Types of Economic Evaluation in Healthcare

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Healthcare Evaluation

Are both costs and outcomes of alternatives assessed?

Is the comparison of two or more alternatives

	No		Yes
No	Examines only outcomes	Examines only costs	
	Partial evaluation • Outcome description	**Partial evolution** • Cost of Illness	**Partial evaluation** • Cost-outcome description
Yes	**Partial evaluation** • Efficacy (Outcomes) analysis	**Partial evaluation** • Cost analysis	**Full economic evaluation** • Cost-Consequences Analysis • Cost-Minimization Analysis • Cost-Effectiveness Analysis • Cost-Utility Analysis • Cost-benefit Analysis

Adapted from Drummond et al. Methods of Economic Evaluation in Healthcare (2006)

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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.

Cost-Consequences Analysis (CCA)

- Systematic description and measurement of a set of intervention attributes that should be considered when making a decision
- Does not prescribe a decision rule
- Provides information to decision maker in a simple disaggregated format and decision maker must make their own choice
  - Akin to everyday attribute-specific decision making
- Disadvantage is that weighting of different attributes is left to individual decision makers
  - Increases welfare of decision maker
  - But decision by individual might not be in the best interest of patients or society

Cost-Consequences Analysis—Example

ORIGINAL RESEARCH ARTICLE

Pharmacoeconomics 1999; 15 Suppl. 1: 23-37
1170-7690/99/0001-0023/$07.50/0

A Prospective Cost-Consequence Analysis of Adding Lamivudine to Zidovudine-Containing Antiretroviral Treatment Regimens for HIV Infection in the US

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Lacey et al. (Results)

Additional costs and consequences of managing 100 patients (time horizon = trial period)

	Placebo	Lamivudine	Difference
Costs			
Total costs ($US * 100)	$531,200—$630,700	$568,300—$595,400	-$35,300—+$37,100
In-patient costs	$457,200—$556,600	$270,300—$297,500	-$186,900—-$259,100
Outpatient costs	$5,600	$4,200	-$1,400
Medications costs	$56,400	$52,500	-$3,900
Lamivudine costs	$12,000	$241,300	+$229,300
Progression			
Disease progression	20	9	-11
No. of HIV-related events	68	41	-27
Deaths	6	3	-3
Resource use			
Patient admissions	11	6	-5
Additional OP visits	15	10	-5
Prescribed medication	43	30	-13

Cost-Minimization Analysis (CMA)

- Cost-minimization analysis is used when outcomes are equal or assumed to be equal (owing to outcomes being roughly identical)
- Historically recommended for economic evaluations of trials showing no statistical significance in effectiveness
- Conduct separate and sequential hypothesis tests on costs and effects to determine whether incremental cost-effectiveness is necessary
- Advantage
  - Simple and easy to interpret
- Disadvantages
  - No longer considered by many to be "valid" (2001 paper by Briggs and O'Brien—Death of CMA) and omitted from seminal text (Drummond et al. (2006)) as a type of economic evaluation
  - Argument is that researchers should do CEA and estimate joint density of costs and effects and examine uncertainty regardless of whether there is a statistically significant difference in effectiveness

Cost-Minimization Analysis—Example

BMC Health Services Research

BioMed Central

Research article

Open Access

Potential impact of task-shifting on costs of antiretroviral therapy and physician supply in Uganda

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Impact of Task Shifting

Table 3: Per visit and annual costs of antiretroviral therapy follow-up for different types of health workers at the Infectious Diseases Institute clinic, Kampala, Uganda from a societal perspective

Health worker type	Cost per visit ($)	Number of visits per year			Annual societal cost of follow-up ($)		
		PF	NF	PWF	PF	NF	PWF
Physician	2.51	12	2	2	30.12	5.02	5.02
Triage	1.68	12	12	4	20.16	20.16	6.72
Nurse	0.98	0	10	2	0	9.80	1.96
Regular PW	0.80	12	12	4	9.60	9.60	3.20
Refill PW	0.22	0	0	8	0	0	1.76
Total	--	--	--	--	59.88	44.58	18.66

PW--Pharmacy Worker, PF--Physician Intensive Follow-up, NF--Nurse Intensive Follow-up, PWF--PW-intensive follow-up

Table 4: Per visit and annual costs of antiretroviral therapy follow-up for different types of health workers at the Infectious Diseases Institute clinic, Kampala, Uganda from a ministry of health perspective

