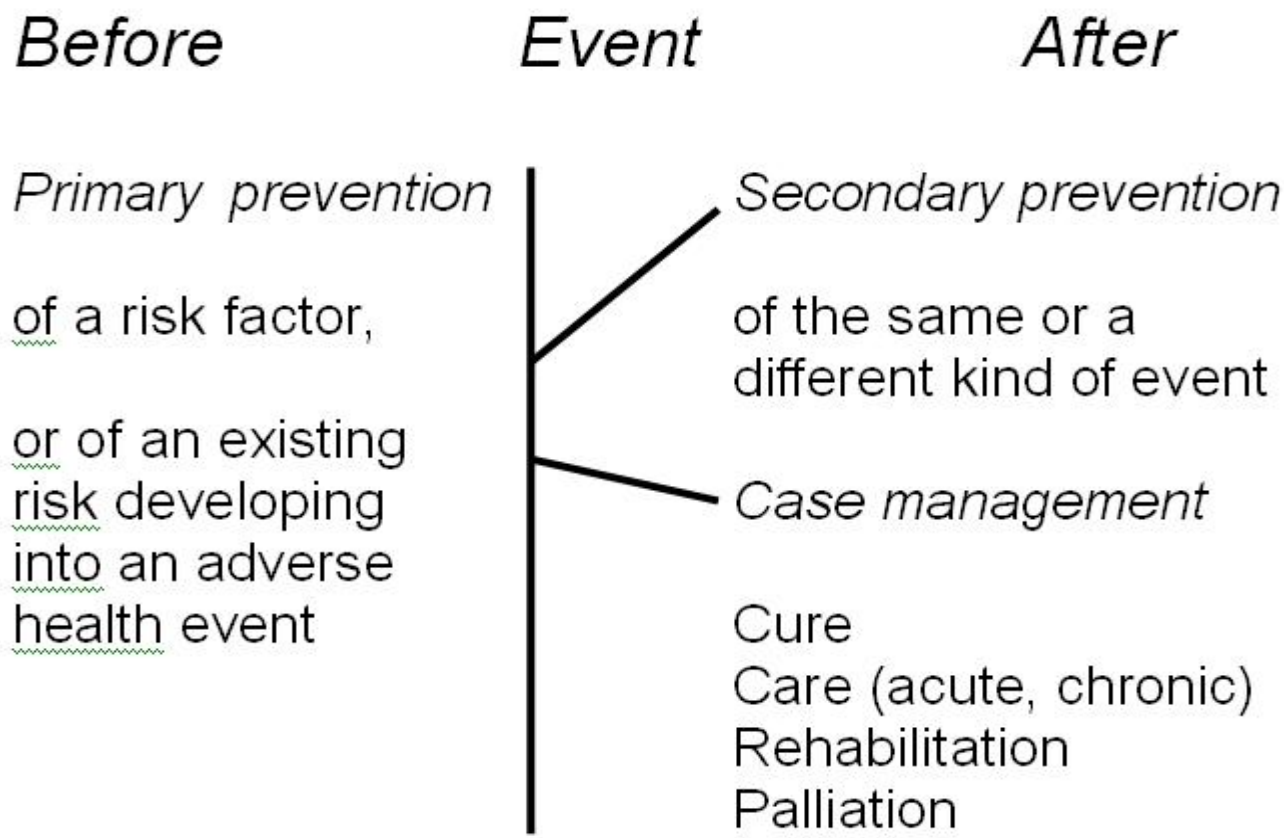
An ***intervention*** is a deliberate action, using one or more resources, intended to improve health, and not undertaken by the patient or beneficiary

To stop smoking is ***not*** an intervention

To make an effort to persuade people to stop smoking ***is*** an intervention

Interventions can:

- Come before, at the time of, or even long after an adverse health event (Figure from Box 15.1);
- Be applied to individuals ("personal") *or* Aimed at or delivered to populations ("population-based"); and
- Pursue one or more of many objectives (primary or secondary prevention, cure, care, rehabilitation, palliation)


