

Data sources and resources for modeling cost-effectiveness of HIV interventions

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Outline

- Data needed for a cost-effectiveness analysis (CEA)
- Sources of data
- Limitations of data sources
- Software for CEA
- Types of models
- Previously developed modeling tools

Motivating example: What is the most cost-effective method to promote voluntary male circumcision in Uganda (Linkages study)?

- **Target population:** HIV- uncircumcised men ages 18-49
- **Options:**
 1. Healthcare worker MC promotion at time of HIV test
 2. Healthcare worker promotion plus SMS follow-up encouraging MC within 1 month
 3. Healthcare worker promotion plus follow-up at 1 and 2 months to encourage MC and address barriers to uptake
- Option 3 may be the most effective but it is likely to incur the most costs.

[Some of the] **Data needed for analysis:**

- Effectiveness of each intervention
- Prevalence of HIV in Uganda, current uptake of MC, ART coverage
- Sexual behavior, age-structure of the population, background mortality rate.
- Costs of interventions and standard of care (ie MC procedure, HIV testing, ART, hospitalization)
- Costs averted by preventing future cases of HIV through MC

Data sources:

- **Published peer-reviewed data**
 - Specific clinical trial or cohort (single study evidence)
 - Literature reviews (e.g. Pubmed): Examine evidence from multiple studies
 - Meta-analyses: pooled evidence from multiple studies
 - Systematic reviews: highest quality reviews or meta analyses
 - Cochrane Collaboration, Cochrane library
- **Ongoing study data**
 - Current clinical trial or cohort study
- **Unpublished data**
 - In country expert opinion
 - Ministry of Health
- **NGO reports**
 - UNAIDS, WHO life tables, WHO-CHOICE website, International drug price indicator Guide, Clinton Health Access Initiative (ART prices)

Published sources:

- Costs of MC, HIV/AIDS treatment, and OIs

The cost of providing comprehensive HIV treatment in PEPFAR-supported programs

Nicolas A. Menzies^{a,b}, Andres A. Berruti^{a,b}, Richard Berzon^c,
Scott Filler^a, Robert Ferris^c, Tedd V. Ellerbrock^a
and John M. Blandford^a

Medical male circumcision for HIV/AIDS prevention in Uganda – the cost of disposable versus re-usable circumcision kits

Trop Doct January 2012 42: 5-7,

HIV prevention costs and program scale: data from the PANCEA project in five low and middle-income countries

Elliot Marseille^{*1}, Lalit Dandona², Nell Marshall¹, Paul Gaist³,

- HIV transmission rates

HIV-1 transmission among HIV-1 discordant couples before and after the introduction of antiretroviral therapy

Steven J. Reynolds^{a,b}, Frederick Makumbi^c, Gertrude Nakigozi^d, Joseph Kagaayi^d, R
H. Gray^e, Maria Wawer^e, Thomas C. Quinn^{a,b}, and David Serwadda^c

VIRAL LOAD AND HETEROSEXUAL TRANSMISSION OF HUMAN IMMUNODEFICIENCY VIRUS TYPE 1

THOMAS C. QUINN, M.D., MARIA J. WAWER, M.D., NELSON SEWANKAMBO, M.B., DAVID SERWADDA, M.B.,
CHUANJUN LI, M.D., FRED WABWIRE-MANGEN, PH.D., MARY O. MEEHAN, B.S., THOMAS LUTALO, M.A.,
AND RONALD H. GRAY, M.D., FOR THE RAKAI PROJECT STUDY GROUP

Male Circumcision and Risk of Male-to-Female HIV-1 Transmission: A Multinational Prospective Study in African HIV-1 Serodiscordant Couples

Jared M. Baeten¹, Deborah Donnell², Saidi H. Kapiga^{4,5}, Allan Ronald⁶, Grace John-Stewart¹, Mubiana Inambao³, Rachel Manongi⁵, Bellington Vwalika³, and Connie Celum¹

- Disability adjusted life years for HIV/AIDS

Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010

Joshua A Salomon^t, Theo Vos, Daniel R Hogan, Michael Gagnon, Mohsen Naghavi, Ali Mokdad, Nazma Begum, Razibuzzaman Shah, Muhammad