Health worker type	Cost per visit ($)	Number of visits per year			Annual payer cost of follow-up ($)		
		PF	NF	PWF	PF	NF	PWF
Physician	1.18	12	2	2	14.16	2.36	2.36
Triage	1.12	12	12	4	13.44	13.44	4.48
Nurse	0.74	0	10	2	0	7.40	0.94
Regular PW	0.34	12	12	4	4.08	4.08	1.36
Refill PW	0.17	0	0	8	0	0	1.36
Total	--	--	--	--	31.68	27.28	10.5

PW--Pharmacy Worker, PF--Physician Intensive Follow-up, NF--Nurse Intensive Follow-up, PWF--PW-intensive follow-up

Cost Effectiveness Analysis

- Outcomes are measured in "natural units"
  - The outcomes are usually clinically relevant e.g. life-years, mm Hg for BP, HbA1c for diabetes, etc.
- Examines the costs of alternative approaches to achieving a specific (health) objective.
  - Can be used to compare interventions to achieve the same outcomes e.g. the same clinical indication
- Identifies the least cost way of achieving the objective to see how both cost and choice of technique vary as the magnitude of the objective varies.
- Advantages are ease of communication and specificity.
- Disadvantage is lack of ability to compare interventions across the health sector i.e., costs can be compared but outcomes cannot.

Cost-Effectiveness Analysis—Example

OPEN ACCESS Freely available online

PLoS one

Cost Effectiveness of a Pharmacy-Only Refill Program in a Large Urban HIV/AIDS Clinic in Uganda

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Abstract

Background: HIV/AIDS clinics in Uganda and other low-income countries face increasing numbers of patients and workforce shortages. We performed a cost-effectiveness analysis comparing a Pharmacy-only Refill Program (PRP), a form of task-shifting, to the Standard of Care (SOC) at a large HIV/AIDS clinic in Uganda, the Infectious Diseases Institute (IDI). The PRP was started to reduce workforce shortages and optimize patient care by substituting pharmacy visits for SOC involving monthly physician visits for accessing antiretroviral medicines.

Methodology/Principal Findings: We used a retrospective cohort analysis to compare the effectiveness of the PRP compared to SOC. Effectiveness was defined as Favorable Immune Response (FIR), measured as having a CD4 lymphocyte count of over 500 cells/μl at follow-up. We used multivariate logistic regression to assess the difference in FIR between patients in the PRP and SOC. We incorporated estimates of effectiveness into an incremental cost-effectiveness analysis performed from a limited societal perspective. We estimated costs from previous studies at IDI and conducted univariate and probabilistic sensitivity analyses. We identified 829 patients, 578 in the PRP and 251 in SOC. After 12.8 months (PRP) and 15.1 months (SOC) of follow-up, 18.9% of patients had a FIR, 18.6% in the PRP and 19.6% in SOC. There was a non-significant 9% decrease in the odds of having a FIR for PRP compared to SOC after adjusting for other variables (OR 0.93, 95% CI 0.55–1.58). The PRP was less costly than the SOC (US$ 520 vs. 655 annually, respectively). The incremental cost-effectiveness ratio comparing PRP to SOC was US$ 13,500 per FIR. PRP remained cost-effective at univariate and probabilistic sensitivity analysis.

Conclusion/Significance: The PRP is more cost-effective than the standard of care. Similar task-shifting programs might help large HIV/AIDS clinics in Uganda and other low-income countries to cope with increasing numbers of patients seeking care.

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Results—Cost Effectiveness Analysis

Table 3. Mean and incremental costs, probability of CD4 cell count over 500 cell/ul at 1 year and cost-effectiveness comparing PRP and standard care in patients on antiretroviral treatment at the IDI clinic, Kampala, Uganda.