Before
Event
After
Primary prevention
of a risk factor,
or of an existing risk developing into an adverse health event
Secondary prevention
of the same or a different kind of event
Case management
Cure
Care (acute, chronic)
Rehabilitation
Palliation

Examples: Cardiovascular disease a collection of specific adverse health events (heart attack, different kinds of stroke, hypertensive heart disease)

Several different interventions available for primary or secondary prevention and for acute management

Interventions can be defined, applied incrementally – one or several drugs

Table 2.B.1. Summary of Personal Interventions for Cardiovascular Disease

Condition	Intervention	Intervention setting	Objective	Target population	Cost-effectiveness (US$/DALY)	DALYs averted (hundreds)	Deaths averted
Ischemic heart disease	Aspirin, beta-blocker, and optional ACE inhibitor	District or referral hospital	Secondary prevention	Adults	688	8.40	—
Ischemic heart disease	Statin, with aspirin, beta-blocker and ACE inhibitor	District or referral hospital	Secondary prevention	Adults	2,028	3.54	—
Ischemic heart disease	Coronary artery bypass graft	Referral hospital	Secondary prevention	Adults	36,793	0.76	—
Myocardial infarction	Aspirin and beta-blocker	District or referral hospital	Acute management	Adults	14	1.04	—
Myocardial infarction	Streptokinase, with aspirin and beta-blocker	District or referral hospital	Acute management	Adults	671	1.04	—
Myocardial infarction	Tissue plasminogen activator, with aspirin and beta-blocker	District hospital	Acute management	Adults	15,869	0.42	—
Myocardial infarction and stroke	Polypill	District hospital	Secondary prevention	Adults	409	—	—
Stroke (ischemic)	Aspirin	Clinic or district hospital	Acute management	Adults over 15	149	1.62	0.12
Stroke (ischemic)	Heparin and recombinant tissue plasminogen activator	District hospital	Acute management	Adults over 15	1,977	1.22	1.70
Stroke (recurrent)	Aspirin and dipyridamole	Clinic or district hospital	Secondary prevention	Adults over 15	81	1.77	14.29
Stroke (recurrent)	Carotid endarterectomy	Referral hospital	Secondary prevention	Adults over 15	1,458	4.93	39.82
Stroke and ischemic and hypertensive heart disease	Polypill by absolute risk approach	District or referral hospital	Primary prevention	Adults	2,128	61.65	—

DALYs and deaths averted are for a 20 percentage point increase in intervention coverage in a hypothetical population of 1 million

Interventions aren't always medical--they can:

- ***Change*** how an intervention is delivered
- ***Improve*** the quality of the intervention
- ***Introduce or modify*** laws or regulations
- ***Impose*** economic incentives (prices, taxes, subsidies)

Examples: reducing the risks of coronary artery disease, ischemic heart disease, stroke, diabetes and traffic accidents by:

- Legislation or Regulation
- Media Campaigns (public education)
- Enforcement of Laws and Rules

Table 2.B.2. Summary of Population-based Interventions for CVD, Diabetes and Traffic Accidents

Condition	Intervention	Intervention setting	Target population[a]	Cost-effectiveness (US$/DALY)	DALYs averted[b] (hundreds)	Deaths averted[b]
Coronary artery disease	Legislation substituting 2% of trans fat with polyunsaturated fat at US$0.50 per adult	Policy level	Adults	48	—	—
Coronary artery disease	Legislation substituting 2% of trans fat with polyunsaturated fat at US$6 per adult	Policy level	Adults	838	—	—
Diabetes, ischemic heart disease, and stroke	Legislation with public education to reduce salt content	Policy level	All ages	1,937	18.73	—
Diabetes, ischemic heart disease, and stroke	Media campaign to reduce saturated fat	Policy level	All ages	2,617	13.86	—
Traffic accidents	Increased speeding penalties, enforcement, media campaigns, and speed bumps	Policy level	Adults	21	0.67	197.16
Traffic accidents	Enforcement of seatbelt laws, promotion of child restraints and random driver breath testing	Policy level	Adults	2,449	0.32	93.87