Ongoing study:

- **Randomized clinical trial**
 - Linkages Study—3 arms of MC promotion
 - Trial will be used to estimate uptake (efficacy) and incremental costs of each intervention
- **Advantages of using a prospective trial:**
 - Detailed costs—not normally recorded
 - Time and motion studies—capture staff time spent on different aspects of intervention
 - Identify areas of inefficiency (wasted resources or time) & modify protocol
 - First-hand assessment of trial quality
 - Quick turnaround of CEA for policymakers

Limitations of data sources:

- **Generalizability**
 - Population chosen for cohort, self-selection into clinical trial
 - Scale-up
- **Time frame**
 - Length of follow-up may be shorter than time horizon of CEA (can be partially addressed through modeling)
- **Study design**
 - Observational studies may contain selection bias, confounding
 - Clinical trials can have differential loss to follow-up, frequently unblinded which can induce bias, varying quality
- **Effectiveness vs. efficacy**
 - Estimates of MC uptake from an RCT may not indicate real world intervention performance (addressed by obtaining real world estimates of intervention uptake)
 - Costs may also be different in the real world (can separate out intervention costs)

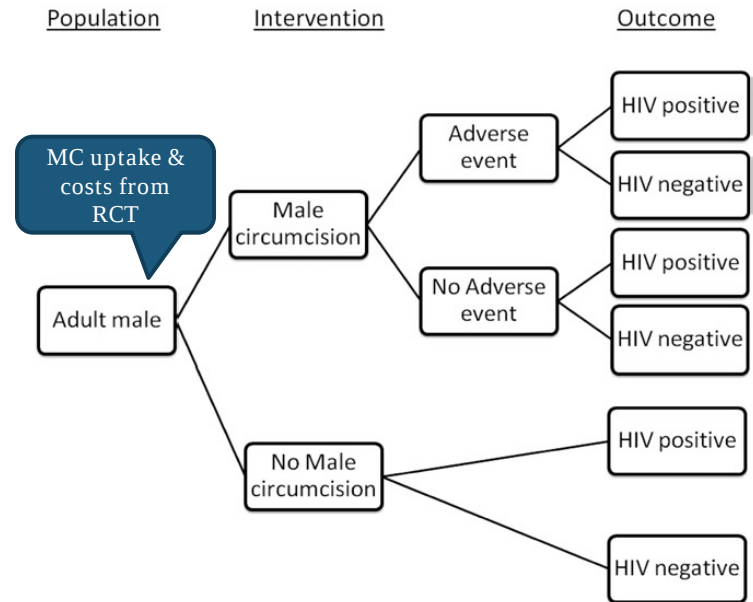
Important to recognize limitations in data and vary uncertain parameters in sensitivity analysis

Synthesizing data into a simulation model

- **Software:**
 - Treeage
 - Microsoft Excel
 - Stella
 - R
 - C++
 - Matlab
 - Java
 - Python

Treeage model

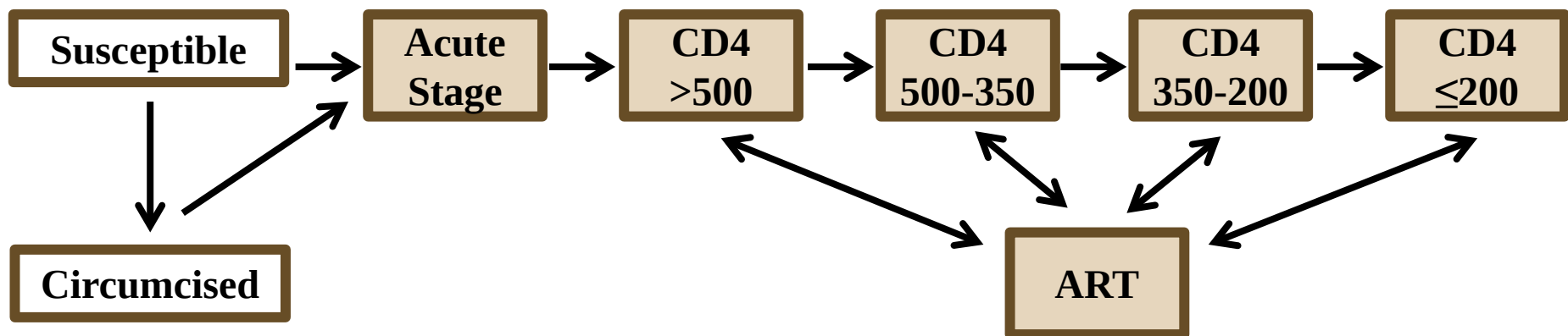
- Advantages
 - Easy to use
 - Visualize decision tree
- Disadvantages
 - Static model—doesn't incorporate herd protection/indirect benefits to women and other men
 - With increasing complexity of interventions, tree can get large/complicated



