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AIDSFree Strengthening High Impact Interventions for an AIDS-free Generation

EVALUATING SERVICE DELIVERY MODELS FOR PREVENTION OF MOTHER-TO-CHILD TRANSMISSION OF HIV

COST AND EFFECTIVENESS OF PROVIDING PMTCT SERVICES IN PUBLIC, PRIVATE, AND CIVIL SOCIETY ORGANIZATIONS

FEBRUARY 2016

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AIDSFree

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ACRONYMS

3TC	lamivudine
ANC	antenatal clinic
ART	antiretroviral treatment
ARV	antiretroviral drug
CBO	community-based organization
CESR	Center for Economic and Social Rights
CHW	community health worker
CSO	civil society organization
CTX	cotrimoxazole
DALY	disability-adjusted life year
DHS	Demographic and Health Survey
ECCE	extracapsular cataract extraction
EFV	efavirenz
EID	early infant diagnosis
EmOC	emergency obstetric care
ETB	Ethiopian birr (Br)
FBO	faith-based organization
FP	family planning
FTC	emtricitabine
GHS	Ghanaian cedi (GH¢)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
SHOPS	Strengthening Health Outcomes through the Private Sector
HAART	highly active antiretroviral therapy
HALE	health-adjusted life expectancy
HTS	HIV testing services
ICCE	intracapsular cataract extraction

ICER	incremental cost-effectiveness ratio
IOL	intraocular lens
MCH	maternal and child health
NGO	nongovernmental organization
NVP	nevirapine
OECD	Organisation for Economic Co-operation and Development
PHC	primary health care
PKR	Pakistani rupee (Rs)
PMTCT	prevention of mother-to-child transmission [of HIV]
PPP	purchasing power parity
QALY	quality-adjusted life year
sd-NVP	single-dose nevirapine
SHOPS	Strengthening Health Outcomes through the Private Sector
SSA	sub-Saharan Africa
STI	sexually transmitted infection
TB	tuberculosis
TDF	tenofovir disoproxil fumarate
UNAIDS	Joint United Nations Programme on HIV/AIDS
USAID	U.S. Agency for International Development
USD	US dollar ($)
VCT	voluntary counseling and testing
WHO	World Health Organization

INTRODUCTION

Since the late 1990s, by providing services to prevent mother-to-child transmission of HIV, many countries have made significant progress toward eliminating new HIV infections in children. As a result, in the 21 priority countries of sub-Saharan Africa (SSA), where 90 percent of pregnant women living with HIV reside, the number of new HIV infections among children has declined by 43 percent since 2009. In 2013, 68 percent of pregnant women living with HIV in these priority countries received antiretroviral medicines (ARVs) for prevention of mother-to-child transmission (PMTCT), more than double the 33 percent who received ARVs in 2009 (Joint United Nations Programme on HIV/AIDS 2014). The introduction and rollout of Option B+ was a contributing factor in these achievements and an important step toward achieving an AIDS-free generation. Nonetheless, access to antiretroviral treatment (ART) and retention in care remain challenges. The main barriers have been cited as: limited capacity of health facilities; insufficient numbers of health care providers; limited knowledge of the new PMTCT regimens; lack of transport to health facilities; long waiting periods in health facilities; and stigma.

Given the low levels of PMTCT service coverage, many governments and development organizations are reaching out to nontraditional partners, including the private for-profit sector, community-based organizations (CBOs), and civil society organizations (CSOs), to scale up and expand access to PMTCT services. CSOs have a long history of providing HIV and AIDS services and could be better utilized to address gaps in PMTCT, particularly in rural and remote areas and among stigmatized populations, which are not easily reached by public providers. Although services in the private sector tend to be fragmented and the public sector is often highly centralized, CSOs have been more flexible in meeting clients' expectations, may be more affordable, and are thought to have a strong customer focus. Published experience suggests that CSOs' delivery models may meet customers' needs more efficiently and effectively than other models.

Meeting patient expectations, especially those of pregnant women and mothers with young children, calls for a customer-centric approach. However, there is limited consolidated knowledge or analysis determining whether CSOs could implement PMTCT interventions more cost-effectively by improving retention in care and treatment and improving linkages to integrated networks of providers. Knowledge as to how that might best be done is also limited.

Several studies of the cost-effectiveness of PMTCT services have been conducted, comparing the various PMTCT treatment regimens against one another. Gopalappa et al. (2014) modeled the cost-effectiveness of three PMTCT treatment options—Option B+, Option B, and Option A—and concluded that Option B+ was the most cost-effective, at $6,000 to $23,000 per infection averted compared to Option A. Similarly, Ciaranello et al. (2013) modeled the cost-effectiveness

of Option A, Option B, and Option B+ against the cost of single-dose nevirapine in Zimbabwe and found an incremental cost-effectiveness ratio of $1,370 per year of life saved for Option B+ compared to Option B and a lifetime cost of $6,620 per mother–infant pair. Ishikawa et al. (2014) also compared the cost-effectiveness of the three options using a decision model based on the Zambian national health system; the finding was that Option B+ was less cost-effective than Option B. Finally, Fasawe et al. (2013) compared the cost-effectiveness of Option A, B, and B+ services against the current practice in Malawi. They found that Option B+ had an incremental cost-effectiveness ratio of $455 per life year gained compared to the current practice. However, none of these studies compare the cost-effectiveness of the various PMTCT regimens based on the ownership of the facilities where the services are delivered. A systematic review of PMTCT cost-effectiveness conducted by Johri and Ako-Arrey (2011) also does not report any findings or existing studies that compare the cost-effectiveness of PMTCT across ownership models.

Objective

The purpose of this literature review is to compare PMTCT programs implemented by CSOs with those implemented by public sector providers and the private, commercial sector, in order to determine the relative cost-effectiveness of each facility ownership model. The study consisted of a literature review to assess the state of current research relating to PMTCT interventions and different ownership models for delivering health care services. The literature review also aimed to collect data on costs and effectiveness of PMTCT and other health services provided by CSOs and the comparison ownership models. AIDSFree also developed a cost-effectiveness model for comparing the three PMTCT ownership types. Finally, the study identifies gaps in available data and proposes a research agenda for the future.

COST-EFFECTIVENESS OF PMTCT DELIVERY MODELS: PARAMETERS AND DEFINITIONS

Treatment Regimen

As the standard for the three ownership models, the study used the Option B+ treatment regimen, the regimen most recently recommended by the World Health Organization for treating pregnant women and preventing HIV transmission to infants. Option B+ involves initial counseling and testing for all pregnant women who enter an antenatal clinic. All women who test positive for HIV receive triple antiretroviral treatment—a once-daily dose of tenofovir disoproxil fumarate (TDF), plus lamivudine (3TC) or emtricitabine (FTC), plus efavirenz (EFV), regardless of CD4 count. Treatment with these first-line ARVs is to continue for life to protect the health of the woman and to prevent transmission during future pregnancies (World Health Organization 2013). The regimen calls for infants born to HIV-positive mothers or to women of unknown HIV status to be tested at four to six weeks of age. HIV-exposed infants are to be tested again at nine months and again six weeks after breastfeeding cessation, if it was stopped earlier. Following Option B+, HIV-exposed infants receive daily nevirapine (NVP) or zidovudine (ZDV) from birth through four to six weeks of age, when they can be definitively tested (World Health Organization 2013).

Ownership Models

Civil Society Organizations

No definition of the term "civil society organization" is universally accepted. CSOs are often equated with nongovernmental organizations (NGOs). The World Health Organization (WHO) describes CSOs as "non-state, not-for-profit, voluntary organizations formed by people within the social sphere of civil society.... [covering] a variety of organizational interests and forms [and] ranging from formal organizations registered with authorities to informal social movements coming together around a common cause" (Civil Society Initiative External Relations and Governing Bodies 2002). The World Bank describes CSOs as "the wide array of nongovernmental and not-for-profit organizations that have a presence in public life, expressing the interests and values of their members or others, based on ethical, cultural, political, scientific, religious or philanthropic considerations [and comprising] a wide of array of organizations: community groups, NGOs, labor unions, indigenous groups, charitable organizations, faith-based organizations, professional associations, and foundations" (World Bank 2013). The U.S. Agency

for International Development (USAID) has adopted the definition of the Center for Civil Society Studies at Johns Hopkins University, which says that CSOs are "any organizations, whether formal or informal, that are not part of the apparatus of government, that do not distribute profits to their directors or operators, that are self-governing, and in which participation is a matter of free choice." This definition includes "both member-serving and public-serving organizations" and embraces "private, not-for-profit health providers, schools, advocacy groups, social service agencies, anti-poverty groups, development agencies, professional associations, CBOs, unions, religious bodies, recreation organizations, cultural institutions, and many more" (USAID 2011).

This paper defines CSOs as not-for-profit organizations that hold a nongovernmental and non-state legal registration status and that have no market interests, regardless of whether they receive public financing. This definition encompasses faith-based organizations (FBOs), but because FBOs are not of primary interest to the study, they will not be part of our focus when analyzing CSOs.

Public Sector

According to the Organisation for Economic Co-operation and Development (OECD), one method to define the scope of the public sector is in terms of the status of its employees (Organisation for Economic Co-operation and Development 1997). In this paper, public sector providers are those that are legally recognized as governmental organizations (i.e., owned by the government) and whose employees are considered civil servants, with services both financed by the government and directly provided by it.

Commercial Private Sector

In this paper, the "commercial private sector" will include all privately owned organizations that hold a nongovernmental and non-state legal registration status and whose primary purpose is to generate a profit. Those NGOs that are registered as private companies but that hold a not-for-profit status will be excluded from this category.