DALYs and deaths averted are for a 20 percentage point increase in intervention coverage in a hypothetical population of 1 million

- Cost: value of total resources used to *produce* the intervention (almost always actually *paid*; question of valuing when donated, volunteered or subsidized)

- Cost users incur to *consume* the intervention, whether paid (travel) or not (lost work time) not counted, because of problems of data and imputation

- Provider's or societal perspective

Few available studies actually measure costs; budget data generally inadequate

Consequence: modeling necessary—

C = S[P(rice) x Q(uantity)] of inputs

Q determined by technology, some variation (substitution) by setting

P known locally or estimated (by WHO/LSHTM) for standardized inputs

Prices in local currency converted to $

International (PPP) $ arguably better measure of real resource use;

but

Exchange rate $ better understood by decision-makers, corresponds to real allocation decisions

No difference, for imported (traded) inputs

Limitations of costing :

- Price estimates only regional
- Quantity estimates assume intervention produced properly (maybe not best practice, but good/standard practice)
- Variation with scale almost never known: ICER = ACER in most cases

Ideal: estimate CER starting from ***status quo*** — relevant for incremental decisions, does not imagine a clean slate, can include cost of adjusting capital stock

Actual: Given only one estimated CER, hard to say if starting from ***status quo*** differs from ***de novo*** introduction; but

Data from actual practice protect from errors of too-simple assumptions

Two kinds of exceptions—

Estimates of scale effects when universal coverage the objective: immunization

Estimates of ICER of one intervention given coverage of another for the same or related objective (ORT, hygiene, water supply, sanitation, etc. for control of diarrhea and other benefits)

e.g., Box 20.1, vaccine preventable diseases – marginal cost of a fully immunized child in Tamil Nadu, 1989-91 was $1.30 less than the average cost

e.g., Table 41.7, water and sanitation – public water source (well, standpipe) reduces diarrhea incidence by 17% compared to no improved sources; house connection for water reduces incidence by a further 63%

- Effectiveness is the health ***improvement*** due to the intervention, equal to the ***reduction*** in Burden of Disease

- Can be measured as prevention of: adverse health events (strokes, heart attacks); deaths from those events; loss of life-years

- Some non-fatal events hard to evaluate (burden unknown)

However :

Burden assumes universal (high) age- specific life expectancies in all regions, 80 years for men, 82.5 for women at birth; ***Discounting*** reduces years lost from death at each age

Effectiveness calculation assumes regional age-specific life expectancies

Effect of Discounting on Life Expectancies				
	Standard		Discounted at 3 %	
Age	Males	Females	Males	Females
0	80.00	82.50	30.31	30.53
5	75.38	77.95	29.86	30.12
15	65.41	68.02	28.65	29.00
30	50.51	53.27	26.01	26.59
45	35.77	38.72	21.93	22.90
60	21.81	24.83	16.01	17.51
70	13.58	16.20	11.15	12.83
80	7.45	8.90	6.67	7.81
90	3.54	4.25	3.36	3.99
100	1.46	2.00	1.43	1.94

Consequences:

- Regional CERs more realistic, given competing causes of ill health; ***but***
- Interventions appear unable to remove total burden even if 100% effective;
- Relatively better cost-effectiveness at later ages due to both discounting and use of regional life expectancies

Examples of cost-effectiveness results:

Medicine vs. surgery after myocardial infarction—preventing both events and deaths from them

Burden of sickle-cell disease—deaths and anemia burden estimated, other events not; only deaths counted in cost-effectiveness analysis of treatment

Table 33.4. Number of Deaths and CVD Events Prevented by the Use of a Four-Component Medical Regimen and CABG per 100,000 Myocardial Infarction Survivors over 10 Years, by Region

