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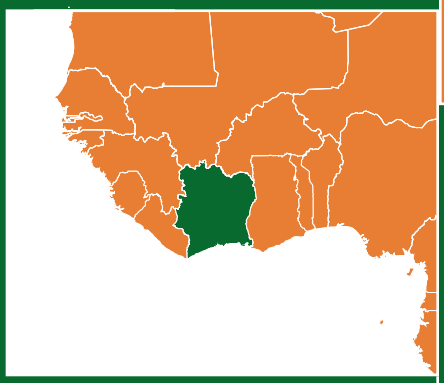
ESTIMATING THE COST OF HIV TREATMENT FOR ADULTS, CHILDREN, AND PREGNANT WOMEN IN CÔTE D'IVOIRE



Final Report

USAID
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HEALTH POLICY PROJECT

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This version of the report is pending a signed foreword by the Ministry of Health. This limited print copy is for USAID internal review only and is not for wider dissemination.

Estimating the Cost of HIV Treatment for Adults, Children, and Pregnant Women in Côte d'Ivoire

Final Report

AUGUST 2015

This publication was prepared by the Health Policy Project, in consultation with the Ministry of Health of Côte d'Ivoire.

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ACKNOWLEDGMENTS

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- United States Government implementing partner organizations: ACONDA, Ariel Glaser Pediatric AIDS Foundation, Elizabeth Glaser Pediatric AIDS Foundation, Health Alliance International, ICAP, and Management Sciences for Health

EXECUTIVE SUMMARY

The government of Côte d'Ivoire is committed to the fight to gain control and turn the tide of the HIV epidemic. In 2011, Côte d'Ivoire joined forces with other committed nations to strive toward a world free of AIDS by signing the Political Declaration on HIV/AIDS: Intensifying our Efforts to Eliminate HIV/AIDS (MSLS 2014). Striving to offer the best standard of HIV treatment, the country aims to adopt the new 90-90-90 target. (By 2020, 90 percent of those living with HIV will know their status, 90 percent who know their status will be on treatment, and 90 percent of those on treatment will be virally suppressed.) The country also aims to roll out "test and offer" for the general population in the near future and begin piloting Option B+ for pregnant women in 2015. Such an intense scale-up of HIV treatment services will require intensified coordination to mobilize resources and effectively target those funds for treatment scale-up and sustainability.

The aim of this cost-outcome analysis study was to estimate the cost of HIV treatment scale-up and the impact of such an expansion by estimating the cost of treatment for one person per year for adults, children, and pregnant women. Currently, limited data exist around the unit cost of HIV treatment in Côte d'Ivoire. To inform policy decisions on how best to finance scale-up of treatment with the limited resources available, understanding the outcome of HIV treatment—and the levers for improving the chances of successful treatment—is critical.

This study found that a total investment of approximately CFA147 billion (US$297 million) is required over the next five years, leading up to the year 2020, to achieve the 90-90-90 target and a 100 percent roll-out of the Option B+ approach for the prevention of mother-to-child transmission (PMTCT). This investment will save more than 35,000 lives and prevent more than 6,000 children from becoming infected via PMTCT compared to the status quo, in which treatment coverage increases at the historical pace.

The study found several opportunities for improvements in the efficiency and quality of HIV treatment, which should be considered in conjunction with resource mobilization to catalyze the treatment scale-up:

- Treatment scale-up requires incremental increases in financial resources, from CFA22.6 billion (US$45.7 million) in fiscal year 2016 to CFA39.1 billion (US$79.1 million) by fiscal year 2020. The government of Côte d'Ivoire should consider developing a resource mobilization strategy to identify opportunities and advocate for additional HIV funding both from within the government and development partners, and identify opportunities for private sector contributions.
- The study shows that significant numbers of patients are being lost to follow-up throughout the treatment cascade. Côte d'Ivoire is on the right track by proceeding with the adoption of the "test and offer" guideline and the roll-out of Option B+ to reduce pre-treatment patient loss. In conjunction with these efforts, further research should be conducted to assess where the patients, especially children, are being lost.
- Achieving cost reduction for antiretroviral medicines will be critical, as these make up the largest portion of the total annual treatment cost. The study found that regimens not aligned with the national treatment guidelines still are being dispensed. To improve treatment outcomes, the government of Côte d'Ivoire should ensure that patients are given treatment in accordance with the national treatment guidelines. Streamlining dispensation of drugs also will improve the country's ability to make bulk purchases, which can lead to cost reductions.
- Laboratory monitoring also requires further alignment with national treatment guidelines. According to the study data, many patients receive only one lab test after initiating treatment, which can delay identification of treatment failure and shifting to alternative regimens. The

government of Côte d'Ivoire should make sure that laboratory staff at the sites are trained to perform routine lab monitoring tests per the national treatment guidelines and that data managers are correctly, accurately, and frequently entering data.

- This study leveraged a nationwide roll-out of the electronic health record (EHR) system, which provides a great opportunity for further data analysis and research. The government of Côte d'Ivoire should make sure that the facility staffs have the capacity to input correct and complete data, and routinely analyze them to yield valuable insights as to the successes and challenges of HIV treatment.

The data gathered show that the average annual treatment cost for adults in the study sample who were on treatment for 12 months and responding was CFA103,856 (US$210), whereas for pediatric patients, it was CFA93,965 (US$190). The average treatment cost was CFA75,172 (US$152) for pregnant women who started PMTCT, stayed on treatment through to their due dates, and responded to treatment. However, these patients usually were not getting the full package of treatment services expected based on the national treatment guideline. For example, the study data showed that adult and pediatric patients received one lab test per year on average and were dispensed antiretrovirals for 290 days and 237 days, respectively. Thus, by appropriately accounting for the cost of the full year of treatment expected by following the national treatment guidelines, **the true total annual cost of treatment would be CFA142,408 (US$288) for adults, CFA217,409 (US$440) for children, CFA84,821 (US$172) for PMTCT Option B, and CFA 102,151 (US$207) for PMTCT Option B+.**

The study calculated the positive outcome production cost—the total investment in all patients to yield one successful responding patient. The cost was CFA290,797 (US$588) for adults, CFA446,086 (US$902) for children, and CFA326,404 (US$660) for pregnant women. This calculation means that to yield one adult patient classified as a treatment success, Côte d'Ivoire currently is spending CFA290,797 (US$588), which includes all of the resources expended on other patients who died, were lost to follow-up, or were unresponsive to treatment. The positive outcome production cost is more than double the average cost of annual treatment of patients on treatment and responding; this significant difference in the cost shows that there are significant resources "lost" within the treatment cascade.

Looking at the relationship between cost, outcome, and other variables of interest for adults, the cost correlated with age, time-to-treatment initiation, and the cluster of differentiation 4 (CD4) count at the start of treatment. Older age at initiation correlated with higher annual treatment cost, and a higher CD4 count at start of treatment correlated with lower cost. Interestingly, a longer time from diagnosis to treatment initiation correlated with a lower total cost of treatment for adults. On the other hand, for pediatric patients, a longer time from diagnosis to treatment initiation correlated with a higher total cost of treatment.

This report describes a 12-month retrospective study focusing on patients who initiated antiretroviral treatment between October 2012 and September 2013 at 25 health facilities in four health regions of Côte d'Ivoire (Abidjan 1, Abidjan 2, Gbeke, and Gbokle-Nawa-San Pedro). The study applied a cost-outcome approach, established by Scott, et al. and refined by Kallarakal et al., in which we gathered facility cost and utilization data to generate a facility-specific service unit cost, which was then applied to each patient's unique HIV service utilization to calculate the patient-specific annual cost of treatment. The study team and the technical advisory group were established in September 2014, data collection occurred from January to April 2015, and the report was finalized in July 2015.

There were two types of data collection: (1) at the facility, to generate each one's unique cost for providing one HIV service, such as a consultation or a lab test; and (2) through the implementing partners, for anonymized EHRs of patients who were on treatment during the study period. Data required to generate facility-specific service unit costs sometimes were missing, potentially influencing the

accuracy of the unit cost. This was especially true for smaller facilities that did not have extensive financial management capacity. The study team used national standards and sample averages to fill gaps as much as possible.

The team analyzed the data to generate each facility's cost of providing one unit of HIV service. We then combined the unit costs with patient records to calculate the patient-specific annual treatment cost. Following that calculation, we classified patients based on outcome: on treatment and responding; on treatment and not responding; and not on treatment (lost to follow-up or dead). The team calculated positive outcome production cost based on total cost invested to yield one successful patient responding to treatment to assess the current efficiency of the health system in getting people on treatment, retaining them on treatment, and providing treatment to which the patient responds. Finally, we compared the annual treatment cost and outcome against several variables to determine whether there were any factors that positively or negatively influenced cost and outcome.

To estimate the total resource necessary to scale up treatment based on coverage goals, the study team first calculated the true annual cost of treatment and combined it with the Spectrum model's projected number of people on treatment to estimate the cost and impact of scaling up treatment to achieve the 90-90-90 goal.

ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral Treatment
ARV	Antiretroviral Medication
CD4	Cluster of Differentiation 4
EHR	Electronic Health Record
FDC	Fixed-dose Combination
HIV	Human Immunodeficiency Virus
INS	Institut National de la Statistique
MOH	Ministry of Health and the Fight against AIDS
MSLS	*Ministère de la Sante et de la Lutte Contre le SIDA*
PEPFAR	The President's Emergency Plan for AIDS Relief
PMTCT	Prevention of Mother-to-Child Transmission
SIGDEP	*Système d'Information de Gestion des Dossier Electronique des Patients*
TAG	Technical Advisory Group
UNAIDS	United Nations Programme on HIV/AIDS
WHO	World Health Organization

BACKGROUND

Global HIV Epidemic and Treatment Recommendations

Since 2000, the World Health Organization (WHO) has recommended HIV treatment standards for the global community. These standards have helped mobilize national governments and their development partners to increase treatment coverage to reduce HIV-related morbidity, mortality, and incidence. Historical data show that a 10 percent increase in treatment coverage correlates with a 1 percent reduction in HIV transmission rates at the population level (UNAIDS 2014). Through these concerted efforts by the global community, almost 14 million people were on treatment in 2014, and new HIV infections fell by 13 percent between 2010 and 2013 (UNAIDS 2014).

To build on past successes, in 2014, the WHO set the ultimate goal of ending the AIDS epidemic by 2030. To achieve this goal, the Joint United Nations Programme on HIV/AIDS (UNAIDS) has set forth an intermediate strategy of "90-90-90 by 2020," whereby 90 percent of those living with HIV will know their status, 90 percent of those who know their status will be on treatment, and 90 percent of those on treatment will be virally suppressed by 2020. To achieve this intermediate strategy, the new WHO treatment recommendation, anticipated to be released in late 2015, will include the "test and offer" scale-up approach—with this approach, anyone who is HIV+ is put on treatment immediately, regardless of cluster of differentiation 4 (CD4) count. Through this rapid scale-up approach, countries around the globe can start outpacing the epidemic.