LITERATURE REVIEW

Search Methodology

AIDSFree conducted a search in PubMed using combinations of the terms "PMTCT," "HIV," "AIDS," "antiretroviral therapy," "mother to child," "public," government," "state," "private," "for-profit," "commercial," "civil society, "CSO," "NGO," "nongovernmental," "non-state," "not-for-profit," "cost," "effect," "cost-effectiveness," "outcome," "coverage," "adherence," and "loss to follow-up." AIDSFree identified 1,890 articles. Abstracts were reviewed to identify articles that reported cost or effectiveness measures of PMTCT services delivered through one or more of the three ownership models. AIDSFree subsequently expanded the search to include other health services, such as adult HIV services and family planning/reproductive health, tuberculosis, and malaria programs in an attempt to provide insight into the relative costs of delivering services through CSOs compared to the cost of delivering services in the public and private commercial sectors. The expanded search identified a total of 6,687 articles. Abstracts were reviewed to identify articles that reported on cost or effectiveness measures of the respective health services delivered through one or more of the three ownership models.

AIDSFree also performed a search of the Avenir Health Units Cost Database for relevant costing data on interventions for PMTCT and other health concerns. The database contained 27 entries reporting PMTCT-related unit costs. AIDSFree removed six entries that did not report on interventions' financial costs. These six entries reported only on economic costs, which comprise costs borne by all sectors of society, including beneficiaries, donors, volunteer workers, and others. Economic costs are not directly comparable to financial costs. This study takes the perspective of the service provider and therefore considers only financial costs incurred by providers.

Next, AIDSFree grouped the results by PMTCT activity. Multiple entries were found for only two activities: cost per pregnant woman receiving services for HIV testing services (HTS) and cost per mother–neonate pair receiving ARV prophylaxis. Only two entries in the database provided costs from a CSO hospital; both were from the same study of a Lutheran-owned hospital in Tanzania, and AIDSFree eliminated them because they had already been reviewed in the PubMed literature review. The remaining studies reported costs from public health facilities or did not specify facilities' ownership. Finally, to minimize the effects of regional price variations, AIDSFree eliminated entries from programs outside sub-Saharan Africa. In the end, AIDSFree was left with seven entries of PMTCT costing information from the unit cost database—two reporting costs for women receiving HTS in public facilities, two providing costs for women receiving HTS in facilities of unspecified ownership in a sample of countries, one providing the cost of a mother

and infant receiving ARV prophylaxis in a public facility, and two providing the cost for ARV prophylaxis in facilities of unspecified ownership in a sample of countries.

AIDSFree performed an additional search of the Avenir Health Unit Cost Database to identify the costs of other health interventions provided by CSOs and other ownership models. The database reported the cost of providing three types of services through CSOs and at least one other ownership model: adult HIV services, care for sexually transmitted infections (STIs), and male circumcision. Finally, AIDSFree supplemented the PubMed and Avenir Unit Cost Database with a review of grey literature using the Google search engine.

Search Results

Costs

Six of the studies identified in the literature review provided a breakdown of costs into five main categories: personnel, capital, recurrent, drugs and supplies, and training. Adesina and Waldron (2013) examined the incremental costs of providing PMTCT services in 20 public health facilities in Zambia and showed it to be approximately US$50 per mother and child pair. Robberstad and Evjen-Olsen (2010) conducted a cost-effectiveness study comparing PMTCT with highly active antiretroviral therapy (HAART) to PMTCT with single-dose nevirapine (sd-NVP) at Haydom Lutheran Hospital in Tanzania and found a PMTCT program cost totaling US$122,227 in 2007. A third study (Koleros 2012), examining costs of providing PMTCT services in 14 public and private facilities in Ghana, found the average per HIV-positive woman on Option B to be US$1,088.46.

The study broke these findings broken by cost category and ownership model (Table 1). The three remaining studies providing cost breakdowns did not analyze PMTCT services. Only one study provided public sector costs, while four studies provided CSO costs and one provided average costs in a mix of public and private facilities. No studies analyzing the cost breakdown for private commercial-sector services were found.

Table 1. Costs by Cost Category and Ownership Model

Cost Category/ Provider Type	Public	Private Commercial	CSO				Mix
Direct personnel	**$9.18**[a] Incremental PMTCT unit cost (Zambia, 2011 USD)		**$14,501**[b] 2004–2005 total annual costs for primary health care (PHC; Bangladesh, 2004 USD)	**$0.76**[c] Per capita cost of integrated health services (Mozambique, 2012 USD)	**$49,149**[d] Annual cost of PMTCT-Plus (Tanzania, 2007 USD)	**$617.00**[e] 2012–2015 average yearly community health worker (CHW) program costs (various SSA countries)	**GH¢155.22**[6f] Cost per HIV-positive woman on ARV prophylaxis—Option B, Ghana, 2011 GHS)
Capital	**$9.70**[a] Incremental PMTCT unit cost (Zambia, 2011 USD)		**$9,790**[b] 2004–2005 total annual PHC costs, (Bangladesh, 2004 USD)	**$0.06**[c] Per capita cost of integrated health services (Mozambique, 2012 USD)	**$8,887**[d] Annual cost of PMTCT-Plus (Tanzania, 2007 USD)		**GH¢12.49**[f] Unit cost per HIV-positive woman on ARV prophylaxis—Option B (Ghana, 2011 GHS)
Recurrent	**$29.92**[a] Incremental PMTCT unit cost (Zambia, 2011 USD)		**$16,858**[b] 2004–2005 total annual PHC costs (Bangladesh, 2004 USD)	**$0.63**[c] Per capita cost of integrated health services (Mozambique, 2012 USD)	**$11,611**[d] Annual cost of PMTCT-Plus (Tanzania, 2007 USD)	**$386.00**[e] 2012–2015 average yearly CHW program costs (various SSA countries)	**GH¢140.84**[f] Unit cost per HIV-positive woman on ARV prophylaxis—Option B (Ghana, 2011 GHS)
Drugs and supplies	**$86.13**[a] Incremental PMTCT unit cost (Zambia, 2011 USD)		**$16,483**[b] 2004–2005 total annual PHC costs (Bangladesh, 2004 USD)		**$49,971**[d] Annual cost of PMTCT-Plus (Tanzania, 2007 USD)	**$1,262**[e] 2012–2015 average yearly CHW program costs (various SSA countries)	**GH¢661.73**[f] Unit cost per HIV-positive woman on ARV prophylaxis—Option B (Ghana, 2011 GHS)
Training	**$14.95**[a] Incremental PMTCT unit cost, Zambia, 2011 USD)		**$100.00**[b] 2004–2005 total annual PHC costs (Bangladesh, 2004 USD)	**$0.36**[c] Per capita cost of integrated health services (Mozambique, 2012 USD)		**$41.00**[e] 2012–2015 average yearly CHW program costs (various SSA countries)	**GH¢0.70**[f] Unit cost per HIV-positive woman on ARV prophylaxis—Option B (Ghana, 2011 GHS)

Sources: [a] Adesina and Waldron (2013); [b] Alam and Ahmed (2010); [c] Subramanian et al. (2013); [d] Robberstad and Evjen-Olsen (2010); [e] The Earth Institute, Columbia University (n.d.); [f] Koleros (2012)

Most studies that AIDSFree identified reported costs by activity, and these activity costs were not broken down by cost category. Two studies, both examining non-PMTCT/non-HIV services, provided cost comparisons across the three ownership models. A study by Shah, Wang, and Bishai (2011) compared the cost of family planning services provided by the private sector to those provided by the government and NGOs in Ethiopia and Pakistan. They found that in Ethiopia, the cost per FP client was lowest when provided by CSOs and highest when provided by the commercial private sector. In Pakistan, however, the cost per FP client when provided by CSOs was higher than the public sector cost but still lower than the commercial private sector cost. Borghi et al. (2005) compared the cost-effectiveness of services to reduce STIs through CSOs and public and commercial private sector facilities in Nicaragua. For six different scenarios (i.e., consultation cost with no treatment per STI client, consultation cost and treatment of gonorrhea per STI client, consultation cost and treatment of chlamydia per STI client, consultation cost and treatment of trichomoniasis per STI client, consultation cost and treatment of syphilis per STI client, and cost of Pap smear per STI client), the costs were lowest when provided in the public sector, followed by the costs of provision by CSOs; costs were highest in the private commercial sector.

Two other studies included comparisons across two of the three ownership models. Zegeya, Sr. et al. (2012) compared the cost-effectiveness of PMTCT services delivered in public and private commercial sectors in Ethiopia. They found that the cost of testing, cost of post-test counseling for HIV-negative cases, and cost of post-test counseling for HIV-positive cases in the commercial private sector was significantly higher than in the public sector. Khan and Ahmed (2003) compared the relative efficiency of provision of nutrition services by governmental and nongovernmental organizations. They found that although nutrition-program personnel costs per participant were lower for CSOs than for the public sector, the nutrition program's total cost per adult was lower in the public sector. Two other studies reported PMTCT costs per service in the public sector only (Table 2).