Region	Number of events prevented with four-component medical regimen compared with no therapy[a]				Number of incremental events prevented with CABG compared with medical therapy			
	IHD deaths averted	Stroke deaths averted	Myocardial infarctions prevented	Strokes prevented	IHD deaths averted	Stroke deaths averted	Myocardial infarctions prevented	Strokes prevented
East Asia and the Pacific	1,900	104	4,077	209	79	11	248	22
Europe and Central Asia	1,990	89	3,964	179	83	1	294	7
Latin America and the Caribbean	**1,913**	**83**	**4,040**	**118**	**62**	**4**	**258**	**18**
Middle East and North Africa	1,908	95	4,294	118	62	1	296	22
South Asia	1,930	97	4,043	122	34	2	275	30
Sub-Saharan Africa	1,909	91	4,233	173	69	12	254	1

Source: Authors' calculations.

a. Aspirin, atenolol, enalapril, and lovastatin.

Table 34.2. Burden of Sickle Cell Disease by Age Group, Assuming 1,000 Births per Year and Survival to Various Ages, Jamaica, Starting in 1973

Category	Age group (years) 0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	Total or average
Number of survivors	876	834	807	777	727	680	627	564	491	440	682.3
Number of deaths	124	42	27	30	50	47	53	63	73	51	560
Death rate (percent/year)	2.61	0.98	0.66	0.75	1.32	1.33	1.61	2.10	2.73	2.17	1.63
Number of DALYs lost/death	28.90	28.59	27.77	26.84	25.82	24.69	23.43	22.00	20.39	18.58	24.70
Total DALY losses from deaths	3,584	1,201	750	805	1,291	1,161	1,242	1,386	1,488	948	13,856
Number of DALYs lost from background (chronic) anemia	188	171	164	158	150	141	130	119	106	93	1,420
Total DALYs lost from deaths and chronic anemia	3,772	1,372	914	963	1,441	1,302	1,372	1,505	1,594	1,041	15,276
Number of pain crises/year	242.7	381.0	383.8	584.4	866.7	600.5	523.6	473.4	309.6	182.2	4,548
Number of other acute clinical events	77.5	22.2		182.2							281.9
Number of other chronic clinical events	49.8	14.8	12.8	10.9							88.3

Source: Authors' calculations based on Hambleton 2004a, 2004b.

Table 34.6. Cost-Effectiveness of Penicillin Prophylaxis for Sickle Cell Disease Detected by Newborn Screening, Jamaica

Category	Monthly injection	Daily oral dose	Total/1,000 children
Monthly cost of penicillin (J$)	22	250	26,560
Nurse's time, 10 minutes/month (J$)	90	n.a.	88,200
Clinician's time, 20 minutes 4–6 times/year (J$)	152.67–229.00	152.67–229.00	152,670–229,000
Total year 1, 8 treatments (J$)	2,117–2,728	3,221–3,832	2,140,000–2,750,000
Total, each of years 2–4, 12 treatments (J$)	3,176–4,092	4,832–5,748	3,210,000–4,130,000
Discounted total (discount rate of 3 percent), first 4 years	11,101–14,303	16,889–20,091	11,220,000–14,420,000
Equivalent in U.S. dollars[a]			
US$1 = J$49.8	223–287	339–407	220,000–290,000
US$1 = J$59.8	186–239	282–336	190,000–240,000
Number of deaths averted by prophylaxis	0.024/child	0.024/child	24 deaths
Costs per death averted (US$)	7,750–11,958	11,750–16,958	7,830–12,058
Costs per DALY gained (US$)	267–412	405–585	270–416

Source: Authors' calculations based on data from Hambleton 2004a, 2004b.
Note: n.a. = not applicable. The results are based on a cohort study of 315 cases.
a. Two exchange rates are shown because the exchange rate changed during the course of the study.

Doesn't the Burden of Disease matter directly? (apart from how reductions in it affect intervention effectiveness)

"Target major causes of death..." etc.

Size of Burden→Total Cost of Supplying an Intervention to Everyone needing it →Whether that is Affordable.