Such a response requires coordinated efforts by all stakeholders at the global, national, and subnational levels. This last mile in the HIV fight will be more difficult and costly to reach, as the goal is to ensure that the entire population, especially those hardest to reach, disenfranchised, or under-served, is covered by antiretroviral treatment (ART).

Despite targeted efforts to increase prevention of mother-to-child transmission of HIV (PMTCT) with the roll-out of Option B+, the number of children on ART is lagging behind that of adults (UNAIDS 2014). Multiple factors contribute to this treatment gap, such as challenges in providers being able to identify potential cases and having the knowledge and tools to appropriately diagnose pediatric HIV cases. Other factors include discomfort among healthcare workers about treating pediatric HIV cases due to lack of familiarity; community, social, and behavioral barriers to early access to care, including parent's or guardian's lack of understanding about the benefits of HIV treatment for children; and limited pediatric-friendly ART formulations. It is critical that countries understand the cost and impact of treatment scale-up so they can mobilize resources effectively and appropriately, and use them efficiently to meet their treatment goals.

HIV in Côte d'Ivoire

Côte d'Ivoire has the one of the highest HIV prevalence in West Africa, at 2.7 percent (UNAIDS 2014). The Spectrum model projects that approximately 400,000 people are living with HIV in 2015. On average, HIV is more prevalent among women than men, and this gender gap is most prominent among youth and young adults (ages 15–29) (INS and ICF International 2013).

Currently, the standard treatment protocol in Côte d'Ivoire for children and adults provides universal treatment for children under the age of two, and patients with a CD4 count less than 350 cells/mm^3, at WHO stage 4, with active TB, or co-infected with Hepatitis B (MSLS and WHO 2013). The country is moving toward universal treatment coverage and plans to adopt the "test and offer" approach based on the anticipated WHO recommendation.

Côte d'Ivoire's PMTCT protocol was updated in 2012 to Option B. The Ministry of Health and the Fight against AIDS (MOH) intends to roll out Option B+ starting in 2015, beginning with a targeted pilot program in high-prevalence health regions.

It is estimated that 112,920 people living with HIV received ART in 2013, including 5,467 children (age 14 and below) (MSLS 2014). Of the HIV+ women who were pregnant, 75 percent had access to some form of PMTCT in 2013 (UNAIDS 2014). On the other hand, ART coverage extended to only 36 percent of the adult HIV+ population and only 8 percent among children living with HIV. The team derived these coverage estimates from the country-specific Spectrum model developed for the UNAIDS 2014 Gap Report.

Electronic Health Record System in Côte d'Ivoire

Since 2008, Côte d'Ivoire, with PEPFAR support, has been installing an electronic health records (EHRs) system, *Système d'Information de Gestion des Dossier Electronique des Patients* (SIGDEP) in health facilities. As of early 2015, close to 400 health facilities out of the 482 PEPFAR-supported sites were in various stages of setting up SIGDEP. Although the government initially is rolling out the system for HIV services only, the vision is to expand it to cover all health areas in the future.

The SIGDEP database comprises two parts: clinical and pharmacy. Clinical SIGDEP builds from the paper record system set up by the MOH for HIV patients and gathers data on a patient's clinical history; consultation records, including WHO staging and treatment status; and laboratory test results. The clinicians and lab technicians use this paper record to note the patient data, which data managers then enter into the clinical SIGDEP system on a daily basis. Pharmacy SIGDEP tracks all ART dispensation by patient. The pharmacy staff enters and manages the pharmacy SIGDEP separately from the clinical SIGDEP data.

At the time of study implementation, the MOH was developing a system to link all SIGDEP at the facilities with a central database housed at the MOH. In the interim, to collect and analyze the data being entered into the SIGDEP at the facility level, the MOH collects data from each one using the monthly reporting tool; monitoring and evaluation officers at the district level aggregate all data coming from the sites and send them to the national MOH office to compile the country-level database. The U.S. Government's implementing partners that support the sites also gather this information (typically monthly or quarterly) for their own reporting purposes and to inform programmatic decision making.

Study Justification

The government of Côte d'Ivoire is committed to the fight to gain control and turn the tide of the HIV epidemic. In 2011, Côte d'Ivoire joined forces with other committed nations to strive toward a world free of AIDS by signing the Political Declaration on HIV/AIDS: Intensifying our Efforts to Eliminate HIV/AIDS (MSLS 2014). When the country adopts the new 90-90-90 target and rolls out "test and offer" for the general population, as well as Option B+ for pregnant women, it will require intensified coordination to mobilize resources and effectively target those funds for treatment scale-up and sustainability.

The national HIV response has been financed primarily by PEPFAR and the Global Fund (the Global Fund) to Fight AIDS, Tuberculosis and Malaria. The country spent CFA21.7 million (approximately US$106 million) on HIV care and treatment in 2011, of which the government of Côte d'Ivoire paid 11.7 percent, and its development partners 87.6 percent (MSLS 2013). The U.S. Government, through PEPFAR, began HIV-related support to Côte d'Ivoire in 2004. This support typically has taken the form of technical assistance and procurement of commodities and laboratory equipment and supplies. The

Global Fund coordinates its funding and procurement of commodities with the government of Côte d'Ivoire and PEPFAR, and provides technical assistance to sites not supported by PEPFAR.

There are limited data around the unit cost of ART in Côte d'Ivoire (MSLS and HPP 2013, Beauliere, et al. 2010). Also, past costing studies in Côte d'Ivoire did not analyze cost against treatment outcomes. As the country aims to increase its treatment coverage to improve the health outcomes and livelihoods of its citizens, the resource needs increase; in the context of the global financial crisis, donor funding cannot be regarded as a long-term strategy to sustain and grow HIV treatment. To inform policy decisions on how best to finance scale-up of treatment with the limited resources available, understanding the outcome of HIV treatment—and the levers involved in improving the chances of successful treatment—is critical.

Such a cost-outcome study was first conducted in 2008 by Rosen, et al. in South Africa and has been replicated several times in other parts of sub-Saharan Africa (Rosen, Long and Sanne 2008, Meyer-Rath, et al. 2012, Scott, et al. 2013). However, the scale of these studies has been limited due to the time-consuming process of manually pulling and reviewing patient data from paper records. As EHRs become more widely adopted throughout health systems in low- and lower-middle-income countries, it will become significantly easier to gather the necessary data to conduct a cost-outcome analysis. Kallarakal et al. have been able to scale the cost-outcome analysis approach from several hundred to several thousand by using EHRs in their work in Haiti and Tanzania (Kallarakal, et al. Publication pending). EHR is a key enabler for routinely measuring the cost and outcome of HIV services to monitor and to inform public health programming.

Côte d'Ivoire is one of the first sub-Saharan African countries to roll out EHRs extensively and is well positioned to utilize the cost-outcome analysis to inform the national scale-up of HIV treatment. **The aim of this study was to estimate the cost of HIV treatment scale-up and the impact of such treatment expansion by calculating the cost of treatment for one person per year for adults, children, and pregnant women.** It analyzed the annual cost of treatment as a function of regimen, stage of illness, when treatment was initiated, retention, and responsiveness to treatment. By using the average annual cost of treatment in conjunction with treatment coverage goals, the study estimated the resources required to achieve universal coverage in Côte d'Ivoire. Additionally, it modeled the impacts of various coverage scenarios regarding infections prevented and deaths averted in the future.

This study will fill the critical information gap on cost as it relates to outcomes. The government of Côte d'Ivoire and its development partners will be able to understand the resources needed for treatment scale-up and will have the data to inform decision making on how to effectively target available resources for HIV treatment.

METHOD

Overview of the Study Process

This study was a 12-month retrospective study focusing on patients who initiated ART between October 2012 and September 2013 in 25 health facilities in four health regions of Côte d'Ivoire (Abidjan 1, Abidjan 2, Gbeke, and Gbokle-Nawa-San Pedro). It applied a cost-outcome approach established by Scott et al. and refined by Kallarakal et al. (2013; publication pending), in which we gathered facility cost and utilization data to generate facility-specific service unit cost, which we then applied to each patient's unique HIV service utilization to calculate the patient-specific annual cost of treatment. The study team and the technical advisory group (TAG) were established in September 2014, data collection occurred between January and April 2015, analysis was conducted between April and June 2015, and the report was finalized in July 2015.

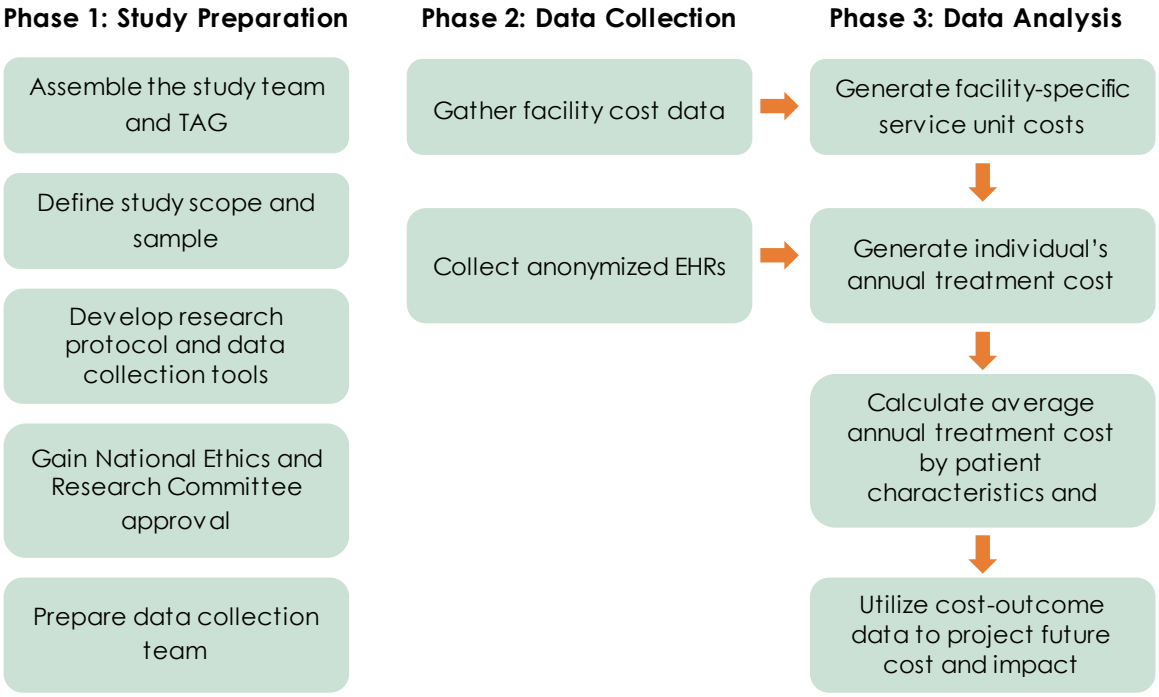
The study had three phases: study preparation, data collection, and data analysis, as summarized in Figure 1 below. During the study preparation phase, the study team and the TAG were established, the study team defined the scope in consultation with the TAG, the study protocol was developed, the team received approval of the study from the National Ethics and Research Committee, and the data collection team was assembled.