Table 2. Costs by Activity and Ownership Model

Service per provider type	Public	Private commercial	CSO	Mix
Cost per family planning client	**Br29.00**[a] (Ethiopia, 2004 ETB)	**Br31.00**[a] (Ethiopia, 2004 ETB)	**Br23.00**[a] (Ethiopia, 2004 ETB)	
Cost per FP client	**Rs72.00**[a] (Pakistan, 2004 PKR)	**Rs445.00**[a] (Pakistan, 2004 PKR)	**Rs238.00**[a] (Pakistan, 2004 PKR)	
Cost per patient (PHC)			**$9.75**[b] (Bangladesh, 2004 USD)	
Cost for pre-test counseling (opt-in)	**Br5.09**[c] (Ethiopia, 2009 ETB)			
Cost for pre-test counseling (opt-out)	**Br4.10**[c] (Ethiopia, 2009 ETB)			
Cost for testing	**Br28.80**[c] (Ethiopia, 2009 ETB)	**Br84.90**[c] **(Ethiopia,** 2009 ETB)		
Cost for post-test counseling for those testing HIV negative	**Br1.71**[c] (Ethiopia, 2009 ETB)	**Br23.20**[c] (Ethiopia, 2009 ETB)		
Cost for post-test counseling for those testing HIV positive	**Br8.45**[c] (Ethiopia, 2009 ETB)	**Br153.20**[c] (Ethiopia, 2009 ETB)		
Cost of ARVs needed for combination drug therapy: zidovudine (ZDV), 3TC, and sd-NVP	**$193.60**[d] (Malawi, 2010 USD)			**Br301.36**[c] (Ethiopia, 2009 ETB)
Cost for sd-NVP	**$0.20**[9] (Malawi, 2010 USD)			**Br39.50**[c] (Ethiopia, 2009 ETB)
HTS cost per test	**$3.50**[d] (Malawi, 2010 USD)			

Service per provider type	Public	Private commercial	CSO	Mix
Cost per CD4 test	**$20.00**[d] (Malawi, 2010 USD)			
Cost per follow-up visit/clinical monitoring	**$2.00**[d] (Malawi, 2010 USD)			
ZDV (for 6 months) and ZDV+3TC (for 7 days)	**$60.00**[d] (Malawi, 2010 USD)			
Infant NVP	**$16.00**[d] (Malawi, 2010 USD)			
Early infant diagnosis (EID)	**$32.50**[d] (Malawi, 2010 USD)			
CTX prophylaxis	**$5.00**[d] (Malawi, 2010 USD)			
Cost per HIV-negative woman				**GH¢84.04**[e] (Ghana, 2011 GHS)
Cost per HIV-positive woman on ARV prophylaxis (Option B)				**GH¢1,088.46**[e] (Ghana, 2011 GHS)
Cost per HIV-positive woman on ART				**GH¢1,553.45**[e] (Ghana, 2011 GHS)
Cost per HIV-exposed infant who is HIV positive at 6 weeks				**GH¢43.46**[e] (Ghana, 2011 GHS)
Cost per HIV-exposed infant who is HIV positive at 6 months				**GH¢74.12**[e] (Ghana, 2011 GHS)

Service per provider type	Public	Private commercial	CSO	Mix
Cost per HIV-exposed infant who is HIV-negative or HIV positive at 12 months				**GH¢101.40**[e] (Ghana, 2011 GHS)
Consultation cost (without treatment) per STI client	**$0.78**[f] (Nicaragua, 1999 USD)	**$28.19**[f] (Nicaragua, 1999 USD)	**$2.16**[f] (Nicaragua, 1999 USD)	
Consultation cost and treatment of gonorrhea per STI client	**$6.67**[f] (Nicaragua, 1999 USD)	**$45.87**[f] (Nicaragua, 1999 USD)	**$19.84**[f] (Nicaragua, 1999 USD)	
Consultation cost and treatment of chlamydia per STI client	**$1.11**[f] (Nicaragua, 1999 USD)	**$29.17**[f] (Nicaragua, 1999 USD)	**$3.14**[f] (Nicaragua, 1999 USD)	
Consultation cost and treatment of trichomoniasis per STI client	**$0.94**[f] (Nicaragua, 1999 USD)	**$28.67**[f] (Nicaragua, 1999 USD)	**$2.64**[f] (Nicaragua, 1999 USD)	
Consultation cost and treatment of syphilis per STI client	**$6.24**[f] (Nicaragua, 1999 USD)	**$63.37**[f] (Nicaragua, 1999 USD)	**$9.90**[f] (Nicaragua, 1999 USD)	
Cost of Pap smear per STI client	**$4.92**[f] (Nicaragua, 1999 USD)	**$31.86**[f] (Nicaragua, 1999 USD)	**$6.48**[f] (Nicaragua, 1999 USD)	
Cost of testing and counseling for PMTCT	**$21.56**[g] (Namibia, 2009 USD) **$9.99**[g] (Rwanda, 2009 USD)			
Cost of CD4+ cell count (PMTCT)	**$17.03**[g] (Namibia, 2009 USD) **$11.17**[g] (Rwanda, 2009 USD)			

Service per provider type	Public	Private commercial	CSO	Mix
Cost of NVP (PMTCT)	**$1.54**[g] (Namibia, 2009 USD)			
	$0.18[g] (Rwanda, 2009 USD)			
Cost of two ARVs for PMTCT	**$25.62**[g] (Namibia, 2009 USD)			
	$63.91[g] (Rwanda, 2009 USD)			
Cost of three ARVs for PMTCT	**$92.76**[g] (Namibia, 2009 USD)			
	$32.68[g] (Rwanda, 2009 USD)			
Cost of CTX prophylaxis for the HIV-exposed infant	**$48.11**[g] (Namibia, 2009 USD)			
	$16.64[g] (Rwanda, 2009 USD)			
Cost of family planning (PMTCT)	**$113.67**[g] (Namibia, 2009 USD)			
	$34.53[g] (Rwanda, 2009 USD)			
Cost of EID (PMTCT)	**$60.92**[g] (Namibia, 2009 USD)			

Service per provider type	Public	Private commercial	CSO	Mix
	$10.91[g] (Rwanda, 2009 USD)			
Cost of Option B (PMTCT)	**$766.78**[g] (Namibia, 2009 USD)			
	$203.33[g] (Rwanda, 2009 USD)			
Personnel cost of nutrition program per participant	**$6.55**[h] (Bangladesh, 2002 USD)		**$3.17**[h] (Bangladesh, 2002 USD)	
Total cost of nutrition program per adult equivalent participating	**$48.84**[h] (Bangladesh, 2002 USD)		**$68.78**[h] (Bangladesh, 2002 USD)	

Sources: [a] Shah, Wang, and Bishai (2011); [b] Alam and Ahmed (2010); [c] Zegeya, Sr. et al. (2012); [d] Fasawe et al. (2013); [e] Koleros (2012); [f] Borghi et al. (2005); [g] Toure et al. (2013) ; [h] Khan and Ahmed (2003)

The review of the Avenir Health Unit costs database resulted in seven entries with comparable PMTCT costs broken down by activity (Table 3). Three of the entries report the costs of public services and four were from multicountry studies that included costs from various ownership models.

Table 3. Results of Analysis of Avenir Health Units Costs Database—PMTCT Costs

Country	Ownership model	Cost data years	Activity	Unit of measurement	Cost (2014 international dollars)
Anglophone Africa		2009	ART	Cost per mother–neonate pair who received ARV prophylaxis	69.26
Francophone Africa		2009	ART	Cost per mother–neonate pair who received ARV prophylaxis	72.59
Ethiopia	Public		ART	Cost per mother–neonate pair who received ARV prophylaxis	11.71
Median					**69.26**
Average					**51.19**
Anglophone Africa		2009	HTS	Cost per pregnant woman receiving HTS services	12.38
Francophone Africa		2009	HTS	Cost per pregnant woman receiving HTS services	6.03
Kenya	Public	2001–2003	HTS	Cost per pregnant woman receiving HTS services	24.75
South Africa	Public		HTS	Cost per pregnant woman receiving HTS services	37.32
Median					**18.56**
Average					**20.12**

The review of the Avenir Health unit cost database also produced non-PMTCT data. AIDSFree identified 62 entries that provided financial costs of interventions and specified the sector through which the interventions were delivered. The entries reported on the per person costs of: treatment with first-line ART, HIV counseling and testing, STI interventions, and male circumcision in sub-Saharan African countries.

The most useful data from the review of grey literature was gathered from two reports on a national health facility costing exercise conducted in Kenya by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the USAID-funded project Strengthening Health Outcomes through the Private Sector (SHOPS). The Kenya exercise provided information on the costs of providing voluntary counseling and testing (VCT) and ART in private, public, and CSO facilities. The costs collected during this exercise are more comparable than most costing data collected from the PubMed review and Avenir Health units cost database because the data originates from a single country and the same time period. AIDSFree examined two reports containing the results of this exercise: an assessment of the cost of private health services produced by SHOPS and an unpublished report by EPOS Consulting and the Center for

Economic and Social Rights (CESR), Kenya (Agnes et al. 2015),[1] specifically looking at the data by HIV activity (Table 4).

Table 4. Unit Costs of HIV Counseling and Testing and Antiretroviral Therapy from a Health Facility Costing Exercise in Kenya

Activity	Country	Ownership Model	Cost Data Years	Unit of Measurement	Cost (2014 international dollars)
HTS	Kenya	Private	2012	VCT per visit	24.12
HTS	Kenya	CSO	2012	VCT per visit	19.58
ART	Kenya	Private	2012	ART cost per year per patient	561.55
ART	Kenya	CSO	2012	ART cost per year per patient	476.56

Effectiveness

The PubMed review identified several studies reporting effectiveness, process indicators, outcomes, or other proxy indicators across each of the ownership models. AIDSFree supplemented this review with a Google search for grey literature and other published articles not found in the PubMed review. Four studies provided effectiveness data from PMTCT interventions delivered by CSOs; eight studies provided effectiveness data from PMTCT interventions delivered through public facilities. AIDSFree did not find effectiveness data from private for-profit PMTCT services.