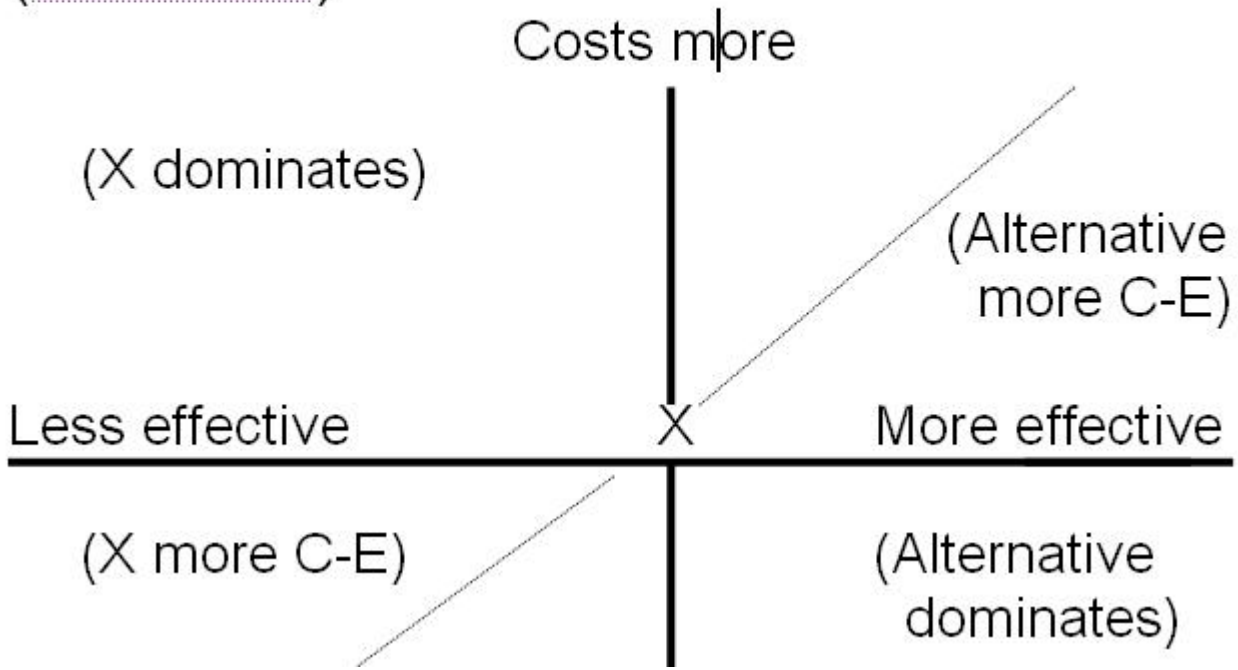
So Burden matters, interacting with CE

One intervention *dominates* another if it is both more effective and cheaper;

Choices about cost-effectiveness have to be made when the intervention that is more effective also costs more, or the cheaper one is also less effective

Doing nothing costs nothing and has no effect, so doing something means a choice about acceptable cost and effect

Alternatives compared to intervention X (Box 15.2)



Can't define a threshold for cost-effectiveness, independent of the Burden of Disease and available resources (diagonal in Box 15.2 a *choice*, not uniform or pre-determined)

$ /DALY $\leq$ GDP per capita,

$/death averted $\leq$ VSL, or any such line

Is not just arbitrary but ignores costs and scale of interventions

CEA concerns ratios, not differences—no comparison as >, < zero

Major distinction with cost-benefit analysis (CBA) which concerns differences—valid when both C and B real amounts, less so when B is only attributed

CEA demands less attribution than CBA

What other considerations matter?

At least 8 other criteria affect priority:

Vertical equity, Horizontal equity, Poverty, Catastrophic cost, Public goods, Externalities, Rule of Rescue, and Public demands

Any of these may be inconsistent with cost-effectiveness

So why emphasize cost-effectiveness?