In the data collection phase, the data collection team collected data to generate each facility's unique cost of providing one HIV service, such as a consultation or a lab test. Simultaneously, it separately gathered the anonymized EHRs of patients who were on treatment during the study period.

In the final phase, the study team analyzed the data to generate each facility's cost of providing one unit of HIV service. It then combined these unit costs with patient records to calculate the patient-specific annual treatment cost. Furthermore, the team, by applying the method established by Kallarakal et al., calculated the "Positive Outcome Production Cost," based on the total cost invested to yield one successful patient responding to treatment, so as to assess the current efficiency of the health system in getting people on treatment, retaining them, and providing treatment to which the patient responds (publication pending). It then compared the annual treatment cost and outcome against several variables to see if there were any factors that positively or negatively influenced cost and outcome.

To estimate the total resource necessary to scale up treatment based on coverage goals, the study team first calculated the true annual cost of treatment. Since the average treatment of the sample did not fully meet the necessary requirements of the national treatment standards (i.e., on average, patients received a suboptimal number of lab tests and treatment days), the average annual treatment cost had to be adjusted upward to account for the expectation that patients will be provided with a complete package of care. The team combined this true annual cost of treatment with the Spectrum model's projected number of people on treatment to estimate the cost and impact of scaling up treatment to achieve the 90-90-90 goal.

Figure 1: Study Process



Phase 1: Study Preparation

The study commenced in September 2014 with the establishment of the study team and the TAG. The scope was defined to estimate the annual treatment cost for both adults and children, and for pregnant women enrolled in PMTCT.

The study sample consisted of 25 facilities,[1] all of which met the following criteria:

- Each site was in one of the five health regions that had the highest HIV prevalence (Abidjan 1, Abidjan 2, Agneby-Tiassa-Me, Gbeke, and Gbokle-Nawa-San Pedro).
- At each site, SIGDEP was operational in both its clinic and pharmacy.
- The team removed unconventional service provision sites, such as military and school clinics, and private sites from the sample, as their cost structures were likely to be significantly different from stand-alone public facilities that make up the majority of ART provision sites in Côte d'Ivoire.

Sample facility characteristics are summarized in Table 1.

[1] Initially, 40 sites were randomly selected based on the criteria, but the study team found that 15 sites did not have a fully operational SIGDEP in both their clinics and pharmacies. Thus, those sites were taken out of the sample, leading to 25 sites in four health regions.

Table 1: Study Sample, by Facility Type and Health Region

Facility Type	Abidjan 1	Abidjan 2	Gbeke	Gbokle-Nawa-San Pedro	Total
Dispensary	1				1
Health Center		5		1	6
Health Facility	5	2			7
Hospital	2	5	1	2	10
Maternity				1	1
Total	**8**	**12**	**1**	**4**	**25**

Study protocol and data collection tools were developed and submitted to the Côte d'Ivoire National Ethics and Research Committee in December 2014. The study received the committee's approval in January 2015, at which time the team mobilized and trained 30 data collectors.

Phase 2: Data Collection

Facility data

The study gathered facility financial and utilization data for the January–December 2013 period. The data collectors retrieved the data in early 2015, so presumably 2014 calendar year facility data would have been available. However, the facilities were not likely to have had enough time to produce an annual report during the data collection period. For this reason, the team decided to collect the 2013 calendar year data.

The study collected the following data:

- Facility service utilization data: number of outpatient visits and inpatient admissions for each facility, broken down by adults and children, as well as specifically for adult HIV, pediatric HIV, and PMTCT services
- Facility staffing data: total number of staff at each facility; number and average salary of healthcare providers working at each of the HIV services by cadre; number and average salary of indirect/administrative staff
- Facility HIV service provision data: types of HIV services provided at each facility; type of staff involved in providing the service; number of minutes dedicated by each provider type to complete the service
- Facility operational and financial data: number and cost of supplies and equipment utilized for HIV services; expenditures for facility operation, such as utilities and rent

During February and March 2015, the data collectors gathered these data at the health facilities on paper data collection forms. In March and April, the data entry team put the data into a custom data entry tool in Excel. The data management team cleaned and verified the data by reviewing them with the data collectors and contacting health facilities to confirm data or gather missing data, as necessary. Several facilities did not have expenditure data on salaries and supplies for consultation and lab tests. For this reason, for salary data, the team sourced supplemental data from the MOH and the implementing partners supporting these sample sites, and used PEPFAR procurement data for supplies for consultations and lab tests. See Annex B for a detailed list of data used in the facility costing and the data sources.

Electronic health records

This study focused on patients who initiated treatment between October 1, 2012 and September 30, 2013. Since the study tracked a patient over the course of his/her first year of treatment, the study team gathered consultation, lab, and pharmacy dispensation data for October 1, 2012 through September 30, 2014 (the study period).

The implementing partners had the most up-to-date SIGDEP database and the capacity to extract specific data from it. For this reason, the study team requested their support to extract the following anonymized data:

- Demographic data of patients on treatment during the study period
- Consultation data of patients in HIV care during the study period
- Lab results of patients in HIV care during the study period
- Pharmacy dispensation for patients on treatment during the study period

Phase 3: Data Analysis

Calculating service unit cost

Using the collected facility data, the study team calculated the cost of one consultation and one lab test,[2] disaggregated by direct personnel, direct supplies, and indirect costs. Using Excel, the team calculated this service unit cost for each facility for each patient type (adult, pediatric, and pregnant women).

The team adopted an economic perspective to evaluate the total cost for the payer; as the study focused on public sector facilities only, the payers would be the government of Côte d'Ivoire and the development partners who support HIV service provision. The team valued all donated inputs and volunteer work on the assumption that these products and services were essential to treatment provision and would require funding if all costs were to be covered in the future. We converted all inputs reported in U.S. dollars into CFA Francs using the 2013 annual average exchange rate,[3] which we also used in this report to convert the CFA Franc results back into dollars.

Specifically, the team calculated direct costs using an ingredient approach. For direct personnel costs, the study team first calculated the average cost per minute for each staff type, using annual salaries, any additional benefits, and the value of on-the-job training provided for the cadre. To generate the direct personnel cost for each service, we then multiplied this per-minute personnel cost by the average time each cadre spent on a specific service. We used national salary standards if the facility did not have the salary information.

Since most facilities did not account for the use of consumables by ward or clinic, for direct supplies costs, we estimated the number of supplies utilized for each service using PEPFAR procurement data, which calculated the expected supplies required for one service in addition to the price of each supply item.

Indirect costs include recurrent operating costs, equipment and capital expenditures, and indirect personnel. We first calculated these costs for the whole clinic and then a per-patient annual indirect cost based on the ART service patient volume. Recurrent operating costs initially included electricity, water,

[2] All facilities in the data sample stated that they always conduct CD4 and routine blood tests, such as biochemistry and hematology, together. Thus, this study has combined all of those lab tests into one lab unit cost.

[3] CFA494.552 = US$1.00.

telephone, fuel, internet service, lab quality assurance, waste management, external laboratory services, and building and ambulance maintenance. We eventually excluded water and electricity from the analysis, due to the low number of facilities with these data. We supplemented missing values for the remaining categories using average total operating costs per facility type across the sample. For capital expenditures, we used a 15 percent annual depreciation rate. When the purchase year was not reported, the team assumed a date of 2013. If purchase costs were missing, we applied average total equipment costs per facility type across the sample.

We calculated the annual cost of antiretroviral medicines (ARVs) for each patient by multiplying the unit cost of the drug by the number of days of drugs dispensed for that patient during the 12 months after treatment initiation. The team gathered patient drug utilization data from the SIGDEP pharmacy data. We calculated the unit cost of ARVs, defined as a daily cost, using the national procurement price of the ARV and dividing it by the volume of syrup or number of pills in the unit, and then multiplying by the required amount of the formulation for one day of treatment.

Patients could take triple combination therapies in a variety of forms, such as pills or syrups, up to four pills. As the SIGDEP data did not specify how the drug was dispensed (i.e., whether in pills or syrup, and whether multiple loose pills comprised one regimen or one pill for an entire regimen), our default assumption was that the facility dispensed the "one pill a day" fixed-dose combination (FDC) drug if that option was available according to the Global Fund procurement data. For regimens in which an FDC drug was not available, we assumed that facility personnel prescribed the combination yielding the least number of pills. If certain multiple combinations of drugs can yield the same regimen with the same number of pills per day, we reviewed the Global Fund procurement data to see which drug formulations were purchased more frequently or in larger quantities.

The analysis accounted for pediatric patients' ability to take pills as compared to syrup by assuming that even if meeting the weight criteria, the patient still used the syrup if he/she was age three or younger. We assumed that patients who met the weight criteria and were four or five years old took syrup or pills in a 50-50 proportion, and that children age six or older took pills. In some cases, facility personnel prescribed drug regimens that are not part of the national treatment guideline ("non-standard regimen") (MSLS and WHO 2013). For these, we calculated ARV cost using the same assumptions as above to yield the drug combination that required the least number of pills. See Annex C for the list of ARVs, regimen type (first line, second line, and non-standard), and the unit cost used in the study.

Estimating annual treatment cost by patient

Using STATA—a data analysis and statistical software package— the study team analyzed the SIGDEP consultation data and identified patients who initiated treatment during the study period. We compiled all of the consultation, laboratory results, and pharmacy dispensation records for the patient from the time of treatment initiation.

For general adult populations and children, we tallied the number of consultations and lab tests conducted during the 12 months since treatment initiation. We also aggregated the number of treatment days per regimen dispensed by the pharmacy for the 12-month period. We categorized the patient's consultation closest to the 12-month mark as "last consultation" and the lab test closest to that mark as "last lab result."

We adopted the outcome categorization criteria defined by Kallarakal et al. for general adult and pediatric patients, and slightly modified this categorization for pregnant women (publication pending). We assigned the general adult and children's outcomes first based on whether they were still in care and on treatment after 12 months of treatment initiation, and second if they were still on treatment, based on whether they were responding to it based on WHO stage or CD4 count. We based the determination of whether the patient was on treatment after 12 months on the date of their last consultation. If the last

consultation was within the 90-day period before or after the 12-month mark, we deemed the patient as "on treatment." If the patient's last consultation occurred within the first nine months of the treatment initiation, we assumed the patient was "lost to follow-up," which was categorized as "not on treatment." We also categorized patients who died during the 12-month period as "not on treatment."

For those who were on treatment at the 12-month mark, the study defined their treatment outcome in alignment with WHO guidelines. We categorized those patients classified as WHO stage 3 or 4 during their last consultation as "not responding to treatment." Even if the patient was classified as WHO stage 1 or 2, if the CD4 count had not increased more than 50 cells/mm^3 over the course of treatment, we deemed the patient as not responding to treatment. Thus, we categorized only patients classified as WHO stage 1 or 2 who also had their CD4 counts rise more than 50 cells/mm^3 as "responding to treatment."