	Societal Cost*(US$)	Inc.	Healthcare Cost*	Inc.	Probability of FIR	Inc.	Limited Societal ICER (US$/FIR)	MoH ICER (US$/FIR)
SOC	655	–	610	–	0.196	–	–	
PRP	520	−135	496	−114	0.186	−0.010	13,500	11,400

Inc. – Incremental; ICER: Incremental Cost-Effectiveness Ration; FIR – Favorable Immune Response; PRP: Pharmacy-Only Refill Program; SOC – Standard of Care.
*All costs are per person per year.
doi:10.1371/journal.pone.0018193.t003

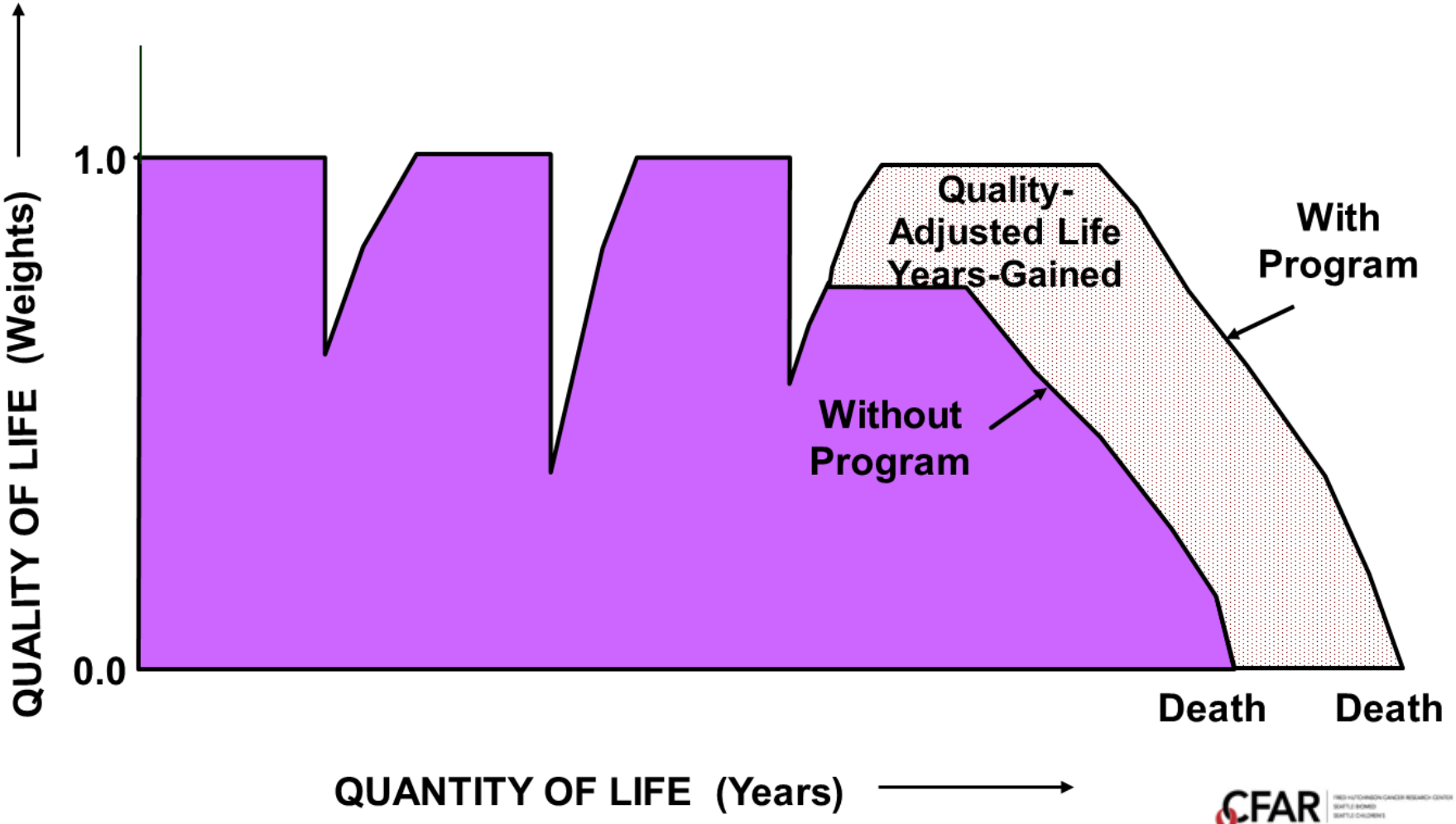
Interpretation

The PRP results in one less FIR for an additional saving of $13,500 from the societal perspective or $11,400 from the MoH (Governmental) perspective