Several of the reviewed studies provided comparative effectiveness indicators from both CSOs and the public sector. Behets et al. (2009), for example, analyzed the effectiveness of services to reduce vertical transmission of HIV through public and CSO providers in the Democratic Republic of Congo. Across three indicators that were measured, the study found that CSOs performed better than the public sector—more specifically, that 94.1 percent of pregnant women seeking antenatal care were tested for HIV in CSOs and 84.4 percent were tested in public facilities. The study also reported that a higher percentage of HIV-positive women and infants seeking care in CSOs received ART compared to women and infants seeking PMTCT services in public facilities. Ladner et al. (2015) assessed 64 PMTCT programs in 25 sub-Saharan African countries and found that overall, 84.2 percent of pregnant women seeking antenatal care in CSOs were tested for HIV, while only 67.2 percent of women seeking care in public facilities were tested for HIV. The study also found that 70.6 percent of HIV-positive women receiving care in CSOs were given ART, while only 61.3 percent of women being treated in public facilities were receiving ART.

[1] The draft of the EPOS/CESR report was *The Cost of Health Care in Kenya: Actual Costing of Keph and Non-Keph Services.*

Other studies provided effectiveness data for only one of the ownership models. For example, van't Hoog et al. (2005) found that 83 percent of women seeking antenatal care in public facilities in Kenya were tested for HIV and that 48 percent of women in public facilities received ART with NVP during pregnancy. Likewise, in Cameroon, Ayouba et al. (2003) reported that 85.5 percent of women seeking antenatal care in public facilities were tested for HIV and that 10.6 percent of infants born to HIV-infected mothers had acquired HIV within six months of birth.

The literature review also uncovered studies reporting the effectiveness of other health interventions delivered through various ownership models. Two studies provided comparisons across all three ownership models. Ambe et al. (2005) assessed the impact of a public–private approach for TB control in Mumbai, India. The highest treatment success rate for new smear-positive cohorts was in CSOs, the lowest in the private commercial sector. However, the public sector had a significantly higher death rate for new smear-positive cohorts than the commercial private sector and CSOs. CSOs had the lowest death rate. The cost-effectiveness study mentioned previously, conducted by Borghi et al. (2005) in Nicaragua, found that the proportion of STIs cured among female sex workers was highest in the public sector and significantly lower in the private commercial sector, compared to both the public sector and to CSOs. The proportion of STIs cured among males at high risk for HIV acquisition was similar in both the public sector and the private commercial sector, but comparably lower in CSOs.

Three other studies compared effectiveness, outcomes, or other proxy indicators across two of the three ownership models. Singh, Garner, and Floyd (2000) compared the cost-effectiveness of cataract surgery services in India. They found similar levels of patient satisfaction with intracapsular cataract extraction (ICCE) and extracapsular cataract extraction (ECCE) surgery and with intraocular lens (IOL) surgery in both public and CSO settings. Dewan et al. (2006) reviewed the effectiveness of tuberculosis control interventions delivered through public–private mix projects, which included collaboration with either commercial providers or NGOs. The findings suggest that NGOs had a higher treatment success rate than commercial private sector providers. Vallabhaneni et al. (2012) measured ART treatment interruption in a cohort of patients from public and private facilities in India and found that patients from private facilities had a higher ratio of ever having had ART treatment interruptions than patients from public facilities. Several other studies reported effectiveness measures for services delivered through only one of the three ownership models; these studies did not permit comparisons across models.

Results of our review of studies reporting effectiveness, process indicators, outcomes, or other proxy indicators, across ownership models are below (Table 5).

Table 5. Effects by Measure and Ownership Model

Effect measure	Public	Private commercial	CSO	Mix
Health-adjusted life expectancy (HALE) gained from services for emergency obstetric care (EmOC)			11,285–27,453[a] (DRC, 2008)	
Maternal deaths averted from EmOC services			20–228 [a] (DRC, 2008)	
Perinatal deaths averted from EmOC services			237–453 [a] (DRC, 2008)	
HIV-1 cases averted from use of HAART for PMTCT (Option B)			370 [b] (Malawi, 2005–2008)	
Disability life years (DALYs) saved via use of HAART for PMTCT (Option B)			10,449 [b] (Malawi, 2005–2008)	
Rate of HIV infection among infants born to HIV-positive mothers at one month after birth			4.1% [c] (Mozambique, 2003)	
Rate of HIV infection among infants born to HIV-infected mothers at six months after birth	10.6% [d] (Cameroon, 2000–2002)		3.7% [c] (Mozambique, 2003)	
Loss to follow-up of pregnant women in PMTCT	25.3%[d] (Cameroon, 2000–2002)		19%[c] (Mozambique, 2003)	
Loss to follow-up of HIV-exposed infants (before learning their HIV status)	15.4% [e] (Brazil, 2000)			
Loss to follow-up after 7 years of HIV treatment	25.4% [f] (South Africa, 2004–2010)			
Loss to follow-up after one year on ART	11.2% [f] (South Africa, 2004–2010)			
TB treatment success rate for new smear-positive cohorts	73% [g] (India, 2002)	61% [g] (India, 2002)	91% [g] (India, 2002)	
Death rate for new smear-positive cohorts	16% [g] (India, 2002)	2% [g] (India, 2002)	1% [g] (India, 2002)	
ART adherence (dropout rate after five years of ART)			22% [h] (China, n.d.)	
ART adherence (missed ARV medication within the three days prior)	12.9% [i] (Ethiopia, 2014)			
Ratio of ever having ART treatment interruptions (not on ART for 48 hours or more since starting)	1 [j] (India, 2006)	2.7 [j] (India, 2006)		

Effect measure	Public	Private commercial	CSO	Mix
Patient satisfaction with ICCE and ECCE surgery	82% [k] (India, 1996–1997)		85% [k] (India, 1996–1997)	
Patient satisfaction with IOL surgery	95% [k] (India, 1996–1997)		93% [k] (India, 1996–1997)	
Treatment success rate for new patients who are sputum smear positive for acid-fast bacilli	86% [l] (Malawi 2008–2010)	78–92% [m] (India, 2001–2002)	85–94% [m] (India, 1995–2002)	
sd-NVP coverage ratio for PMTCT programs	0.41 [n] (SSA, 2000–2011)		0.62 [n] (SSA, 2000–2011)	
% of women who learned their status who received ART	70% [o] (NVP) (Kenya, 2002–2003)			
	92.8–96.4% (three-drug regimen) [p] (Kenya 2009–2011)			
DALYs averted from PMTCT-Plus intervention			0.067 [q] (Tanzania, n.d.)	
Women receiving pre-test counseling (%)	92% [o] (Kenya 2002–2003)			
Women receiving post-test counseling (%)	90% [o] (Kenya 2002–2003)			
Number of women seeking antenatal care who were tested for HIV (%)	84.4% [r] (DRC, 2002–2005)		90.9–97.2% [r] (DRC, 2002–2005)	
	85.5% [d] (Cameroon, 2000–2002)			
	83% [o] (Kenya, 2002–2003)			
Number of HIV+ women who were informed of their test results (%)	64.3% [r] (DRC, 2002–2005)		78.6–92.4% [r] (DRC, 2002–2005)	
	68% [o] (Kenya 2002–2003)			
Number of HIV+ women who received NVP during the third-trimester ANC visit (%)	23.1% [r] (DRC, 2002–2005)		41.2–41.5% [r] (DRC, 2002–2005)	

Effect measure	Public	Private commercial	CSO	Mix
	48% [s] (12% in first trimester and 40% in second trimester) (Ghana, 2008–2012)			
	48% [o] (not clear whether this was during the third trimester) (Kenya 2002–2003)			
% of pregnant women reporting to take ARVs before, during, and after delivery	15–21% [p] (Kenya, 2009–2011)			
% of pregnant women reporting to take ARVs during and after delivery	11–40% [p] (Kenya, 2009–2011)			
% of pregnant women reporting to never take ARVs	39% [p] (Kenya, 2009–2011)			
% of HIV-exposed infants who were tested at six weeks	18–25% [p] (Kenya, 2009–2011)			
% of HIV-exposed infants who were tested by nine months	57–67% [p] (Kenya, 2009-2011)			
Number of HIV-exposed infants who took NVP within 72 hours after delivery (%)	85.2% [r] (DRC, 2002–2005)		95.2–97% [r] (DRC, 2002–2005)	
% of HIV-exposed children ever receiving prophylaxis	90% [e] (Brazil, 2000)			
% of infants testing positive for HIV by six weeks	4.2–6.6% [p] (Kenya 2009–2011)			
% of HIV-exposed infants testing positive by nine months	7.3–8% [p] (Kenya 2009–2011)			
DALYs averted by ART, per patient			13 [t] (Burundi, n.d.)	
Number of STIs cured among female sex workers	30 [u] (Nicaragua, n.d.)	9 [u] (Nicaragua, n.d.)	23 [u] (Nicaragua, n.d.)	
Number of STIs cured among males at high risk for HIV exposure	10 [u] (Nicaragua, n.d.)	10 [u] (Nicaragua, n.d.)	3 [u] (Nicaragua, n.d.)	