If we knew the patient was on treatment but data were missing on health status (i.e., WHO staging or CD4 count) so that their treatment outcome could not be determined, we took the patient out of the sample; we did the same for patients who were transferred out.

In the case of pregnant women, we tallied the number of consultations and lab tests conducted between the time of treatment initiation and expected due dates. We categorized the pregnant women's consultations closest to their due date as "last consultation" and the pregnant women's lab tests conducted closest to their due date as "last lab result."

We applied outcome classification similar to those of general adult HIV+ patients for pregnant women, but assessed the treatment retention based on whether the pregnant woman returned for treatment up to her due date. If the woman's last consultation was within the 30-day period of the due date, we deemed her to be "on treatment." If her last consultation was more than 30 days before that date, we categorized the patient as "lost to follow-up" and thus "not on treatment."

The team's outcome classification of pregnant woman on treatment at the time of due date was the same as for the general adult and pediatric patients. We summarize the outcome criteria in Table 2.

Table 2: Definition of Treatment Outcome

Outcome	General Adult and Pediatric Patients	Pregnant Women
On treatment	Patient is alive and on treatment 12 months after initiating ART, as defined by patient's last consultation occurring within the 90-day period before or after the 12-month mark	Patient is alive and on treatment on due date, as defined by patient's last consultation occurring within the 30-day period before or after the due date
On treatment—not responding	Patient is on treatment at 12 months after initiation of ART and:	Patient is on treatment on due date and:
	• Classified as WHO stage 3 or 4 during the last consultation OR • Classified as WHO stage 1 or 2, but CD4 count had not risen more than 50 cells/mm^3 from treatment initiation*	
On treatment—responding	Patient is on treatment at 12 months after initiation of ART and:	Patient is on treatment on due date and:
	• Classified as WHO stage 1 or 2 AND • CD4 count has risen more than 50 cells/mm^3 from treatment initiation*	
Not on treatment	Patient has died or been declared lost to follow-up. "Lost to follow-up" is defined as patient's last consultation being less than 9 months after treatment initiation	Patient has died or has been declared lost to follow-up. "Lost to follow-up" is defined as patient's last consultation being more than 30 days prior to due date

* Some of the last consultations were missing a CD4 count. In such a case, we used the CD4 count for the last lab result. The last lab result was used only if the lab was conducted within the 90-day period before or after the 12-month mark for general adult and pediatric patients, and the 30-day period for pregnant women. If the last lab result was not within this period, we removed the patient from the study.

We applied the service unit cost calculated in the previous step to each patient's annual treatment record (i.e., number of consultations conducted, number of lab tests conducted, and number of days of treatment received per treatment regimen) to calculate the patient's unique annual treatment cost.

Cost-outcome analysis

The study produced a metric, "Positive Outcome Production Cost," that reflected the total cost invested by the health system to produce one successful patient on treatment and responding. We calculated the positive outcome production cost by dividing the total cost expended to treat all patients within a cohort (HIV+ adults, children, or pregnant women) by the number of HIV+ patients successfully responding to treatment. The better the country is in getting people on treatment, retaining them, and improving their health status, the lower this positive outcome production cost will be.

The study team also analyzed cost and outcome against the following variables to see if there were any relationships:

- Age at initiation
- Time between HIV care initiation and treatment initiation (time to initiation)
- CD4 count at initiation of ART
- Treatment course (first line, second line, or non-standard)

The analysis procedure differed based on whether the variables were categorical or continuous. The analysis method is summarized in Table 3.

Table 3: Cost-outcome Analysis Method

	Cost Comparison (continuous variable)	Outcome Comparison (categorical variable)
Age at initiation (Continuous variable)	Correlation analysis	Average and standard deviation of age at initiation, by outcome type
Time to initiation (Continuous variable)	Correlation analysis	Average and standard deviation of time to initiation, by outcome type
CD4 count (Continuous variable)	Correlation analysis	Average and standard deviation of time to initiation, by outcome type
Treatment course (Categorical variable)	Average and standard deviation of treatment cost, by regimen type	Count and percentage of regimen type, by outcome type

Cost and impact projection

The team estimated the total resources necessary to achieve treatment coverage by multiplying the total number of people on treatment (an output of the Spectrum model) with the true cost of annual treatment. This true cost of treatment was based on the study sample's average cost of annual treatment for patients on treatment and responding, adjusted to align with the national treatment guideline. We made adjustments to the number of days of ARVs dispensed and the number of lab tests, since the average number of days on treatment was less than 365 days and average number of lab tests was lower than five, the number expected based on the national treatment guideline. This adjustment produces a "true cost of successful annual HIV treatment."

Furthermore, although the study focused on the first year of treatment, the projection includes those who have been on treatment for longer than one year. These patients will require fewer consultations and lab tests than those in their first year of treatment. Thus, the study assumed that patients who have been on treatment for longer than a year will receive consultations four times a year and labs twice a year, in accordance with the Côte d'Ivoire national treatment guideline. We based the projection of futures costs on the 2013 fixed U.S. dollar.

The study used the Spectrum model to project population growth, number of people living with HIV, number of people on treatment, number of new infections, and number of deaths due to HIV between 2015 and 2020 based on planned ART treatment coverage. We modeled two scenarios: (1) status quo—historical rate of growth in treatment coverage; and (2) 90-90-90—90 percent of those who know their status are on treatment by 2020, and the roll-out of PMTCT Option B+ is complete by 2020.

Under scenario 1, we applied the coverage growth rate between 2009 and 2015 constantly through to 2020. Given the impressive increase in PMTCT coverage over the last six years (from 44% in 2009 to 75% in 2015), the status quo scenario expects PMTCT to grow consistently to reach 100 percent coverage by 2020. With the intended roll-out of Option B+, Option B coverage would decline as sites adopt Option B+; we assumed that by 2020, 50 percent of pregnant women will be covered by Option B+.

In scenario 2, we modeled the coverage growth rate to increase exponentially to the 90-90-90 coverage goal. For PMTCT, we projected treatment coverage in 2020 to be 100 percent, and the swift move from Option B to Option B+ to be complete by 2018. For other adults and children, we set the coverage target for the total HIV population at 81 percent, since the 90-90-90 goal is that 90 percent of people living with HIV will know their status, and 90 percent of those people who know their status will be on treatment. Table 4 summarizes the annual coverage for each scenario.

Table 4: Annual Treatment Coverage Used in Spectrum Model, 2015–2020

	Scenario 1: Status Quo						Scenario 2: 90-90-90					
Year	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
PMTCT	**75.0**	**80.0**	**85.0**	**90.0**	**95.0**	**100.0**	**75.0**	**80.6**	**85.9**	**90.8**	**95.5**	**100.0**
Option B	*72.0*	*66.9*	*62.2*	*57.9*	*53.8*	*50.0*	*72.0*	*48.0*	*24.0*	*0.0*	*0.0*	*0.0*
Option B+	*3.0*	*13.1*	*22.8*	*32.1*	*41.2*	*50.0*	*3.0*	*32.6*	*61.9*	*90.8*	*95.5*	*100.0*
Adult	**36.0**	**36.7**	**37.3**	**38.0**	**38.6**	**39.3**	**36.0**	**42.3**	**49.8**	**58.6**	**68.9**	**81.0***
Pediatric	**8.0**	**9.3**	**10.7**	**12.0**	**13.4**	**14.7**	**8.0**	**12.7**	**20.2**	**32.1**	**51.0**	**81.0***

* The denominator for adult and pediatric patient coverage is the total number of adults or children living with HIV. The coverage level in 2020 for Scenario 2 for adults and pediatric patients was set to 81 percent, since the 90-90-90 goal is that, by that year, 90 percent of people living with HIV will know their status, and 90 percent within that group (i.e., 90% of those people who know their status) will be on treatment. In other words, we took the 90 percent of the 90 percent to calculate the proportion of people living with HIV that know their status and are on treatment.

RESULTS

Annual Treatment Cost, by Patient Type and Outcome

During the study period, 1,281 patients initiated HIV treatment at the 25 study facilities (1,043 adults, 37 children, and 201 pregnant women). Of the adults, 785 women started treatment, making up a significantly larger portion (75%) of the adult cohort. For children, there was no significant gender difference, with 21 girls starting treatment as compared to 16 boys. Patient demographics and ART service characteristics are summarized in Table 5 and Table 6 below.

General adult and pediatric patients on treatment came in for consultation on a relatively consistent basis—approximately every two months. However, patients seem to have received a significantly less than expected number of days of treatment for the year. Whereas patients should receive 365 days of treatment per year, results show that, on average, adults (excluding pregnant women) received 290 days and children received 237 days of treatment over the course of a year. Treatment facilities also conducted laboratory monitoring on a limited basis, with patients receiving lab tests once a year on average after treatment initiation, whereas the national treatment guideline states that five lab tests should be conducted during the first year of treatment.

On average, pregnant women were on treatment for 168 days until their due date. This means that pregnant women typically were identified and put on treatment at around four months into their pregnancy. In total, these women were usually on treatment for 248 days, signifying that many received post-delivery treatment while breastfeeding.

A portion of the study patients who were on treatment did not have any ARV dispensation records. These missing data were isolated to three facilities, and regimens were missing for all patients responding to treatment, thus likely indicating a lack of record keeping for the study period at the pharmacy rather than patients not going to the facility to pick up their treatments. To reduce the bias caused by these missing data, we excluded these patients (145 adults, three children, and 110 pregnant women) when calculating the average number of days and cost of ARVs.

The majority of patients were on first-line treatment, as they were treatment naïve upon initiation (among patients whose treatment regimens were known, 93% of adults, 94% of children, and 92% of pregnant women were on first-line treatment). The study team found that some patients received non-standard treatment regimens. Whereas very few patients received an entire year's worth of treatment using non-standard regimens, between 3 percent (adults and pregnant women) and 5 percent (pediatric) of patients on treatment received a non-standard regimen at least once during the year of treatment.

Treatment retention was low, with adults achieving 61 percent retention over the 12-month period, whereas only 51 percent of pediatric patients achieved retention. Pregnant women achieved retention 52 percent of the time. Of those on treatment, only one-third of the adults and children, and a quarter of pregnant women responded to the treatment regimens (35% of adults, 32% of children, and 28% of pregnant women).