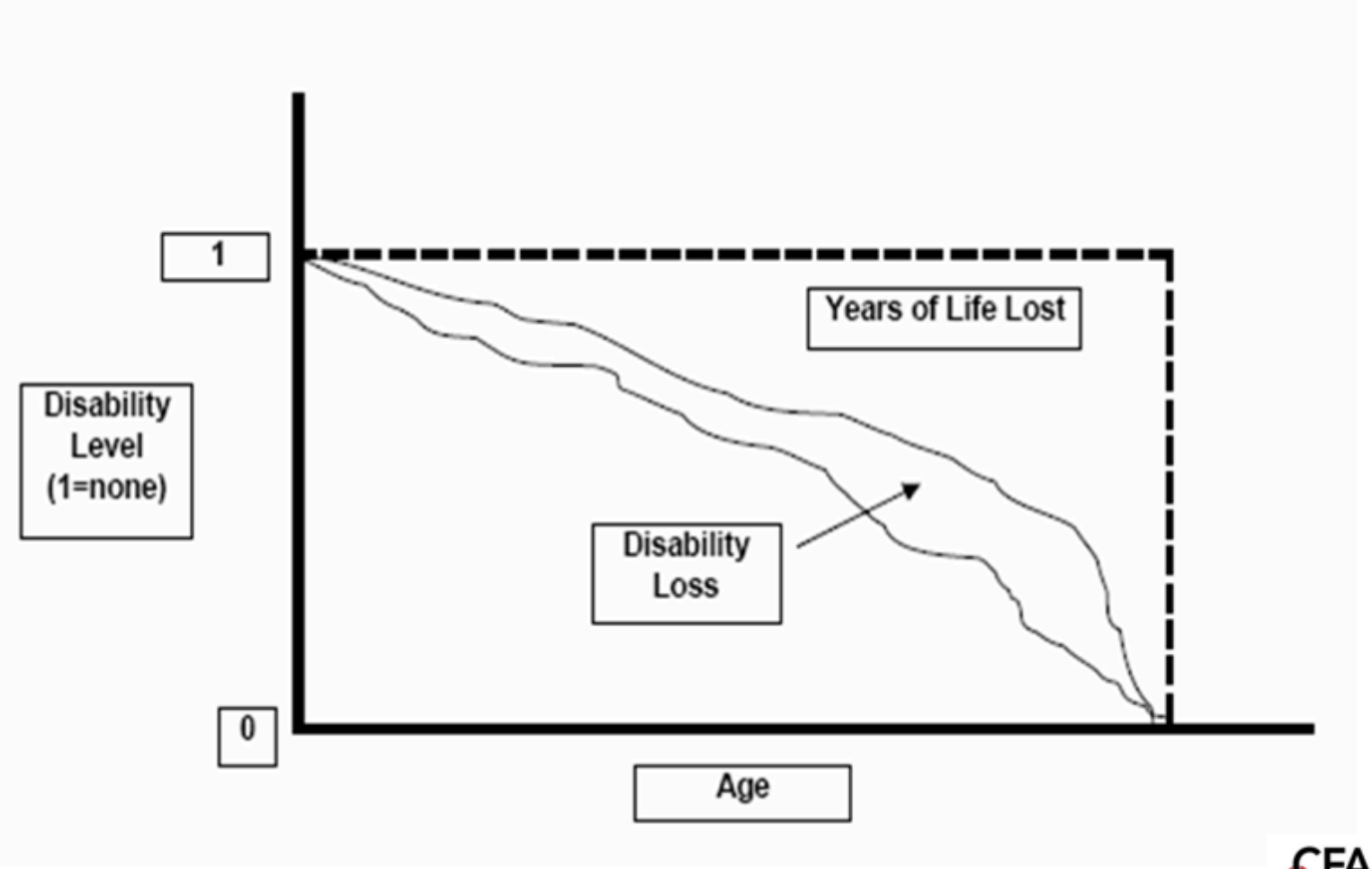
Cost-Utility Analysis (CUA)

- Uses a non-financial common metric that allows comparisons across the health sector i.e., can compare different drugs or technologies
- Metric is a combination of length of life and quality of life
  - Quality-adjusted life-year (QALY)
  - Disability-adjusted life-year (DALY)
- CUAs may not capture inter-health sector comparisons completely
  - Some health interventions have other outcomes which must be explicitly listed as inputs to the decision-making process
- CUAs require studies to estimate **utility** (for QALY measurement) or **disability weights** (for DALY measurement)
- There are many theoretical controversies and measurement issues in this field, but QALYs are generally seen as a reasonable, practical measure of utility to the patient.