Effect measure	Public	Private commercial	CSO	Mix
Median time between first visit and commencement of antenatal ZDV	5 days [v] (South Africa, 2012)			
Median duration of receiving ZDV for PMTCT before delivery	16.9 weeks [v] (South Africa, 2012)			
Percentage of women receiving lifelong ART by time of delivery	27.7–45.2% [v] (South Africa, 2012)			
HIV transmission in infants	3.4% [v] (South Africa, 2012) 10.2% [s] (Option B, excluding 1% during breastfeeding) (Ghana, 2008–2012) 1% [s] (Option B+, excluding 1% during breastfeeding) (Ghana, 2008–2012)			
Overall uptake of EID	51.4% [v] (South Africa, 2012)			
Increase in proportion of patients on ART	17% (2008) to 40% (2010) [l] (Malawi, 2008–2010)			
Projected maternal life expectancy under Option B+ (years)	16.1 [s] (Ghana, 2008–2012)			
Maternal quality-adjusted life years (QALYs) gained, Option B+	13.2 [s] (Ghana, 2008–2012)			
Maternal QALYs gained, Option B	13.1 [s] (Ghana, 2008–2012)			
Child QALYs gained, Option B+	167.0 [s] (Ghana, 2008–2012)			
Child QALYs gained, Option B	159.0 [s] (Ghana, 2008–2012)			
QALYs gained per child, Option B+	66.8 [s] (Ghana, 2008–2012)			

Effect measure	Public	Private commercial	CSO	Mix
QALYS gained per child, Option B	63.6 [s] (Ghana, 2008–2012)			
Total life years gained, Option B+	196.7 [s] (Ghana, 2008–2012)			
Life years gained, Option B	186.4 [s] (Ghana, 2008–2012)			
Life years gained per child, Option B+	71.4 [s] (Ghana, 2008–2012)			
Life years gained per child, Option B	71.4 [s] (Ghana, 2008–2012)			
Virologic responders to ART	15% [w] (Brazil, n.d.)			
Immunologic responders to ART	13% [w] (Brazil, n.d.)			
Complete responders to ART	53% [w] (Brazil, n.d.)			
Nonresponders to ART	18% [w] (Brazil, n.d.)			
Months with an occurrence of stockouts of HIV testing commodities	51.4% [x] (Mozambique, 2009–2010)			
Months with occurrence of stockouts of drugs for maternal and child health (MCH) interventions	47.8% [x] (Mozambique, 2009–2010)			
Percent receiving counseling on ART adherence	77.9% [i] (Ethiopia, 2014)			
HIV-positive mothers responding true to "seropositive women can transmit HIV to their babies during pregnancy" during survey	88.6% [i] (Ethiopia, 2014)			
HIV-positive mothers responding true to "HIV-positive women can reduce the risk of HIV transmission to their babies if they take PMTCT drugs"	84% [i] (Ethiopia, 2014)			

Sources: [a] Deboutte et al. (2013); [b] Orlando et al. (2010); [c] Marazzi et al. (2005); [d] Ayouba et al. (2003); [e] Gouveia, da Silva, and de Albuquerque (2014); [f] Fox et al. (2012); [g] Ambe et al. (2005); [h] Li et al. (2010); [i] Ebuy, Yebyo, and Alemayehu (2015); [j] Vallabhaneni et al. (2012); [k] Singh, Garner, and Floyd (2000); [l] Tweya et al. (2013); [m] Dewan et al. (2006); [n] Ladner et al. (2015); [o] van't Hoog et al. (2005); [p] Washington et al. (2015); [q] Robberstad and Evjen-Olsen (2010); [r] Behets et al. (2009); [s] VanDeusen et al. (2015); [t] Renaud et al. (2009); [u] Borghi et al. (2005); [v] Fatti et al. (2014); [w] Hofer, Schechter, and Harrison (2004); [x] Geelhoed et al. (2013)

Demographic, Coverage, and Disease Data

Calculating the cost-effectiveness of PMTCT programs requires knowledge of basic demographic, service coverage, and disease data for the population of interest. Information on the number of pregnant women in the population, HIV prevalence, ANC coverage, the percentage of deliveries that occur in a health facility, the number of live births that occur in the population over a given period, and other indicators are important determinants of the cost and effectiveness of delivering PMTCT services through the various ownership models. Many of these indicators are available in demographic and health surveys (DHS) or in other disease-specific surveys, from national statistics offices, or in the databases of international organizations.

For demonstration purposes, AIDSFree chose Kenya as the setting for the cost-effectiveness analysis, but any country or region with available data could be used. AIDSFree reviewed the 2009 and 2014 DHS, the 2012 Kenya AIDS Indicator Survey, WHO data on stillbirth rates, and birth data from the United Nations statistics division. A sample of the demographic, service coverage, and HIV prevalence data AIDSFree collected for Kenya is below (Table 6).

Table 6. Demographic, Service Coverage, and HIV Prevalence Data, Kenya

	Value	Year	Source
Mother			
% of pregnant women attending at least one ANC visit	96	2014	Kenya National Bureau of Statistics [KNBS] et al. 2015
% of the above women attending a public antenatal clinic	86	2012	National AIDS and STI Control Programme (NASCOP), Kenya 2014
% of all pregnant women attending a public antenatal clinic	82	2012-2014	Author's estimation
Stillbirth rate	2.0	2009	WHO and Save the Children 2009
Births delivered in a health facility	61	2014	KNBS et al. 2015
% of total female population that gave birth in private health facility	10	2009	KNBS and ICF Macro 2010
% of total female population that gave birth in public health facility	32	2009	KNBS and ICF Macro 2010
% of health facility deliveries taking place in a private facility	24	2009	KNBS and ICF Macro 2010
% of health facility deliveries taking place in a public facility	76	2009	KNBS and ICF Macro 2010
HIV prevalence among women aged 15–64	7.0	2012	NASCOP Kenya 2014
Infant			
Live births	954,254	2014	UNStats 2015
Infant deaths	18,672	2014	UNStats 2015

Model Methodology

To model the cost-effectiveness of public sector, CSO, and private sector PMTCT programs, this study disaggregates the PMTCT Option B+ intervention by core activity: HTS and ART for the mother and, for the infant, early diagnosis, appropriate antiretroviral and CTX prophylaxis, and treatment for those testing positive for HIV. AIDSFree then developed a probability tree to visualize the steps in the mother-to-child transmission process, starting with a pregnant woman attending ANC and ending with the HIV-positive infant receiving lifelong ART. Next, AIDSFree

transferred costs, effectiveness data, and basic demographic and service coverage data collected from the literature review into the probability tree to estimate the overall costs and impacts of delivering PMTCT interventions through CSOs, public facilities, and private facilities in a real-world setting. The probability tree outputs can be used to create a cost-effectiveness ratio demonstrating the cost per infant infection averted and cost per QALY gained through each ownership model.

Components of PMTCT

To develop the cost-effectiveness model, AIDSFree disaggregated PMTCT interventions into the six main components of Option B+ (Table 7). Two of the composite activities aim to test and treat a pregnant woman; four aim to test, prevent HIV transmission to, and treat the infant.

Table 7. Primary Components of PMTCT Option B+ Interventions

Mother	HTS
	Lifelong ART
Infant	EID
	Daily appropriate antiretroviral NVP prophylaxis (NVP or AZT) for HIV-exposed infants from birth until six weeks of age
	CTX prophylaxis for HIV-exposed infants beginning at six weeks of age
	Lifelong ART for HIV-infected infants

Costing Methodology

This model uses an activity-based costing approach to categorize the costs of PMTCT interventions. AIDSFree used this approach for three reasons. First, most costing data available in the literature is categorized by activity. Second, listing the activities and associated costs facilitates the comparison of interventions. Finally, using an activity-based approach allowed AIDSFree to cost activities from various sources and combine them to create a single model intervention.

AIDSFree converted the costs collected in the literature review to 2014 international dollars by inflating the cost in local currency to 2014 price levels and dividing by the purchasing power parity (PPP) conversion factor for private consumption for 2014.[2] This allowed AIDSFree to standardize costs that were incurred in different years and in different countries, where price levels of labor and basic inputs may differ. Some inputs for PMTCT interventions, such as ARVs, are internationally traded and should be compared using market exchange rates, but AIDSFree converted all costs to international dollars because many sources did not specify what percentage of the cost of a specific activity was attributable to locally procured supplies or human resources and what percentage to internationally traded goods.

[2] PPP conversion factors are available from the World Bank's Databank, http://data.worldbank.org/indicator/PA.NUS.PRVT.PP . Inflation data are from the International Monetary Fund's World Economic Outlook Database (April 2015), at https://www.imf.org/external/pubs/ft/weo/2015/01/weodata/weoselco.aspx?g=2603&sg=All+countries+%2f+Emerging+market+and+developing+economies+%2f+Sub-Saharan+Africa.

The lack of costing data from CSO-provided PMTCT interventions made it difficult to compare PMTCT intervention costs among different facility ownership types. To address this issue, AIDSFree calculated the average difference in costs between providing HIV or other health services through CSOs and providing the same services through other ownership models. AIDSFree organized data on the costs of services for adult HTS, ART, and STI care into groups by intervention and provider ownership and created a weighted average of the costs of each group. AIDSFree weighted the studies from the literature review based on the number of sites included in the costing. For example, a study that reported the costs of ART in one facility was given less weight than a study that reported the costs reflected from many facilities. These calculations resulted in a summary cost for each activity for the public sector, the private sector, and CSOs. Using the weighted average costs for each ownership model, AIDSFree created a ratio representing the difference in average costs for each activity delivered via a CSO and via the other ownership models.