Table 5: Patient Demographics and Outcome Summary for Adults and Children, Excluding Pregnant Women

	Adult	Pediatric
Patient demographics		
Number of patients who initiated treatment (female/male)	785/258	21/16
Average age at ART start	37	4
Characteristics of ART services for patients on treatment at 12 months		
Average days of ARV per patient#	290	237
Average number of visits per patient	7	6
Average number of lab tests per patient	1	1
Number of patients on first-line regimen at 12 months	455	15
Number of patients on second-line regimen at 12 months	33	1
Number of patients on non-standard regimen at 12 months	1	0
Number of patients on non-standard regimen at any time during 12 months	18	1
Number of patients without any pharmacy dispensation records	145	3
Median baseline CD4 count	206	438
Patient outcomes at 12 months		
On treatment	634	19
Not on treatment	409	18
Retention rate	61%	51%
On treatment, responding	222	6
On treatment, not responding	412	13
Response rate (out of total on treatment)	35%	32%

Excludes patients from the three health facilities that did not keep complete ARV records.

Table 6: Patient Demographics and Outcome Summary, Pregnant Women

	PMTCT
Patient demographics	
Number of patients who initiated treatment	201
Average age at ART start	30
Characteristics of ART services for patients on PMTCT*	
Average days of ARV per patient#	248
Average days of ARV per patient during pregnancy	168
Average days of ARV per patient after delivery	70
Average number of visits per patient	3
Average number of lab tests per patient	1
Number of patients on first-line regimen	84
Number of patients on second-line regimen	5
Number of patients on non-standard regimen	2
Number of patients on non-standard regimen at any time	7
Number of patients without any pharmacy dispensation records	110
Median baseline CD4 count	405
Patient outcomes at 12 months	
On treatment	104
Not on treatment	97
Retention rate	52%
On treatment, responding	27
On treatment, not responding	77
Response rate (out of total on treatment)	28%

* We tracked patient records until September 30, 2014 or if they stopped receiving treatment, whichever came earlier.
# Excludes patients from the three health facilities that did not keep complete ARV records.

Table 7 summarizes the cost of treatment, broken down by cost component and patient outcome. As the table shows, the average annual treatment cost for all patients initiated on ART is in the range of CFA80,000 (CFA79,623 [US$161] for adults, CFA83,579 [US$169] for children, and CFA71,710 [US$145] for pregnant women), but this average cost increases as we focus on a subset of the study population. The cost of treatment is significantly higher for patients on treatment at 12 months or at due date, compared to all patients initiated on treatment, as the latter group includes patients who stop treatment mid-course. With patients who are on treatment and responding, the average cost was closer to CFA90,000 (CFA103,856 [US$210] for adults, CFA93,965 [US$190] for children, and CFA75,172 [US$152] for pregnant women). The cost of annual treatment is slightly higher for patients on treatment and responding than all patients on treatment at 12 months. In all cases, ARVs make up the largest portion of the cost, at approximately 70 to 85 percent.

Table 7: Annual Treatment Cost of Study Sample, Disaggregated by Cost, Treatment Outcome, and Patient Type[4]

	Adult CFA (%)	Pediatric CFA (%)	PMTCT CFA (%)
All patients initiated on ART	n = 1,043	n = 37	n = 212
Consultations	2,967 (4%)	3,956 (5%)	3,956 (6%)
Laboratory	5,935 (7%)	6,429 (7%)	6,429 (9%)
ARV cost	66,270 (83%)	69,732 (83%)	53,906 (75%)
Overhead	4,451 (6%)	3,956 (5%)	7,913 (11%)
Total cost	79,623	83,579	71,710
Patients on treatment*	n = 634	n = 19	n = 86
Consultations	2,967 (3%)	4,946 (6%)	4,451 (8%)
Laboratory	7,418 (8%)	8,407 (9%)	6,924 (12%)
ARV cost	79,623 (86%)	71,215 (82%)	55,884 (69%)
Overhead	2,967 (3%)	2,967 (3%)	7,418 (11%)
Total cost	92,976	87,041	74,677
Patients on treatment and responding*	n = 222	n = 6	n = 23
Consultations	2,967 (3%)	6,924 (7%)	5,935 (6%)
Laboratory	8,902 (9%)	9,396 (10%)	9,396 (9%)
ARV cost	88,525 (86%)	74,677 (80%)	52,423 (75%)
Overhead	2,967 (3%)	2,473 (3%)	7,913 (10%)
Total cost	103,856	93,965	75,172

* For adults and pediatric patients, at the 12-month mark; for pregnant women, at their due date.

Among the adult patients on treatment at the 12-month mark and responding, the average annual cost of treatment was CFA103,856 (US$210), but successfully scaling up treatment by providing the full treatment would cost much more. This increase is because the study sample had less than the expected number of days on treatment and number of lab tests over the course of the treatment year. Thus, by appropriately accounting for the cost of a full year's worth of expected treatment by following the national treatment guidelines, **the true total annual cost of treatment would be CFA142,408 (US$288) for adults, CFA217,409 (US$440) for children, CFA84,821 (US$172) for PMTCT Option B, and CFA 102,151 (US$207) for PMTCT Option B+.** Table 8 summarizes the cost breakdown of this true annual treatment cost.

[4] See Annex F for all cost tables in U.S. dollars.

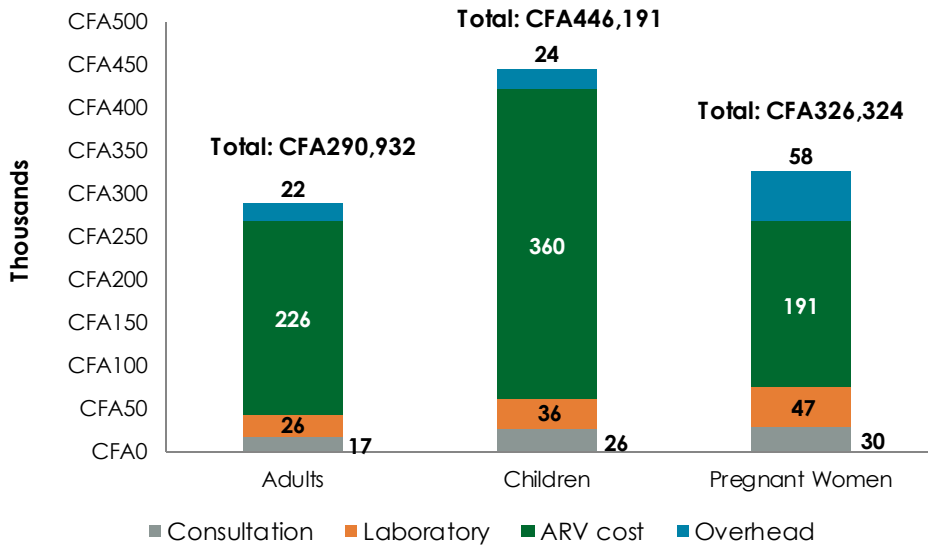
Table 8: True Annual Treatment Cost for First Year and Assumptions, Disaggregated by Cost Type and Patient Type

	Adult CFA (%)	Pediatric CFA (%)	PMTCT Option B CFA (%)	PMTCT Option B+ CFA (%)
Breakdown of annual cost of treatment				
Consultation	3,462 (2%)	5 056 (2%)	4,720 (6%)	4,720 (5%)
Laboratory	34,020 (24%)	34,377 (16%)	18,641 (22%)	18,641 (18%)
ARV cost	99,666 (70%)	174,723 (80%)	52,208 (62%)	69,537 (68%)
Overhead	5,243 (4%)	3,253 (1%)	9,253 (11%)	9,253 (9%)
Total cost	142,408	217,409	84,821	102,151
Treatment assumptions				
Number of consultations				
First year of treatment	6		3	3
Following years of treatment	4		n/a	n/a
Number of labs				
First year of treatment	6		3	3
Following years of treatment	2		n/a	n/a
Number of days of treatment	365		248	168
Treatment regimens	No change	No change	No change	91% on TDF/3TC/EFV (first line) and 9% on TDF/3TC/LPV/r (second line)

Cost-outcome Analysis

The positive outcome production cost (i.e., the total investment made in all patients to yield one successful patient) was CFA290,932 (US$588) for adults, CFA446,191 (US$902) for children, and CFA326,324 (US$660) for pregnant women (Figure 2). This means that to yield one adult patient who actually succeeds on treatment, Côte d'Ivoire is currently spending CFA290,932 (US$588), which includes all of the resources expended on patients who died, were lost to follow-up, or were unresponsive to treatment. The positive outcome production cost is more than double the average cost of the annual treatment of patients on treatment and responding; this significant difference in the cost shows that there are significant resources "lost" within the treatment cascade.

Figure 2: Positive Outcome Production Cost, by Patient Type



Looking at the relationship between cost, outcome, and other variables of interest for adults, cost correlated with age, time to treatment initiation, and CD4 count at the start of treatment. Older age at initiation correlated with higher annual treatment cost ($r = 0.1295$, $p = 0.00$), and higher CD4 count at start of treatment correlated with lower cost ($r = -0.1275$, $p = 0.00$).

Interestingly, a longer time from diagnosis to treatment initiation correlated with a lower total cost of treatment for adults ($r = -0.1277$, $p = 0.0012$). On the other hand, for pediatric patients, a longer time from diagnosis to treatment initiation correlated with a higher total cost of treatment ($r = 0.4977$, $p = 0.0301$). No other correlation analysis produced statistically significant results at the $p = 0.05$ level.

Looking at treatment outcome and age, no obvious differences appeared in the adult cohort (average age ranged between 35.6 and 37.8). For children, patients who were lost to follow-up tended to be slightly younger (an average age of 2.72) as opposed to those on treatment (an average age of 5.5 for responding patients and 6.4 for patients not responding to treatment).

The study found a greater likelihood of patients being on treatment and responding if they were classified as WHO stage 1 or 2 at the time of treatment initiation. In the case of pregnant women, all patients who were on treatment and responding to treatment at the 12-month mark were classified as either WHO stage 1 or 2. On the other hand, we saw no obvious trend in WHO classification in patients who died during the study period. See Annex D for detailed tables of the results of the cost-outcome analysis.

Scenario-based Projection of Cost and Impact of Treatment Scale-up

Projections in Spectrum estimate that if Côte d'Ivoire continues to increase treatment coverage at the historical rate (i.e., the status quo scenario), 302,311 adults and 32,714 children will be living with HIV by 2020. In comparison, 336,440 adults and 31,037 children will be alive with HIV in the 90-90-90 scenario because of treatment scale-up, which allows more people to survive with the disease.

By 2020, the 90-90-90 scenario projects that 272,517 adults and 25,336 children will be on treatment, and 16,820 pregnant women will have access to PMTCT (100% on Option B+). With this scale-up in treatment, 35,154 deaths will be avoided cumulatively between 2015 and 2020. At the same time, the mother-to-child transmission rate will decline significantly to 4.5 percent by 2020 in the 90-90-90

scenario, as compared to 12.6 percent for the status quo scenario. The projections estimate that 6,041 new infections among newborns will be averted if the 90-90-90 goal is achieved by 2020.

Figure 3 and Figure 4 capture the coverage scenario for the three cohorts, Table 9 highlights key projection outputs, and Annex E contains detailed projection results.