QALYs Gained by Health Intervention



QALYs gained vs. DALYs averted



Cost-Utility Analysis Example

ORIGINAL RESEARCH ARTICLE

Pharmacoeconomics 2009; 27 (11): 963-973
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Cost Effectiveness of Facility-Based Care, Home-Based Care and Mobile Clinics for Provision of Antiretroviral Therapy in Uganda

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Abstract

Background: Stakeholders in HIV/AIDS care currently use different programmes for provision of antiretroviral therapy (ART) in Uganda. It is not known which of these represents the best value for money.

Objective: To compare the cost effectiveness of home-based care (HBC), facility-based care (FBC) and mobile clinic care (MCC) for provision of ART in Uganda.

Methods: Incremental cost-effectiveness analysis was performed using decision and Markov modeling of adult AIDS patients in WHO Clinical Stage 3 and 4 from the perspective of the Ugandan healthcare system. The main outcome measures were cost (year 2008 values), life expectancy in life-years (LY) and the incremental cost-effectiveness ratio (ICER) measured as cost per QALY or LY gained over 10 years.

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Results

Table II. Mean and incremental costs ($US, year 2008 values), life expectancy (LE) and cost effectiveness for provision of antiretroviral therapy (ART) in Uganda

Programme[a]	Cost	Incremental cost	LE (y)	Incremental LE (y)	ICER ($US/LY)	QALYs	Incremental QALYs	ICER ($US/QALY)	10-year survival (%)
FBC	3212		3.6			2.3			8.4
MCC	4782	1569	4.3	0.7	2241	2.9	0.6	2615	14.9
HBC	7033	2251	5.3	1.0	2251	3.7	0.8	2814	22.9

a The methods of ART provision are ordered by increasing effectiveness.

FBC = facility-based care; **HBC** = home-based care; **ICER** = incremental cost-effectiveness ratio; **LY** = life-year; **MCC** = mobile clinic care.

- FBC appears to be the most cost-effective program for provision of ART in Uganda.
- The analysis supports the implementation of FBC for scale-up and sustainability of ART in Uganda.
- HBC and MCC would be competitive only if there is increased access, increased adherence or reduced cost.

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Cost-Utility Analysis Example

Evaluating the cost-effectiveness of combination antiretroviral therapy for the prevention of mother-to-child transmission of HIV in Uganda

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Objective To model the cost-effectiveness in Uganda of combination antiretroviral therapy (ART) to prevent mother-to-child transmission of human immunodeficiency virus (HIV).

Methods The cost-effectiveness of ART was evaluated on the assumption that ART reduces the risk of an HIV-positive pregnant woman transmitting HIV to her baby from 40% (when the woman is left untreated) to 25.8%, 17.4% and 3.8%, respectively, when the woman is given: (i) single-dose nevirapine (at an estimated total drug cost of 0.06 United States dollars [US$]); (ii) dual therapy with zidovudine and lamivudine for 7 weeks (at a total drug cost of US$ 15.63); or (iii) ART for 18 months (at a total annual cost of US$ 469.77). Lifetime ART (US$ 6883), recommended for pregnant women with < 350 CD4+ T lymphocytes per mm^3, was assumed to give the same reduction in transmission risk in each subsequent pregnancy.

Findings Compared with single-dose nevirapine, dual therapy and no therapy, 18 months of ART averted 5.21, 3.22 and 8.58 disability-adjusted life years (DALYs), respectively, at a cost of US$ 46, US$ 99 and US$ 34 per DALY averted. The corresponding figures for lifetime ART are, respectively, 19.20, 11.87 and 31.60 DALYs averted, at a cost of US$ 205, US$ 354 and US$ 172 per DALY averted.