The cost of providing first-line ART is on average 37 percent less expensive per patient in public facilities than in CSO facilities (Table 8). The cost of providing HTS per person is on average 15 percent more expensive in public facilities than in CSOs and 25 percent more expensive in private commercial facilities than in CSOs. Finally, the cost of treating an STI is on average 34 percent more expensive in the public sector than in a CSO.

Table 8. Weighted Summary Unit Costs and Cost Ratios by Selected Health Interventions

Intervention	Ownership model	Average cost	Weighted average cost	Cost ratio
ART				
	CSO	$1,854.59	$2,049.46	1.00
	Public	$1,769.92	$1,294.34	0.63
	Private	UA	UA	UA
HTS				
	CSO	$19.25	$19.51	1.00
	Public	$22.11	$22.43	1.15
	Private	$24.12	$24.12	1.25
STI				
	CSO	$46.97	$46.97	1.00
	Public	$77.73	$62.92	1.34
	Private	UA	UA	UA

UA = data unavailable

Next, AIDSFree averaged the ratios of each intervention to produce a summary ratio representing the differences in costs for each ownership model across the three interventions. The cost per person receiving ART varied significantly depending on the country where the treatment was provided and the year of delivery. This is likely due to the substantial decline in the prices of many ARVs over the past decade and also to the wide variation in costs among

drug regimens. Therefore, AIDSFree did not include ART costs in the final summary ratio. After eliminating them, AIDSFree determined that it did not have enough information to produce a ratio for private commercial costs. Averaging ratios for the costs of HTS and STI treatment delivered in public and CSO facilities provided the best approximation of the overall difference in costs of health services between public and CSO providers, given the available data. Nevertheless, AIDSFree acknowledges that because of the extent of the assumptions made during calculations, this ratio is not a robust approximation of cost differences.

On average, it costs 24 percent more to provide a health service in a public facility than in a CSO (see Table 9 below).

Table 9. Summary Cost Ratio by Ownership Model

Ownership Model	HTS Cost Ratio	STI Cost Ratio	Summary Cost Ratio
CSO	1.00	1.00	1.00
Public	1.15	1.34	1.24

Basing the cost-effectiveness study in a particular country would increase the comparability of the costing data and reduce the need to average cost figures from different settings and time periods. For example, on average, HTS in Kenya costs 7 percent less per person to provide through the public sector than the CSO sector, while providing ART costs 8 percent more in the public sector than the CSO sector (see Table 10). AIDSFree used the summary cost ratio developed previously to estimate the differences in costs of EID, NVP prophylaxis, and CTX prophylaxis because the project could not find sufficient data to create a specific cost ratio for these activities. Finally, the treatment of HIV-positive infants costs on average 8 percent more to provide through the public sector than in the private sector.

Table 10. Cost Ratios for PMTCT Activities in Kenya, by Ownership Model

Intervention Costed	CSO	Public	Notes	Source
Mothers				
VCT	1	0.93		Korir et al. (2014)
ART	1	1.08		Korir et al. (2014)
Infants				
EID	1	1.24	Average weighted ratio of public and CSO costs for various health interventions	Avenir Health Unit Cost Repository
Daily NVP prophylaxis for HIV-exposed infants from birth until six weeks of age	1	1.24	Average weighted ratio of public and CSO costs for various health interventions	Avenir Health Unit Cost Repository
CTX prophylaxis for HIV-exposed infants from six weeks	1	1.24	Average weighted ratio of public and CSO costs for various health interventions	Avenir Health Unit Cost Repository
ART for HIV-infected infants	1	1.08		Korir et al. (2014)

Effectiveness Methodology

To calculate the effectiveness of PMTCT interventions, AIDSFree developed a list of output and outcome indicators based on a review of the literature and categorized the data by country and facility ownership model. AIDSFree then created a weighted average for each indicator based on the number of sites included in the source study (Table 11 on the following page). Some journal articles reviewed reported effectiveness measures from a single PMTCT facility; others reported the average effectiveness of PMTCT interventions across more than 60 sites based on a national or multinational study. As reported in the literature review section of this study, AIDSFree was unable to find effectiveness data for PMTCT interventions or adult HIV services delivered through the private commercial sector, and thus did not calculate summary effectiveness indicators for the private sector.

Table 11. Summary Effectiveness Indicators of PMTCT Interventions Weighted by Number of Facilities, by Country and Ownership Model

	Civil Society Organizations						Public Facilities								
	DRC	Mozambique	China	25 SSA countries	Average	Weighted average	Kenya	DRC	Cameroon	Ghana	South Africa	Brazil	25 SSA countries	Average	Weighted average
Mother															
% of pregnant women seeking ANC who were tested for HIV	94.1			84.2	**89.1**	**86.6**	83.0	84.4	85.5				67.2	**80.0**	**72.1**
% of pregnant women tested who returned for their test results	85.4			68.6	**77.0**	**72.8**		75.7					63.5	**65.8**	**66.5**
% of pregnant women who attended ANC and received their test results							68.0							**68.0**	**68.0**
% of HIV-positive women receiving ART during the third trimester	41.4				**41.4**	**41.4**	48.0	23.1		48.0	36.5			**38.9**	**27.4**
% of HIV-positive pregnant women receiving ART during labor	86.5			70.6	**78.6**	**74.5**	25.5	67.7					61.3	**51.5**	**60.4**
% of HIV-positive women receiving ART during breastfeeding															
% of HIV-positive pregnant women never receiving ART							39.0							**39.0**	**39.0**
% of pregnant women in PMTCT program not lost to ART follow-up		81	78		**79.5**	**79.0**								**81.8**	**78.2**
Total QALYs gained for mother										13.2				**13.2**	**13.2**
Life years gained for mother										16.1				**16.1**	**16.1**
Infant															
% of HIV-exposed infants tested for EID							21.5							**21.5**	**21.5**
% of HIV-exposed infants lost to follow-up before learning their HIV status												15.4		**15.4**	**15.4**
% of HIV-exposed infants testing positive in EID		4.1			**4.1**	**4.1**	5.4							**5.4**	**5.4**

	Civil Society Organizations						Public Facilities								
	DRC	Mozambique	China	25 SSA countries	Average	Weighted average	Kenya	DRC	Cameroon	Ghana	South Africa	Brazil	25 SSA countries	Average	Weighted average
% of HIV-exposed infants receiving NVP	96.1			56.9	**76.5**	**66.6**		85.2					48.9	**67.1**	**57.9**
% of HIV-exposed infants receiving CTX prophylaxis															
% of HIV-exposed infants who are breastfed															
% of HIV-exposed infants receiving an antibody test at nine months							62.2							**62.2**	**62.2**
% of HIV-exposed infants receiving an antibody test at 18 months (or six weeks after the cessation of breastfeeding)															
Rate of HIV infection among infants born to HIV-infected mothers		3.7			**3.7**	**3.7**	7.7		10.6	2.0	3.4			**5.9**	**6.6**
Life years gained per child										71.4				**71.4**	**71.4**
Total QALYs gained for children										167.0				**167.0**	**167.0**
QALYs gained per child										66.8				**66.8**	**66.8**

For each effectiveness indicator, AIDSFree created summary ratios representing the differences in effectiveness between CSO and public service providers. The ratios were created by dividing the weighted summary effectiveness average for each indicator from the public sector by the weighted average of the CSO indicators. On average, 17 percent fewer pregnant women seeking antenatal care are tested for HIV in the public sector than in the CSO sector, and nine percent fewer pregnant women tested in public sector facilities return for their results than do women tested in CSO facilities (Table 12). Data for some indicators were not available.

Table 12. Summary Effectiveness Ratios for PMTCT Services, by Ownership Type and Indicator

Effectiveness indicator	Weighted ratio	
	CSO	Public
Mother		
% of pregnant women seeking ANC who were tested for HIV	1	0.83
% of pregnant women tested who returned for their test results	1	0.91
% of pregnant women who attended ANC and received their test results		
% of HIV-positive pregnant women receiving ART during third trimester	1	0.66
% of HIV-positive pregnant women receiving ART during labor	1	0.81
% of HIV-positive women receiving ART during breastfeeding	UA	UA
% of HIV-positive pregnant women never receiving ART	UA	UA
% of pregnant women in PMTCT program not lost to ART follow-up	1	0.99
Infant		
% of HIV-exposed infants tested for EID	UA	UA
% of HIV-exposed infants lost to follow-up before learning their HIV status		
% of HIV-exposed infants testing positive in EID	1	1.32
% of HIV-exposed infants receiving NVP	1	0.87
% of HIV-exposed infants receiving CTX prophylaxis	UA	UA
% of HIV-exposed infants who are breastfed	UA	UA
% of HIV-exposed infants who are replacement fed		
% of HIV-exposed infants receiving an antibody test at nine months	UA	UA
% of HIV-exposed infants receiving an antibody test at 18 months (or six weeks after the cessation of breastfeeding)	UA	UA
Rate of HIV infection among infants born to HIV-infected mothers	1	1.77
% of HIV-exposed infants testing negative in EID	1	0.99
% of infants born to HIV-infected mothers but not themselves infected with HIV	1	0.97

UA=Data unavailable

AIDSFree used data collected from two studies of PMTCT interventions in public facilities in Kenya to demonstrate how summary ratios can be used to estimate CSO effectiveness measures when not enough data is available (van't Hoog et al. 2005; Washington et al. 2015). To do this, AIDSFree simply multiplied the summary ratios by the effectiveness measures from public facilities cited in the Kenya study (Table 13 on the following page).