Figure 3: Adult and Pediatric Year-on-Year Treatment Coverage, by Scenario

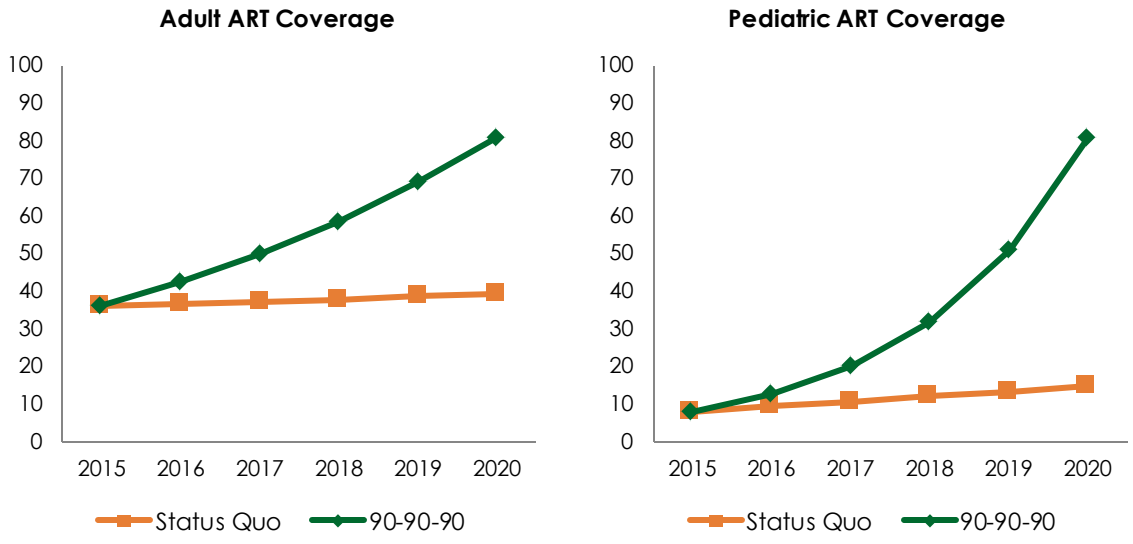


Figure 4: PMTCT Year-on-Year Treatment Coverage, by Scenario and Method

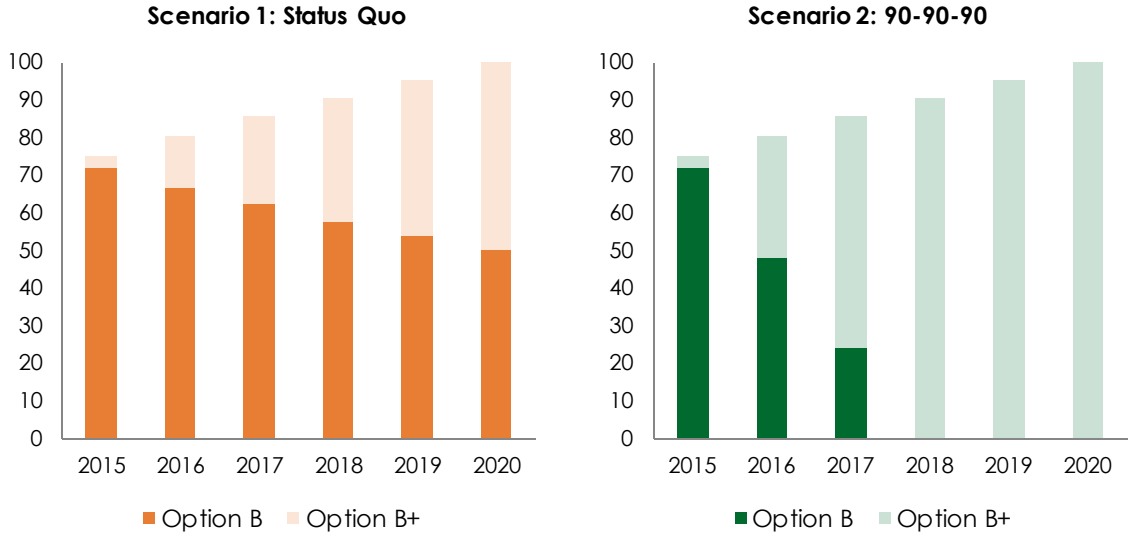


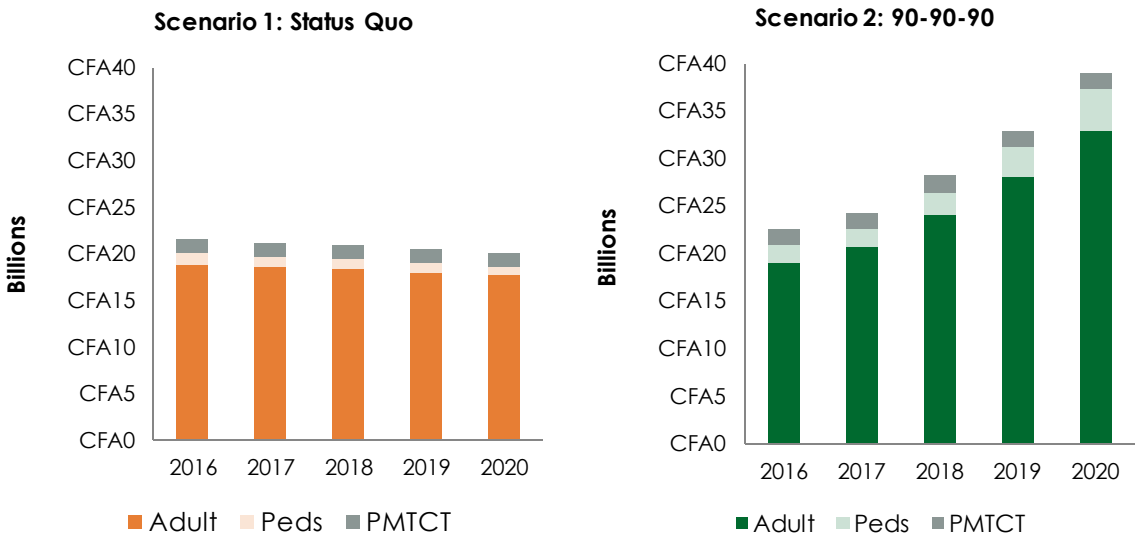
Table 9: Summary of Impact Projection

	Scenario 1: Status Quo	Scenario 2: 90-90-90
HIV-related deaths		
Cumulative number	93,146	57,992
Deaths averted as compared to scenario 1	-	35,154
HIV infections		
Cumulative number, total population	47,603	41,732
Cumulative number, new child HIV infections due to mother-to-child transmission	15,544	9,503
Mother-to-child transmission rate in 2020*	12.64%	4.54%
Total HIV population at 2020		
Adults	302,852	336,440
Children	32,714	31,037
Total HIV population on treatment in 2020		
Adults (#, % coverage of HIV+ adults)	119,021 (39)	272,517 (81)
Children (#, % coverage of HIV+ children)	5,032 (15)	25,336 (82)
Pregnant women (#, % coverage of HIV+ pregnant women)	15,698 (100)	16,820 (100)
Option B (#, % coverage of HIV+ pregnant women)	7,849 (50)	0 (0)
Option B+ (#, % coverage of HIV+ pregnant women)	7,849 (50)	16,820 (100)

* Final transmission rate, including breastfeeding period.

To achieve the 90-90-90 goal, investment in HIV treatment must grow from CFA22.6 billion (US$45.7 million) per year to CFA39.1 billion (US$79.1 million) per year between fiscal years 2016 and 2020, for a total investment of CFA147.1 billion (US$297.4 million) over the course of five years (Figure 5). In comparison, the investment will decline if Côte d'Ivoire maintains its coverage growth rate, with a year-on-year investment of approximately CFA21 billion (US$42 million), for a total investment of CFA104.6 billion (US$211.5 million) over the same five years. The necessary resources will decline over the years, whereas coverage will grow because the total HIV+ population will decline as death outpaces the number of new infections and fewer people survive on treatment.

Figure 5: Year-on-Year Total Treatment Cost, by Scenario



DISCUSSION

This study shows that with an incremental increase in funding for HIV treatment, Côte d'Ivoire will be able to save 33,914 adults' and 1,239 children's lives, and prevent more than 6,000 neonatal infections. The government of Côte d'Ivoire is already moving in the right direction by aiming to adopt the "test and offer" approach for the general population and rolling out Option B+ for pregnant women. The results indicate that these steps will allow the country to achieve the 90-90-90 goal in a more efficient manner. By getting people on treatment immediately, without waiting for the patient's condition to worsen enough for them to become eligible for treatment, treatment is more likely to be successful and cheaper. By getting pregnant women on lifelong treatment with easy-to-take FDC drugs, infections to newborns will be prevented and mothers can live healthier, longer lives. The study identified several opportunities for further improvements in the HIV treatment cascade, so that resources mobilized for HIV treatment are used effectively and efficiently.

Getting people on treatment

The sites identified a relatively large number of adults living with HIV. These 25 sample facilities, which make up approximately 8 percent of the total PEPFAR-supported sites in the five health regions (309 total), initiated more than 1,300 adults on treatment (including patients with insufficient data or those transferred out also). In total, they were providing HIV treatment to 21,517 adults, including 767 pregnant women.

However, children living with HIV do not seem to be identified and put on treatment at an acceptable rate. Population-level prevalence data estimate that for every 100 adults living with HIV, 16 children will be living with HIV, including those who became infected through mother-to-child transmission. Yet, the study sites provided treatment services to only 1,649 children, which amount to eight children with HIV for 100 adults with HIV. It is likely that children are not being routinely tested for HIV as often as adults, and those who test positive are not being initiated on treatment. The cause is unclear, as the study did not collect qualitative information regarding the motivations and challenges of providers, patients, or children's caregivers to test and initiate treatment for HIV+ children. However, the global trends and challenges to getting children on treatment, such as provider familiarity and comfort, parent or caregiver understanding, and openness to treating HIV in children, likely apply in Côte d'Ivoire as well.

In addition, potential patients who should be on treatment may be missed because of the lack of available lab data. According to the study results, the majority of patients who started treatment had only one CD4 and routine blood test conducted during their first year of treatment in addition to the test conducted before treatment initiation. If this frequency was the norm before treatment initiation as well, it could delay initiation, since the provider would be unaware of whether the CD4 count had gone below the threshold for starting treatment. There are several potential reasons for the low frequency of lab tests, such as lack of resources at the facility and the patient's inability or unwillingness to return for the tests. The "test and offer" treatment standard will overcome these barriers by initiating treatment without requiring lab results, thus increasing the chances of successful treatment.

Keeping people on treatment

The study found that the sites had poor retention rates—just over half of the patients stayed on treatment over the course of the year. Loss to follow-up accounted for the majority of the discontinued patients (91% of adults, 100% of children, and 99% of pregnant women). Patients may have difficulty in presenting themselves for continued treatment due to a variety of reasons, including cultural stigma; adverse side effects of the treatment; and logistical factors, such as the distance to a health facility. The lower-than-expected disbursement of ARVs over the course of the treatment may indicate periodic stockouts, which can lower patient satisfaction with the service, thus causing ART discontinuation.