Inappropriate criterion for an individual paying own way—wants interventions only for own health problems, better CERs for other problems irrelevant

Not utility-maximizing--savings from better CER not applied to health of others but to other uses for self (value of health vs. other uses for money)

Strictly a social criterion:

Obvious for comparing different interventions for the ***same*** outcome (just cost-minimizing)

Still useful for different outcomes of the same ***kind*** (health only—common unit)

Can't compare outcomes of ***different*** kinds (health vs. education vs. roads)

CEA tells whether intervention is (relatively) worth doing—*value for money*

Does not say who should do it*; or*

Who should pay for it

Distributional assumptions built in
(all life-years, DALYs or QALYS equal)

Is CEA itself worth doing? criticisms—

Conclusions obvious, recommended (save newborns, immunize, improve obstetric care, hand out bednets, kill mosquitoes, treat STDs, use DOTs)

Best practice and cost unknown; CEA helps with scaling up, choices among interventions (HIV, malaria, injuries), coping with new threats (CVD, diabetes)

Example: choice among interventions with objectives related in sequence--

reducing vehicular crashes and their health consequences

Can intervene at three stages

Can intervene on any of three factors

Look for simple, self-enforcing interventions if system capacity limited

Table 39.2. The Haddon Matrix as Applied to Road Traffic Injuries

		Factors		
Phase	**Nature of intervention**	**Human**	**Vehicles and equipment**	**Environment**
Precrash	Crash prevention	Information Attitudes Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed management	**Road design** **Road layout** Speed limits Pedestrian facilities
Crash	Injury prevention during crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash-protective design	Forgiving roadside (for example, crash barriers)
Postcrash	Life sustaining	First-aid skill Access to medical personnel	Ease of access Fire risk	Rescue facilities Congestion

Source: Authors.

Table 39.5. Annualized Costs and DALYs averted for an Intervention to Build Speed Bumps for the Top 10 Percent of the Most Lethal Junctions in a City of 1 Million, by Region

Region	Cost to intervene in population of 1,000,000 for 1 year[a] (2001 US$)	Present value of annual DALYs averted		Cost per DALY averted (2001 US$)	
		Discounted at 3 percent per year	Discounted at 6 percent per year	Discounted at 3 percent per year	Discounted at 6 percent per year
East Asia and the Pacific	725	167	105	4.34	6.89
Europe and Central Asia	708	158	99	4.48	7.11
Latin American and the Caribbean	**299**	**147**	**92**	**2.04**	**3.23**
Middle East and North Africa	1,070	238	150	4.49	7.12
South Asia	324	168	106	1.93	3.06
Sub-Saharan Africa	498	220	151	2.26	3.30

Source: Authors' calculations.

a. Costs do not include cost offsets from prevented medical care and prevented vehicle repair.

Countries already trying most of these interventions, facing finance constraints

Often at too small scale; very often with poor quality, organization, results; CEA can show quality improvements, cost-savings vs. status quo or (nearly) cost-free gains in outcomes; a little extra rationality can't hurt, even if moves only to 2nd- or 3rd-best (TEHIP: $ ~ burden); how to do, not only what to do

Too much of “would be good if--” advice that country’s health systems are just too dysfunctional to follow; ideal the enemy of the not so bad

Use CEA to set standards for cost and outcome, or find better ones; emphasize systemic interventions, not only medical ones; find out why so dysfunctional; combine CE advice with own knowledge and views about equity, poverty, needs

Not related to or helpful for existing Bank practices and promises: added criteria and pressures, diversion from already exacting demands

CEA highly relevant to meeting MDGs, also a valid critique of concentrating so much on them; ill health→productivity loss, poverty, financial ruin, so CEA of intervention→net cost-saving or point to greater capacity to pay for health care

Far too little data, too much guesswork for results to be persuasive, conclusive

Ignore small differences in CERs, look at orders-of-magnitude; supply local data to fill holes or improve on imputed values; use concept of CE even when numbers have errors or wide confidence intervals; value is conceptual as well as quantitative, especially where little tradition of any economic analysis

Not a general solution to development problems, allows choices only in one sector, doesn't maximize overall welfare

Amen: but portable, accurate, reliable, inter-person comparable utilometer not invented yet; all choices among goods, people, sectors, intervals, generations, values difficult; CEA and DCPP results in general a partial but real help; health crucially important to development