Table 13. Using Summary Effectiveness Measures to Estimate the Effectiveness of PMTCT Interventions in Kenya, by Ownership Model

	CSO			Public		
Indicator	Percent	Year	Source	Percent	Year	Source
Mothers						
% of pregnant women seeking ANC who were tested for HIV	99.80		Weighted ratio	83.0	2002–2003	van't Hoog et al. (2005)
% of pregnant women tested who returned for their test results	89.61		Weighted ratio	81.9	2002–2003	van't Hoog et al. (2005)
% of HIV-positive women receiving ART during the third trimester	72.57		Weighted ratio	48	2002–2003	van't Hoog et al. (2005)
% of HIV-positive women receiving ART during labor	UA			UA		
% of HIV-positive women receiving ART during breastfeeding	UA			UA		
% of HIV-positive women never receiving ART	UA			UA		
ART loss to follow-up	20.96	various	Weighted ratio	21.78	Various	Weighted average from literature review
% in ART not lost to follow-up	79.04	various	Weighted ratio	78.23		Weighted average from literature review
Infant						
% of HIV-exposed infants tested for EID				21.5	2009–2011	Washington et al. (2015)
% of HIV-exposed infants lost to follow-up before learning their HIV status	UA			UA		
% of HIV-exposed infants testing positive in EID	4.1	Various	Weighted ratio	5.4	2009–2011	Washington et al. (2015)
% of HIV-exposed infants receiving NVP	66.58	Various	Weighted ratio	57.87	Various	Weighted average from literature review
% of HIV-exposed infants receiving CTX prophylaxis	UA			UA		
% of HIV-exposed infants receiving an antibody test at nine months	UA			62.15	2009–2011	Washington et al. (2015)
% of HIV-exposed infants receiving an antibody test at 18 months (or six weeks after the cessation of breastfeeding)	UA			UA		
Rate of HIV infection among infants born to HIV-infected mothers	4.31	Various	Weighted ratio	7.65	2009–2011	Washington et al. (2015)

UA=Data unavailable

Creating Probability Tree Models

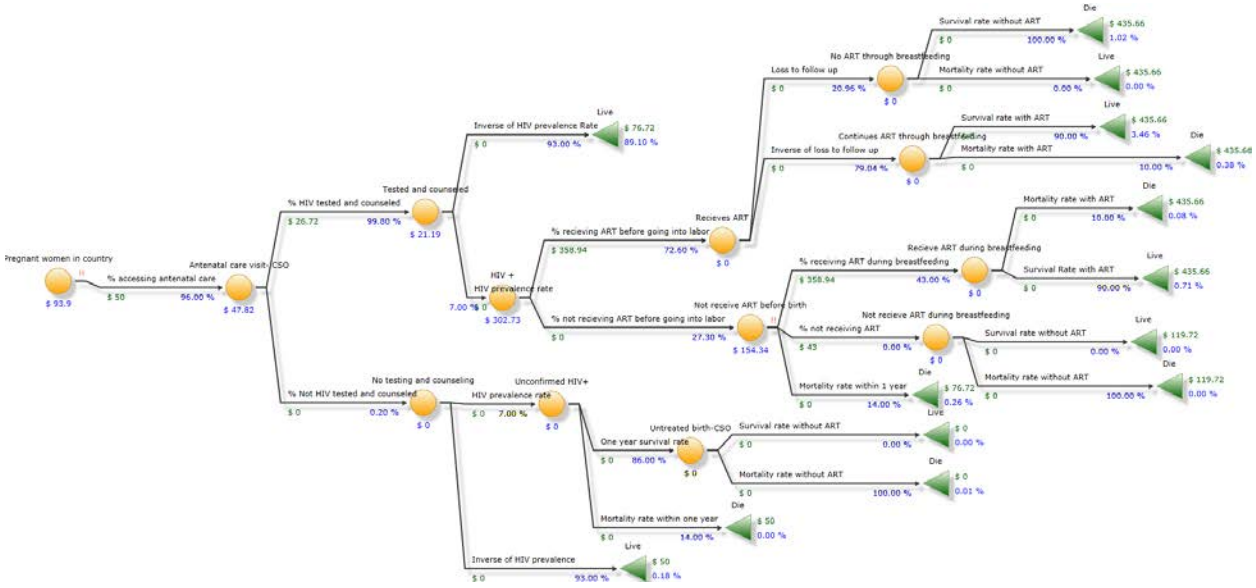
AIDSFree developed two separate probability trees, one for the mother (Figure 1) and another for the infant (Figure 2), to model the progression of PMTCT activities that a beneficiary may experience from the time he or she enters the health system through the final outcome of life or death for the mother and HIV-positive status or HIV-negative status for the infant. Each of the

probability trees has one branch for PMTCT services delivered by CSOs, another for services delivered by public facilities, and a third for services delivered through the private for-profit sector. AIDSFree used the open source software Silverdecisions to design the probability trees.

The mother's probability tree begins with a pregnant woman entering the health system by attending ANC for a checkup in a public, private, or CSO facility. If the woman is tested for HIV, returns for her test results, and is found to be HIV positive, she will be eligible for lifelong ART. If she receives ART, her chance of surviving over a given period will be significantly higher than if she does not. If the pregnant women never receives ANC, is not tested for HIV, does not return for her test results, or is tested and found to be HIV negative, the woman does not access the PMTCT intervention, with implications for both costs and outcomes. Women who receive ART through a public, private, or CSO provider and who remain in treatment through the birth of the child reduce the chance of their child contracting HIV and increase their own chance of survival.

PMTCT interventions can also reduce transmission of HIV by providing ART to women who are breastfeeding. HIV-positive mothers who breastfeed and receive ART throughout the breastfeeding period can reduce the risk of transmitting HIV to their infants compared to HIV-positive women who breastfeed and are not on ART. HIV-positive mothers can also chose not to breastfeed, but replacement feeding carries increased risk of death from diarrhea, pneumonia, and malnutrition for infants (World Health Organization 2013).

Figure 1. Sample CSO PMTCT Decision Tree, Mother



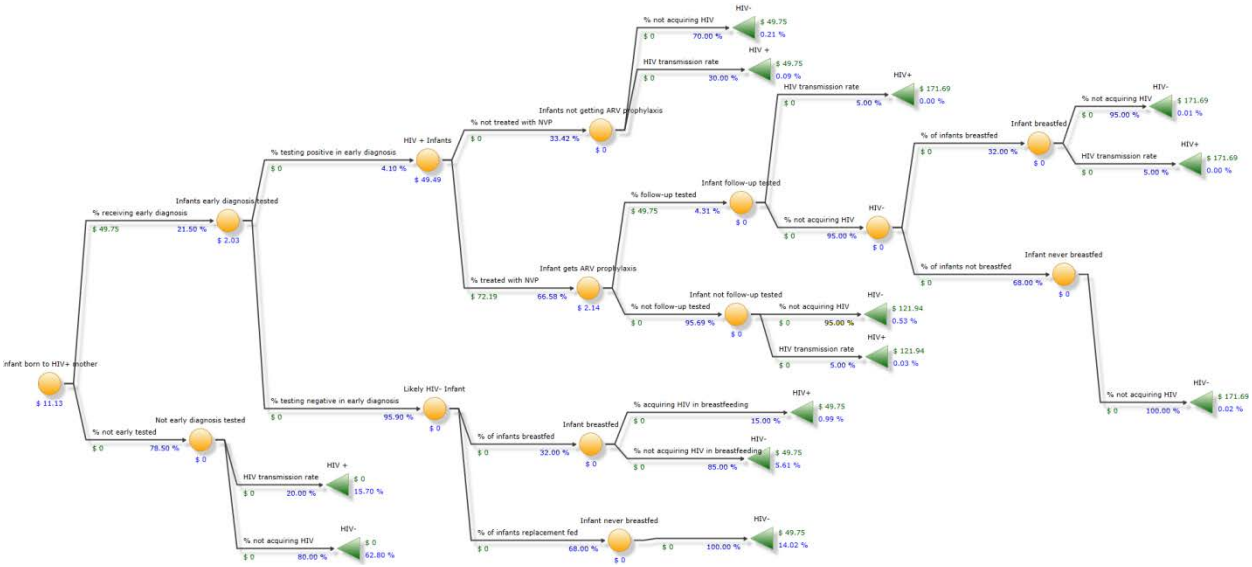
Note: The original probability tree diagram is too complex to include in this report. This diagram is for demonstration purposes only. It does not include all steps in the process, so the outputs are different than in the original.

The infant's probability tree begins with the birth of an infant in a public, private, or CSO facility from an HIV-positive mother who has either received or not received ART. The mother's treatment status is a determining factor of the infant's eventual HIV status. If an infant is HIV

positive and does not receive EID within the first six weeks after birth, his or her probability of dying within the first year is high. An infant who does not receive EID may still be tested and treated during the first year of life, but studies have found that infants who are HIV positive and do not receive treatment have a 52 percent chance of dying before their second birthday (World Health Organization 2013).

Infants testing positive in EID should immediately initiate ART as prophylaxis and should be tested again to confirm infection. HIV-negative infants should also be tested again after nine months of age to confirm their HIV-negative status. Finally, infants who are breastfed should be tested again six weeks after cessation of breastfeeding to confirm they were not infected during breastfeeding. All infants testing positive in follow-up virological tests should be started on lifelong ART, while infants who are over 18 months of age, who have not been breastfed during the previous six weeks, and who test negative in virological tests are confirmed HIV negative (World Health Organization 2013).

Figure 2. Sample CSO PMTCT Decision Tree, Infant



Note: The original probability tree diagram is too complex to include in this report. This diagram is for demonstration purposes only. It does not include all steps in the process, so the outputs are different than in the original.