Retention has been an issue for HIV treatment in Côte d'Ivoire for some time; the government, in collaboration with development partners, has been working to improve retention. This study focused on patients who started treatment between October 2012 and September 2013. It is worthy of note that current PEPFAR data indicate significant improvements in retention, with adults at 70 percent, children at 73 percent, and pregnant and breastfeeding women at 58 percent (PEPFAR 2014).

Getting people to respond to treatment

Stockouts or gaps in treatment provision, as evidenced by lower-than-expected disbursement of ARVs, can lower the chance of a patient successfully responding to treatment and increase the risk of resistance. A handful of patients also received non-standard treatments. This is an indication that pharmacies still have stock of formulations that are not part of the general guidelines; either they are dispensing their own combination of drugs to patients due to stock management issues, or the providers are prescribing old regimens because they are not familiar with the efficacy of the new regimen and thus prefer to prescribe those with which they are familiar.

Patients given non-standard treatment at least once during their year of treatment were more likely either to be lost to follow-up or not respond to treatment, although the relationship was not statistically significant. Treatment efficacy may be improved by making sure that the pharmacies are appropriately stocked with the ARVs found in the current treatment guidelines and providing additional trainings to providers to address any of their concerns about the new regimens.

Improving efficiency to achieve positive outcomes

ARVs make up the bulk of the cost of treatment; thus, reducing ARV cost will be critical in improving treatment efficiency. The variety of regimen options being offered at the health facilities—some of them non-standard—prevents an accurate forecasting of which drugs to purchase in bulk, thus reducing economy of scale. Moreover, prescribing less effective regimens lowers chances of successful treatment. Limiting the number of regimen options to those that are most efficacious could have a compounding effect in improving the chances of positive treatment outcomes with the same or reduced ARV expense.

The positive outcome production cost is more than double the cost of the average annual treatment cost. The difference is primarily due to the low retention and treatment success rates. The investments made to initiate and maintain a person on treatment are lost when the patient dies, stops coming for treatment, or is not given an appropriate treatment for his/her condition. Furthermore, the risk of resistance and forward transmission increases significantly when patients stop treatment.

When resources are limited, it is critical that these efficiencies are realized so that a larger number of people can be put on treatment, more people can respond to treatment successfully, and chances of forward transmission decrease. If patients are provided with the most effective treatment in a timely manner and retained on that treatment, HIV-related morbidity, mortality, and incidence can be reduced while making the same monetary investment.

Study Limitations

The study team performed this analysis with the greatest possible level of detail and used conservative assumptions, but several limitations should be considered.

The data required to generate a facility-specific service unit cost sometimes were missing, potentially influencing the accuracy of that unit cost. Often, the facilities did not have financial data for those items primarily expended at the regional and national levels. For example, several facilities did not maintain a good record of salaries and utility costs or an equipment inventory. The majority of facilities did not track how many supplies each ward and clinic used. This was especially true for smaller facilities, which did

not have an extensive financial management capacity. The study used national standards and sample averages to fill gaps to the extent possible.

Record keeping often was not well organized at the facilities, and the data collectors faced challenges in identifying where the old records were being kept. A handful of facilities did not have client volume data for the entire year. In such case, the client volume for the months for which the data were available was multiplied proportionately to estimate the total volume for the year.

Some health facility data were missing because they were collected by the facilities only for the implementing partner's use. Thus, either the data were not available any more, or the facility requested that the study team retrieve this information from the implementing partners. The retrieval of the facility data through the implementing partners turned out to be difficult, as the support facilities changed in October 2013; thus, some partners did not have a full year's worth of data. The study team retrieved as much data as possible from the partners and proportionately increased them to account for the full year, if necessary.

Overall, the study team paid close attention during the facility cost analysis process so as to minimize cost fluctuation due to missing data, either by excluding cost categories for which the information was considered too problematic (utilities and capital expenses) or using national-level data (national salaries, national unit cost for lab tests). However, it is likely that some costs were missed, thus causing an underestimation of the unit cost.

The ingredient approach could also lead to an underestimation of direct personnel cost as the time providers reported might not account for the additional administrative time spent on their work in ART or PMTCT services. As much as possible, we limited this impact by considering as indirect personnel those cadres that spent most of their time performing administrative duties, such as chief nurses, the data management team, and the lab team.

The lab and ARV dispensation records pulled from SIGDEP were significantly lower than expected, compared to the national treatment guidelines. The team utilized all data available within the SIGDEP system, but it is possible that some data were not recorded in the system, thus making it seem that patients were not receiving the quantity of treatment services they actually did. Notably, PEPFAR routine data showed that patients generally received at least two lab tests during their first year of treatment. Given that the consultation data seemed complete (with patients coming into the clinic six or seven times during their first year of treatment, as expected), the study team used the data as available, although further investigation into the data management system may be warranted to assess data quality.

The study team assumed that ARVs were dispensed as FDC drugs and, if these were not available, that patients would receive a drug combination requiring the least number of pills. This assumption will create bias, since the cost of FDCs will be different from the regimen produced by combining multiple pills. Although there is no remedy for this bias for this study, such bias is likely to be reduced as the regimens dispensed at the facility become more standardized in alignment with national protocols.

RECOMMENDATIONS AND CONCLUSION

A sustained increase in HIV treatment funding will be critical to Côte d'Ivoire's progress toward achieving the 90-90-90 goal. By mobilizing CFA143 billion (US$290 million) for HIV treatment over the course of five years, the country can put 272,517 adults—including 16,820 pregnant women—and 25,336 children on treatment. This aggressive scale-up in treatment will prevent 35,154 deaths and 6,041 infections, allowing thousands of Ivoirians to live healthier and more productive lives.

To catalyze this HIV treatment funding, the following programmatic and policy opportunities should also be considered for successful treatment scale-up:

- Develop an HIV treatment resource mobilization strategy, utilizing the study results to identify opportunities and advocate for additional HIV funding from within the government of Côte d'Ivoire and development partners, and identify opportunities for private sector contributions to HIV treatment scale-up.
- Proceed with the adoption and roll-out of "test and offer" guidelines (in line with current evidence and anticipated WHO recommendations) in conjunction with the development and implementation of a fast-track system for treatment initiation. This will virtually eliminate the pre-ART period, during which a large proportion of clients are being lost.
- Continue with the roll-out of Option B+, paying close attention to the hand-off process between the antenatal clinic where the woman initiates treatment and the adult outpatient clinic where she will continue the treatment after birth. Consider integration or linkage with the pediatric clinic where the newborn child receives care, so that services are streamlined and the mother-baby pair can receive seamless care and treatment.
- In conjunction with the roll-out of the Option B+ treatment guideline, initiate the TDF/FTC/EFV FDC regimen as the primary method of treatment, which is recommended for its efficacy and simplicity. Fast track the roll-out of this regimen for adults in general to further maximize scale while reducing providers' confusion and the pharmacy's stock management burden.
- Strengthen the procurement and distribution of ART so patients are accessing the right treatments all of the time. This includes rapidly resolving the problem of facilities initiating treatment with regimens no longer recommended in the national guidelines. This resolution also may improve ARV purchase pricing through bulk purchase, as a smaller variety of drugs will be procured in larger quantities.
- Provide capacity building and supportive supervision at the health facility level to improve compliance with the national treatment guideline on dispensed regimens.
- Improve lab monitoring to match national guidelines throughout the cascade of HIV care and treatment to ensure that patients are responding to treatment, and the treatment regimen can be modified quickly when needed to improve patient retention. Also, improve the capacity of data managers to enter data completely and accurately into SIGDEP. Viral load monitoring is being rolled out throughout the country with the establishment of reference labs. This effort may be combined with capacity building at the facility level so that sites conduct CD4 and routine blood tests on site in accordance with the national guidelines, while appropriately sending out viral load samples for testing at reference labs.
- Conduct a rapid analysis of contextual factors and specific points at which clients are engaged and lost along the continuum of adult, pediatric, and PMTCT care and treatment cascades. This analysis will help unravel the root cause of slow patient recruitment and poor retention. PEPFAR and its implementing partners already are or soon will be conducting relevant studies on PMTCT

cascade analysis, adult and pediatric ART outcomes evaluation, and retention. The results of these studies should be proactively integrated into programmatic interventions.

- Informed by the results of the rapid analysis, revise the national treatment guideline for HIV, which will shorten the cascade and improve long-term retention. Include innovative and effective interventions at the client, household, community, and health facility levels.
- Develop and implement an active pediatric case identification plan strategically designed to find more HIV+ children and rapidly link them with HIV care, treatment, and prevention services. Implementation of this plan can consider provider-initiated testing at key facility entry points, such as triage, external consultation, emergency care, and inpatient pediatric wards, and expansion of family and partner testing to include all children.
- Continue with the roll-out of SIGDEP, in addition to continued capacity building at the facility level, to ensure that data management staff enter data correctly. This study shows that SIGDEP stores a wealth of information that could be useful in understanding the current status of HIV treatment and can inform decision making.
- Routinize analysis of HIV treatment data. Data are especially sparse for children and adolescents. Much greater attention is needed to better understand the specific challenges in the early part of the pediatric HIV treatment cascade, up through adolescents. Causes for drop-out along the cascade can be assessed by disaggregating data by age, medication adherence, disclosure, and other potential contributing actors.
- EHRs can enable improved treatment monitoring and follow-up. Consider adding functionalities to the SIGDEP so that captured data are used to minimize patient loss and develop pathways to locate and recover lost patients. For instance, select portions of data could be made available to community health workers to facilitate follow-up and reminders to patients. The system could also be improved so as to send text messages automatically to clients for appointment and drug refill reminders. Such expansion of SIGDEP capabilities must be done with sensitivity to patient disclosure—patients should be given the choice of opting in or out of these services so they do not infringe on people's privacy, especially if they have not disclosed their HIV status to their partner, household, or community.

ANNEX A. TECHNICAL ADVISORY GROUP MEMBERS

The Technical Advisory Group for this study was established by Dr. Raymonde Goudou Coffie, Minister of Health, through Arrêté # 1618 of October 16, 2014. Chaired by Pr. Boa Yapo, Director General of Health, and coordinated by Dr. Abo Kwame, Director-Coordinator of the National AIDS Programme, the study benefited greatly from the technical direction, input, and support of the Technical Advisory Group.