Source: Aremu O., The cost-utility analysis of adult male circumcision for prevention of heterosexual acquisition of HIV in men in sub-Saharan Africa: a probabilistic decision model. Value in health ,2011,Vol.14(1),p.70-79

Dynamic simulation model:

Soon to be publically available



- Incorporates indirect benefits, varies transmission by CD4 count and ART status, estimates intermediate (MC uptake) and long-term outcomes (HIV infections and DALYs averted).

Previously developed models

Eg. Decision Makers Program Planning Tool (DMPPT)
developed by UNAIDS

- Excel-based model that can estimate costs and effectiveness (infections averted) associated with different scenarios of MC scale-up.
- Scenarios can vary:
 - Priority populations: all males, young adults, newborns, or most-at-risk groups
 - Coverage levels and scale-up rates
 - Service delivery modes: hospital, clinic, mobile van; public, private, NGO
 - Task shifting
 - Risk compensation
 - Male → Female transmission reduction with MC
 - Population age-structure, birth and mortality rate
 - Sexual behavior
 - Discounting

Decision Makers Program Planning Tool

Enter Country-specific Data

Demography

Sexual Behavior

HIV Prevalence Trends

Review or Revise Epidemiological and Economic Assumptions

Effectiveness of Male Circumcision

Epidemiological Assumptions

Economic Assumptions

Fit the Model to the Prevalence Trends

Fit the model

Set Policy Options

Specify Priority Population Groups and Target Coverage

Specify Service Delivery Options

View Results

New HIV Infections

New HIV Infections by Age and Sex

HIV Incidence

Adult HIV Prevalence

Percent of Males Circumcised

Number of Circumcisions Performed

Number of Male Circumcisions per Infection Averted

Net Cost of Male Circumcisions