Inputting Cost, Effects, Epidemiological and Demographic Data

To calculate the differential costs and effectiveness of the three facility ownership models, each activity's summary unit costs, each indicator's summary effectiveness measures, and the demographic, service coverage, and HIV prevalence data should be put into the probability tree models. Data from any country or region can be inputted into the model; for demonstration purposes, AIDSFree used demographic, epidemiological, coverage, and prevalence data, as well as costs and effectiveness data from PMTCT and other health interventions in Kenya. The probability tree model produces a total cost per person and a proportion of the population

incurring that cost for each possible outcome in the tree. For example, the model estimates the percentage of pregnant women who are receiving ART and who give birth in a CSO based on the percentage of women who are tested for HIV, the percentage that return for test results, the proportion that receive ART, and the percentage that adhere to their ART regime through birth. For each of the three ownership models, based on each activity's unit cost, the probability tree produces a total cost per person for each of the final outcomes. As mentioned, the final outcomes for women are death or life and the final outcomes for infants are HIV-positive status or HIV-negative status. The model therefore estimates the probability of mortality during a given period for a pregnant woman who receives PMTCT from a CSO and the probability of mortality for a woman accessing care through the other ownership models. Finally, for each ownership model, the probability tree estimates the likelihood of an infant acquiring HIV.

Calculating Cost-Effectiveness

Cost-effectiveness studies typically compare interventions using an incremental cost-effectiveness ratio (ICER). The ICER presents the difference in costs between two or more interventions divided by the difference in effectiveness of those interventions. The intervention with the lowest ICER, or lowest cost per additional unit of effectiveness, is considered to be the most cost-effective alternative. However, the decision to pursue a policy option typically depends on how much a decision maker or society is willing to spend on an additional unit of effectiveness.

To calculate the ICER using this model, the unit cost for each scenario mapped in the probability tree can be added together and multiplied by the size of the target population to produce the total cost for providing PMTCT services to all pregnant woman and infants in the population under each facility ownership model. Then, AIDSFree can calculate total effectiveness for each ownership model, starting with the effectiveness of providing PMTCT services to pregnant women. The life years gained by mothers over a given period are calculated using the differential survival rate of pregnant women for each ownership model. A quality factor can be applied to the life years gained, based on estimates of the gains in quality of life experienced by HIV-positive individuals receiving ART, compared to those not on treatment. For example, Tengs and Lin (2002) estimated that an AIDS patient, enjoys only 70 percent of a healthy individual's quality of life and an asymptomatic HIV patient experiences 94 percent. The resulting calculation yields the number of QALYs gained for the mother from PMTCT services delivered through each ownership model.

The effectiveness of PMTCT for infants is measured by calculating HIV infections averted for each ownership model. The output of the probability tree is the probability of an infant ending up with an HIV-positive diagnosis for each ownership model. The total proportion of HIV-positive infants for each ownership model can be multiplied by the total number of infants in the population and compared with the number of infants who would have contracted HIV without access to PMTCT services. This calculation results in the total number of infant infections

averted per ownership model. Infections averted for infants can be converted to QALYs gained using international estimates and added to the QALYs gained for the mother to produce an effectiveness measure for each ownership model (Holtgrave and Pinkerton 1997).

The cost per QALY gained for each ownership model is calculated by dividing the total cost in dollars by the number of total QALYs gained. Finally, the ICER for each ownership model is calculated by subtracting the cost per QALY gained of the least effective intervention from the cost per QALY gained of the next most effective intervention, producing a cost per additional QALY gained. If a more effective intervention costs more than the alternatives, a policymaker would need to decide how much he or she is willing to spend for an additional QALY.

DISCUSSION AND WAY FORWARD

The objective of this exercise was to assess the current literature related to providing PMTCT services through CSOs and to collect the data to construct a model for assessing the cost-effectiveness of CSOs for providing PMTCT services. The literature review did not find any other studies that specifically evaluated CSOs' cost-effectiveness for providing PMTCT in comparison to public and private facilities. Many cost-effectiveness analyses of PMTCT programs instead focused on the differences among WHO regimens (Option B+ versus Option B versus Option A). Pooling publications and reports on several health services provided by different ownership models, AIDSFree found that CSOs are somewhat less costly and marginally more effective in providing services than public facilities. More specifically, AIDSFree found that:

- On average, providing selected health services in public facilities cost 24 percent more than providing similar services in CSOs.
- Providing STI services cost 34 percent more in public facilities than in CSO facilities, on average.
- Providing HTS cost on average 15 percent more in public facilities than in CSOs.
- CSO facilities performed better than public facilities on all 10 PMTCT effectiveness indicators for which data was available.

However, the dearth of studies in this area confirms the need for additional research on the role of ownership models in determining the cost-effectiveness of a PMTCT program.

Data Gaps and Limitations

This study collected hundreds of data points from published and grey literature on the cost and effectiveness of PMTCT and other health interventions. The data collection process revealed several gaps and limitations in the available information. First, many reports and articles documenting costing, impact, and cost-effectiveness studies of PMTCT programs do not specify the ownership model of the facilities providing the services. Thus, much of the data could not be used for a comparison of the costs and effects of different ownership models.

Second, most studies that did specify the ownership model of the facility where the PMTCT services were delivered were disproportionately conducted in the public sector. This was especially apparent when published effectiveness data was reviewed; AIDSFree found no data for the effectiveness of private PMTCT services and only a few sources for data about CSO-provided PMTCT services.

Third, indicators for both cost and effectiveness of PMTCT services were often not comparable across studies. Costing methodologies differed in the type of PMTCT regimen costed, the drugs used for treatment, and the units used to measure costs. The rapid decline in the cost of ARVs

over the past decade compounded the data incomparability. Costs of ART differed substantially, depending on study year.

Effectiveness indicators also differed substantially across studies. Variations in the type of PMTCT regimen evaluated impacted the effectiveness reported. For example, it was difficult to compare the effectiveness of a CSO in providing the Option A regimen for PMTCT with that of a public sector facility providing Option B+. Changes in prevention guidelines heightened the challenge. Other differences in effectiveness indicators included: the ART timeframe, the testing timeframe, and the definition of loss to follow-up. Furthermore, few studies reported data on Option B+, the regimen now recommended by the WHO.

Addressing Data Challenges

Lack of data comparability made it challenging to conduct a cost-effectiveness analysis based solely on a literature review. Narrowing down the data to include only data from comparable sources reduced the sample size substantially and left gaps in important indicators. To rectify this gap, AIDSFree collected data from studies on other health services that purposely compared the costs and effectiveness of CSOs to costs and effectiveness of service provision in the public and private commercial sectors. Using comparable data from these studies, AIDSFree constructed ratios representing the average differences in costs and effectiveness among ownership models. To increase comparability of data, AIDSFree also selected a single country (Kenya) for our focus. Kenya was selected because costing data from both adult and child HIV programs was available for the same geographical area, and collected during the same time period. AIDSFree was able to use this information to create more specific ratios to represent the average difference in the costs of components of HIV programs provided by CSO and public institutions.

The ratios constructed from many different health interventions in various countries suggested, on average, that it costs less for CSOs to deliver health services than for public or private providers and that CSOs are also more effective in their service provision than public providers (with effectiveness data from private providers insufficient to draw a conclusion). The ratios constructed from the costs of HIV programs in Kenya suggested that for CSOs to deliver ART was less costly than for the public sector to do so, to both adults and children. On the other hand, the ratios highlighted that providing voluntary counseling and treatment is more costly for CSOs than for the public sector.

Finally, AIDSFree created a probability tree to calculate the cost-effectiveness of PMTCT provided by CSOs and, as discussed, developed an approach for converting the outputs of the probability tree model into an ICER that can be used by policymakers. However, gaps in information for costs and effectiveness of PMTCT services delivered under different health

facility ownership models persisted, and AIDSFree did not ultimately calculate their comparative cost-effectiveness for provision of PMTCT.

Next Steps

Conducting a rigorous evaluation of the cost-effectiveness of PMTCT programs delivered by CSOs requires complete, comparable data on both costs and effectiveness. The most effective way to acquire the necessary data is through field data collection at a sample of CSO, public, and private commercial facilities in a single country. Collecting data from the field would limit the variability arising from data collection in different countries with differing national PMTCT and HIV policies and changes in ARV costs over time. Most importantly, a field costing study could be designed to collect data on the same indicators at facilities using a standard methodology from each ownership model, thus circumventing the factors contributing to the incomparability of the data collected during the literature review.

The next steps for completing the cost-effectiveness analysis include choosing a study site, defining the facility sample size, and organizing data collection. To ensure that the necessary effectiveness data is available, data collection should occur at facilities that have well-functioning information, monitoring, and evaluation systems as well as previous experience collecting impact and outcome data from PMTCT programs.

CONCLUSION

This report summarizes the steps taken to conduct a cost-effectiveness analysis of PMTCT services delivered by CSOs. It develops a definition of PMTCT services and the various ownership models through which those services are delivered. The report also explains the methodology used for reviewing the current literature on the cost-effectiveness of PMTCT and other health interventions delivered by CSOs, and presents the results of the review. It explains the process of developing a cost-effectiveness evaluation in a step-by-step manner and describes how the data collected during the literature review should be analyzed and input into the cost-effectiveness model. Finally, the report highlights the gaps in available data and suggests that the best course to overcome data collection challenges is to conduct a field costing exercise and effectiveness evaluation of PMTCT services delivered under different facility ownership models.

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