Conclusion In Uganda, ART appears highly cost-effective for the prevention of mother-to-child HIV transmission, even if continued over the patients' lifetimes. Given the additional public health benefits of ART, efforts to ensure that all HIV-positive pregnant women have access to lifelong ART should be intensified.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Results

Table 2. **Results from four models used to evaluate the incremental cost-effectiveness of combination antiretroviral therapy (ART) in Uganda relative to other treatment regimens or none, 2011**

Variable	Model					
	1a: 18-month ART, relative to		1b: lifetime ART, relative to		2a: 18-month ART, relative to NT	2b: lifetime ART, relative to NT
	sdNVP	DT	sdNVP	DT		
Cost difference per patient (US$)	482	467	4817	4747	689	6883
Cost offset per patient (US$)	240	148	884	547	395	1455
Incremental cost per patient (US$)[a]	242	318	3933	4200	294	5428
DALYs averted per patient	5.21	3.22	19.20	11.87	8.58	31.60
Incremental cost per DALY averted (US$)	46	99	205	354	34	172

DALY, disability-adjusted life year; DT, dual therapy; NT, no treatment; sdNVP, single-dose nevirapine; US$, United States dollar.
[a] Calculated by subtracting the cost offset from the cost difference.

- In Uganda, ART appears highly cost-effective for the prevention of mother-to-child HIV transmission, even if continued over the patients' lifetimes.
- Given the additional public health benefits of ART, efforts to ensure that all HIV-positive pregnant women have access to lifelong ART should be intensified.

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Cost-Benefit Analysis (CBA)

- Places monetary values on inputs (costs) and outcomes thereby allowing comparison of projects (or interventions or investments) across the entire economy.
- The practical difficulty of monetary valuation of benefits and the fundamental problem in health of placing a dollar value on human life (or other health outcomes) limit the use of CBA.
- CBA allows the assessment of intrinsic value i.e., if benefits exceed costs the intervention is worth doing (ignoring deadweight loss from taxation and fiscal constraints).
- CBA results can indicate intervention desirability independently of a comparison to alternatives (other economic evaluation methods cannot).

Monetary Valuation of Health Benefits

- Given good markets for products or labor, benefits and costs can be assessed in monetary terms using market prices
- In health sector, market prices are often lacking so questions in surveys can be used to estimate hypothetical willingness-to-pay (contingent valuation).
- Two problems of contingent valuation in healthcare suggest caution: tendency for individuals to systematically underestimate risks and ignorance about intervention effectiveness
- Alternative human capital approach estimates the effect of a health intervention on productivity
- Other method is value of a statistical life (VSL) — from the applied welfare economist's perspective, valuing a saved life means finding the amount of money that someone is willing to accept for the extra risk involved with an activity that might, with a specified probability, lead to death

Cost-Benefit Analysis—Example

HEALTH ECONOMICS
Health Econ. **19**: 154–172 (2010)
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A SOCIAL COST–BENEFIT CRITERION FOR EVALUATING VOLUNTARY COUNSELING AND TESTING WITH AN APPLICATION TO TANZANIA

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SUMMARY

Rationale: There are many interventions for HIV/AIDS that require that people know their status and hence require a HIV test. Testing that is driven by a desire to prevent the spread of the disease often has an indirect effect on others. These external effects need to be identified, quantified and included as part of the benefits and costs of testing. Pioneering analyses of HIV testing by Philipson and Posner have introduced the economic calculus of individual expected benefits and costs of activities into an understanding of the HIV epidemic. What is required for social evaluations is an extension of the analysis to ensure that external effects are included.

Objectives: The objective of this paper is two-fold. First we seek to formulate cost–benefit criteria that incorporate fully the external effects in the evaluation of Voluntary Counseling and Testing (VCT). We achieve this by recasting the individual calculus of benefits and costs to a couple setting. We can then compare an individual's cost–benefit analysis of being tested with social criteria that look at outcomes from a couple's perspective for both separate and dual/joint testing. Second we aim to apply our social criteria to VCT programs as they currently operate in Tanzania and how these programs might operate in the future when they are scaled up to relate to the general population.

Methodology: We develop social criteria for evaluating separate and dual VCT using a couple's perspective with and without altruism. Therefore, the welfare function is based on two individual expected utility functions viewed as a couple, either married or regular partners. The benefits are the averted lives lost whenever discordant couples are revealed. The costs of VCT are the benefits of unprotected sex that the couple foregoes and the costs of the testing and counseling. The cost–benefit criteria are applied to VCT programs in Tanzania. The four main ingredients estimated are: the foregone benefit of unprotected sex (measured by the compensated wage differentials charged by commercial sex workers); the probability of infection; the cost of an infection (measured by both the value of a statistical life and the human capital approaches) and the cost of a single test (which includes behavior-modifying counseling).