Net Cost and Savings per Infection Averted

AIDS Deaths

Sensitivity Analysis

Review Methods and Model Equations

Methods

Sensitivity Analysis

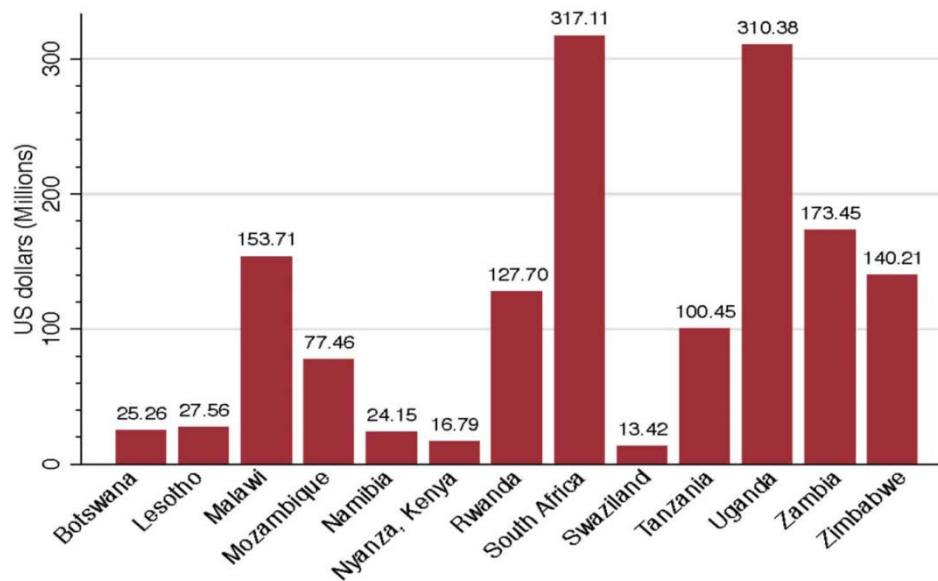
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Perform Sensitivity Analysis	Parameter Values	Results (2009-2025)			
		Infections Averted	Number of Circumcisions per Infection Averted	Net Cost per Infection Averted	Cost Savings per Infection Averted
Base Case		51,518	7.3	\$689	\$10,569
Effectiveness	30%	25,059	14.7	\$1,410	\$9,848
	60%	51,518	7.3	\$689	\$10,569
	75%	65,218	5.8	\$545	\$10,713
Reduction in M->F Transmission	0%	51,518	7.3	\$689	\$10,569
	30%	67,444	5.7	\$508	\$10,750
Discount Rate	3%	51,518	7.3	\$689	\$10,569
	5%	51,518	7.3	\$741	\$10,517
	7%	51,518	7.3	\$798	\$10,460
Lifetime Cost of ART	\$8,000	51,518	7.3	\$689	\$7,311
	\$11,000	51,518	7.3	\$689	\$10,311
	\$14,000	51,518	7.3	\$689	\$13,311
	Minimum	25,059	5.7	\$508	\$7,311
	Base Case	51,518	7.3	\$689	\$10,569
	Maximum	67,444	14.7	\$1,410	\$13,311

Example of analysis conducted with DMPPT

Voluntary Medical Male Circumcision: Modeling the Impact and Cost of Expanding Male Circumcision for HIV Prevention in Eastern and Southern Africa

Emmanuel Njeuhmeli^{1*}, Steven Forsythe², Jason Reed³, Marjorie Opuni⁴, Lori Bollinger², Nathan Heard⁵, Delivette Castor¹, John Stover², Timothy Farley⁶, Veena Menon⁷, Catherine Hankins⁸



Results: Costs of scaling up VMC to 80% by country

Additional planning tools and models

- Reproductive Health (RH) Costing Tool
- Integrated Healthcare Technology Package (iHTP) Simulation Tool
- Spectrum: PMTCT Cost Effectiveness
- Goals Model
- Planning, Costing and Budgeting Framework (PCBF)
- CORE Plus
- Integrated Health Model
- Planning & Budgeting for TB Control
- Resource Needs Model HIV/AIDS
- One Health Model