Conclusions: We find separate testing in existing VCT programs to be only marginally worthwhile. However, in scaled-up programs the benefit–cost ratio is over three. Dual testing is always more beneficial than separate testing. However, this advantage is reduced in scaled-up programs. VCT should be greatly expanded throughout Tanzania as future returns would be even higher for both separate and joint counseling and HIV testing.

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KEY WORDS: cost–benefit analysis; social welfare and externalities; Voluntary Counseling and Testing; HIV policy; Tanzania

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Methods

- Interventions
  - Current VCT and Scaled-Up VCT
  - Separate testing vs. couple testing
- Costs
  - Benefits of unprotected sex (measured by the compensated wage differentials charged by commercial sex workers)
  - Costs of VCT (including behavior modification counselling)
- Monetized benefits
  - Averted lives lost whenever discordant couples are revealed (product of the probability of infection and cost of infection measured as the VSL and human capital approaches

Results

Table II. Cost–benefit outcomes for separate VCT testing, Tanzania 1997–2001

	Existing VCT program ($p = 0.708$)				Scaled-up VCT program ($p = 0.070$)			
	(1) $C = 23.4$, $B = 3.3$	(2) $C = 4.1$, $B = 3.3$	(3) $C = 23.4$, $B = 1.7$	(4) $C = 4.1$, $B = 1.7$	(5) $C = 23.4$, $B = 3.3$	(6) $C = 4.1$, $B = 3.3$	(7) $C = 23.4$, $B = 1.7$	(8) $C = 4.1$, $B = 1.7$
Total VCT costs $N^{T+T'}[K]$	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1
Total foregone benefits $N^{T+T'}[p(2B)]$	16 796.4	16 796.4	8398.2	8398.2	1660.7	1660.7	830.3	830.3
Total costs = VCT costs+foregone benefits	16 892.5	16 892.5	8494.3	8494.3	1756.7	1756.7	926.4	926.4
Number of lives lost averted $N^{T}[p(1-p)]$	741.4	741.4	741.4	741.4	233.4	233.4	233.4	233.4
Benefits per person $[C]$	23.4	4.1	23.4	4.1	23.4	4.1	23.4	4.1
Total benefits $N^{T}[p(1-p)C]$	17 313.9	3039.7	17 313.9	3039.7	5452.0	957.2	5452.0	957.2
Benefit–cost ratio	1.03	0.18	2.04	0.36	3.10	0.54	5.89	1.03

Table III. Cost–benefit outcomes for dual VCT testing, Tanzania 1997–2001

	Existing VCT program ($p = 0.708$)				Scaled-up VCT program ($p = 0.070$)			
	(1) $C = 23.4$, $B = 3.3$	(2) $C = 4.1$, $B = 3.3$	(3) $C = 23.4$, $B = 1.7$	(4) $C = 4.1$, $B = 1.7$	(5) $C = 23.4$, $B = 3.3$	(6) $C = 4.1$, $B = 3.3$	(7) $C = 23.4$, $B = 1.7$	(8) $C = 4.1$, $B = 1.7$
Total VCT costs $2N^{T+T'}[K]$	192.2	192.2	192.2	192.2	192.2	192.2	192.2	192.2
Total foregone benefits $N^{T+T'}2[p(1-p)(2B)]$	9809.1	9809.1	4904.5	4904.5	3088.8	3088.8	1544.4	1544.4
Total costs = VCT costs+foregone benefits	10 001.2	10 001.2	5096.7	5096.7	3281.0	3281.0	1736.6	1736.6
Number of lives lost averted $N^{T}2[p(1-p)]$	1482.7	1482.7	1482.7	1482.7	466.9	466.9	466.9	466.9
Benefits per person $[C]$	23.4	4.1	23.4	4.1	23.4	4.1	23.4	4.1
Total benefits $N^{T}2[p(1-p)C]$	34 627.8	6079.5	34 627.8	6079.5	10 904.1	1914.4	10 904.1	1914.4
Benefit–cost ratio	3.46	0.61	6.79	1.19	3.32	0.58	6.28	1.10

- Separate testing in existing VCT programs is only marginally worthwhile
- Scaled-up programs are cost-beneficial (have benefit–cost ratio of over three)
- Dual testing is always more beneficial than separate testing but this advantage is reduced in scaled-up programs
- VCT should be greatly expanded throughout Tanzania as future returns would be even higher for both separate and joint counseling and HIV testing

Thanks Very Much

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