Choosing the right tool

Tool Name	Marginal Budgeting for Bottlenecks	Reproductive Health (RH) Costing Tool	Planning & Budgeting for TB Control	Spectrum: PMTCT Cost Effectiveness	Goals Model	Resource Needs Model HIV/AIDS	Integrated Health Model	One Model	
Tool developer	UNICEF / World Bank	UNFPA	WHO / MRC	Constella Futures/ Futures Institute	Constella Futures/ Futures Institute	MSH	MSH	UNDP	WHO
Objective	To identify bottlenecks and model impact of reducing them to increase coverage of	To help users estimate cost to scale up a package of reproductive health services from	To help users improve health service delivery by identifying the optimal mix of resources needed for interventions. Can also determine	To evaluate costs and benefits of various strategies to prevent mother-to-child transmission of HIV and	Tool allows users to determine the effect of resource allocation on achievement of HIV/AIDS	To translate strategic program goals into costs and budgets, calculate funding gaps—originally designed for	To estimate the expected number of each type of intervention and the	To estimate scale-up costs of health system as a whole to ensure capacity to deliver	To develop comprehensive budget recommendations
Intended users	Health economists & policymakers at MOHs	Health planners at the country level	Planners, decision-makers and managers at all levels of healthcare system, technical assistance	Public sector policy makers and planners	National, multidisciplinary team of government planners and civil society	National and sub-national policy makers and planners, program-specific technical	Planners and managers of government, private	Health system planners	TB program the cou
Built in interventions	PMTCT including counseling ART, and feeding counseling. Condom use. Cotrimoxazole prophylaxis for HIV+ adults and children of HIV+ mothers, ART for	HIV/AIDS prevention and treatment, family planning, newborn health interventions. Condom promotion for commercial sex workers, MSM, and other vulnerable populations.	6,000 built-in WHO scenarios.	7 interventions: Long-course ZDV, Short-course ZDV (Thailand regimen), Shortcourse ZDV - PETRA Arm A, Short-course ZDV - PETRA Arm B, Neonatal only, Nevirapine HIVNET 012 protocol, Universal	VCT, social marketing, behavior change interventions for high-risk/vulnerable populations including MSM, sex workers, and IDU. Condom promotion, PMTCT, ARVs, M & E, capacity building.	N/A. User inputs strategic plan with coverage target, health outcomes, costs and quantities.	Scenarios-- A: Actual services and actual costs; B: Actual services and normative costs; C: Needed services and normative costs; D: Projected	HIV/AIDS home-based & palliative care, ARVs, treatment of OIs, nutrition, other STIs, facilities, vehicles, human resources, HIV prevention for vulnerable populations, condom	HIV testing, patient TB patient HIV tre
Assumptions	Reductions in bottlenecks are hierarchical and reduction of one has a cascading downstream affect, Efficacy stays	Data in tool is from sources like UN Population Division, WHO's Burden of Disease, UNICEF, Demographic Health	Medical equipment and pharmaceutical database based on WHO database, clinical guidelines, epidemiological profiles, other built-in data linked to International Statistical Classification of Diseases	Built-in demographics data, input prices and quantities and effectiveness, HIV vertical transmission rate	Default data on impact values, sexual behavior, costs, STI prevalence, cost-effectiveness interventions, HAART success rate and standard epidemiological	All assumptions are inputted by the user	User inputs intervention prices and quantities, and demographic and epidemiologic information.	Demographic data from UNFPA.	Default Global the Glc 2006-2 WHO/8 and ep
Training	5 day training course needed, partially complete user's manual available. Using tool require a	1 to 4 days of training generally needed. Detailed user manual available. Skills required include finance,	3-5 day training workshop suggested and three to six months to use the tool and get results. Post-training help file and resource kit available.	1 day of training to use. User manual available, knowledge of PMTCT programs needed. Tool free on internet.	Several days of training required. Takes users two weeks to set up the tool and get results from it. Users should have knowledge of	2-day training recommended. User's manual available.	3 day training suggested, users should possess skills in epidemiology,	1-2 day training suggested and user's manual available.	3 days weeks Help de manua user's
Software	Excel file	Excel file	Program-based (non-Excel)	Program-based (non-Excel)	Excel file	Excel file	Excel file	Excel file	Excel f
Ease of use	Intended for use with UNICEF or World Bank	Training and technical assistance needed to use	Technical assistance required.			Fairly simple to use			User fr
Website	http://www.aidstar-one.com/focus_areas/tre	http://www.who.int/pmnch/topics/economics/costing_tools/en/index9.htm	http://www.who.int/pmnch/topics/economics/costing_tools/en/index9.htm	www.futuresinstitute.org/pages/resources.aspx	http://www.futuresinstitute.org/pages/resources.aspx	http://erc.msh.org/toolkit/Tool.cfm?lang=erty/tools.htm#nact	http://www.undp.org/pov	http://www.undp.org/pov	http://www.undp.org/pov
Limitations	The ordering of bottlenecks appears to be arbitrary.	This tool does not incorporate budget & financing effectiveness	Does not include health outcome, health production function, intervention price, macroeconomic	Does not consider service availability (counseling, testing, training, formula	Does not incorporate macroeconomic conditions.	Does not incorporate effectiveness	Does not incorporate effectiveness	Does not incorporate effectiveness	Does not incorporate effectiveness

Thank you!

Study Participants

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