- Le Conseiller Technique en charge du VIH/Sida
- Le Directeur Général de la Nouvelle Pharmacie de la Santé Publique
- Le Directeur de la Santé Communautaire et de la Médecine de proximité
- Le Directeur des Ressources Humaines
- Le Directeur des Infrastructures, de l'Equipement et de la Maintenance
- Le Directeur des Affaires Financières
- Le Directeur de l'Information, de la Planification et de l'Evaluation
- Le Directeur de l'Institut National de Santé Publique
- Le Directeur-Coordonnateur du Programme National de Nutrition
- Le Directeur-Coordonnateur du Programme National Mère-Enfant
- Un Représentant du Ministère auprès du Premier Ministre chargé du Budget
- Un Représentant du Ministère auprès du Premier Ministre chargé de l'Economie et des Finances
- Le Représentant Résident de l'OMS
- Le Coordonnateur de l'ONUSIDA pour la Côte d'Ivoire
- Le Représentant Résident de la Banque Mondiale
- La Coordonnatrice du PEPFAR

ANNEX B. LIST OF TYPE AND SOURCE OF FACILITY DATA COLLECTED

Cost	Description	Variables Used	Source
Personnel	Time and cost associated with staff involved in HIV services, by cadre; includes salaried, seconded, and volunteer staff	• Salaries, incentives, and training costs for clinical and health staff involved in the direct provision of HIV services • Salaries for administrative and support staff • Average time spent by each staff category to provide key services per intervention, including ART consultations, routine blood tests, and CD4 count tests	• Health facility records • Ministry of Health national standards • Implementing partners' records
Recurrent supplies	Quantity and costs for supplies used in the delivery of HIV services	• CD4, biochemistry, and hematology tests; consumables for blood draw; durable and biosecurity commodities; and general consumables (waste bags, data forms, etc.)	• PEPFAR procurement pricing data
Recurrent operating costs	Expenditures and types of utilities and goods that allow for the facility to continue operating	• Phone; internet; fuel; insurance; and external services, such as cleaning and gardening services, external quality assurance, and building maintenance • Water and electricity were not included because data could not be collected for most of the sample facilities	• Health facility records
Capital	One-time purchases or acquisitions, usually related to equipment, as well as any relevant maintenance or replacement costs	• Equipment, vehicles, building maintenance. • Ambulances were not included, as the interventions studied did not require their use • Building capital costs (rent or construction costs) were not included because the data could not be collected for most of the sample facilities	• Health facility records
Output	Health outputs produced by the facility for each service	• Number of consultations and patients for each service: HIV+ adults, HIV+ infants, HIV+ pregnant women, and breastfeeding women • Number of hospitalizations and hospitalization days, including observations for smaller facilities	• Health facility records • Implementing partner records

ANNEX C. LIST OF ARV UNIT COSTS

All drugs reported under SIGDEP to be used for the study sample patients are listed below. "Unit cost" is defined as cost of ART per day.

Adult Regimens

Regimen	Unit Cost (CFA)	Unit Cost (US $)
First line		
AZT 3TC EFV	326.40	0.66
AZT 3TC NVP	207.71	0.42
AZT 3TC TDF	262.11	0.53
TDF 3TC EFV	321.46	0.65
TDF FTC EFV	326.40	0.66
Second line		
AZT 3TC LPV/r*	731.94	1.48
TDF 3TC LPV/r*	726.99	1.47
TDF FTC LPV/r	786.34	1.59
Non-standard		
ABC 3TC EFV	608.30	1.23
AZT	133.53	0.27
AZT 3TC ABC	613.24	1.24
AZT 3TC DDI LPV/r	781.39	1.58
TDF 3TC NVP	202.77	0.41
TDF FTC NVP	262.11	0.53

* First-line drug for HIV Type 2 patients.

Pediatric Regimens

Regimen	Age	Unit Cost (CFA)	Unit Cost (US $)
First line			
ABC 3TC NVP	3 and under	657.75	1.33
ABC 3TC NVP	4–5	519.28	1.05
ABC 3TC NVP	6+	375.86	0.76
AZT 3TC ABC	3 and under	672.59	1.36
AZT 3TC NVP	3 and under	341.24	0.69
AZT 3TC EFV	4–5	504.44	1.02
AZT 3TC EFV	6+	143.42	0.29
Second line			
AZT 3TC LPV/r*	3 and under	474.77	0.96
AZT 3TC LPV/r*	4–5	474.77	0.96
AZT 3TC LPV/r*	6+	474.77	0.96
Non-standard			
ABC 3TC EFV	3 and under	1,177.03	2.38
ABC 3TC EFV	4–5	776.45	1.57
ABC 3TC EFV	6+	370.91	0.75
AZT 3TC ABC	4–5	529.17	1.07
AZT 3TC ABC	6+	385.75	0.78
AZT 3TC EFV	3 and under	860.52	1.74
AZT 3TC NVP	4–5	247.28	0.5
AZT 3TC NVP	6+	148.37	0.3
TDF FTC LPV/r	3 and under	519.28	1.05
TDF FTC LPV/r	4–5	519.28	1.05
TDF FTC LPV/r	6+	519.28	1.05

* First-line drug if child received PMTCT or has HIV Type 2.

PMTCT Regimens

Regimen	Unit Cost (CFA)	Unit Cost (US $)
First line		
AZT 3TC NVP	143.42	0.29
AZT 3TC LPV/r	731.94	1.48
TDF FTC EFV#	380.81	0.77
Second line		
TDF 3TC EFV	267.06	0.54
Non-standard		
ABC 3TC LPV/r	1,013.83	2.05
AZT	133.53	0.27
AZT 3TC EFV	326.40	0.66
AZT TDF FTC	351.13	0.71
D4T 3TC EFV	242.33	0.49
TDF 3TC LPV/r	726.99	1.47
TDF 3TC NVP	202.77	0.41
TDF FTC LPV/r	786.34	1.59
TDF FTC NVP	262.11	0.53

Option B+ recommended FDC regimen.

ANNEX D. COST-OUTCOME ANALYSIS TABLES

Adult patients

Correlation of age, time to treatment initiation, and CD4 count at the time of treatment initiation, as compared to cost, for patients who were on treatment at the 12-month mark:

	Age	Time to Treatment Initiation (days)	CD4 Count at Time of Treatment Initiation
Cost	r = 0.1546 n = 642 p = 0.001	r = -0.1277 n = 642 p = 0.0012	r = -0.2098 n = 623 p = 0.000

Average cost as it compares to regimen type and WHO stage at the start of treatment, for patients on treatment at the 12-month mark:

Regimen Type	
First line	Average cost = CFA84,741.49 (US$171.35) Std. dev. = 64.59 n = 461
Second line	Average cost = CFA203,992.81 (US$412.48) Std. dev. = 124.84 n = 33
Non-standard	Average cost = CFA21,755.34 (US$43.99) Std. dev. = n/a n = 1
No treatment	Average cost = CFA18,605.05 (US$37.62) Std. dev. = 15.30 n = 147

WHO Stage	
0	Average cost = CFA91,714.67 (US$185.45) Std. dev. = 75.65 n = 61
1	Average cost = CFA56,284.96 (US$113.81) Std. dev. = 100.73 n = 150
2	Average cost = CFA73,975.09 (US$149.58) Std. dev. = 105.51 n = 238
3	Average cost = CFA88,104.44 (US$178.15) Std. dev. = 99.25 n = 184
4	Average cost = CFA77,783.14 (US$157.28) Std. dev. = 104.38 n = 9

Average age, time to treatment initiation, and CD4 count at the start of treatment initiation, as it compares to treatment outcome, for all patients who initiated treatment during the study period:

Age	
Death	Average age = 37.75 Std. dev. = 7.44 n = 36
Lost to follow-up	Average age = 36.89 Std. dev. = 9.88 n = 377
On treatment—Not responding	Average age = 37.40 Std. dev. = 9.40 n = 416
On treatment—Responding	Average age = 35.61 Std. dev. = 9.56 n = 226

Time to Treatment Initiation (days)	
Death	Average time = 35.08 Std. dev. = 63.37 n = 36
Lost to follow-up	Average time = 165.33 Std. dev. = 414.21 n = 377
On treatment—Not responding	Average time = 205.12 Std. dev. = 461.24 n = 416
On treatment—Responding	Average time = 255.13 Std. dev. = 504.63 n = 226

CD4 Count at Start of Treatment Initiation	
Death	Average CD4 count = 174.41 Std. dev. = 188.84 n = 36
Lost to follow-up	Average CD4 count = 206.10 Std. dev. = 146.75 n = 377
On treatment—Not responding	Average CD4 count = 212.41 Std. dev. = 151.56 n = 416
On treatment—Responding	Average CD4 count = 222.42 Std. dev. = 123.91 n = 226

Number and percentage of patients, by regimen type and treatment outcome:

	First Line		Second Line		Non-standard		No Treatment		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*
Death	24	3	1	2	2	20	9	4	36	3
Lost to follow-up	215	29	30	46	5	50	129	54	379	36
On treatment—Not responding	179	24	13	20	2	20	35	15	229	22
On treatment—Responding	326	44	21	32	1	10	68	28	416	39
Total	**744**		**65**		**10**		**241**		**1,060**	

* Percentage of regimen type.

Number and percentage of patients, by WHO stage at the time of treatment initiation, and treatment outcome:

	Death		Lost to Follow-up		On Treatment—Not Responding		On Treatment—Responding		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*
Stage 0	10	28	94	25	43	10	18	8	165	16
Stage 1	3	8	46	12	74	18	76	34	199	19
Stage 2	6	17	115	30	116	28	122	54	359	34
Stage 3	15	42	118	31	174	42	10	4	317	30
Stage 4	2	6	6	2	9	2	0	0	17	2
Total	**36**		**379**		**416**		**226**		**1,057**	

Pediatric patients

Correlation of age, time to treatment initiation, and CD4 count at the time of treatment initiation, as compared to cost, for patients who were on treatment at the 12-month mark:

	Age	Time to Treatment Initiation (days)	CD4 Count at Time of Treatment Initiation
Cost	r = -0.3869 n = 19 p = 0.1018	r = 0.4977 n = 19 p = 0.0301	r = 0.1304 n = 17 p = 0.6179

Average cost as it compares to regimen type and WHO stage at the start of treatment, for patients on treatment at the 12-month mark:

Regimen Type	
First line	Average cost = CFA93,786.84 (US$189.64) Std. dev. = 141.97 n = 15
Second line	Average cost = CFA79,128.32 (US$160) Std. dev. = n/a n = 1
Non-standard	Average cost = n/a Std. dev. = n/a n = 0
No treatment	Average cost = CFA9,287.69 (US$18.78) Std. dev. = 14.20 n = 3

WHO Stage	
0	Average cost = CFA52,565.93 (US$106.29) Std. dev. = 29.49 n = 2
1	Average cost = CFA113,479.90 (US$229.46) Std. dev. = 182.01 n = 7
2	Average cost = CFA48,154.53 (US$97.37) Std. dev. = 86.51 n = 4
3	Average cost = CFA74,311.38 (US$150.26) Std. dev. = 136.36 n = 5
4	Average cost = CFA50,127.79 (US$101.36) Std. dev. = n/a n = 1

Average age, time to treatment initiation, and CD4 count at the start of treatment initiation, as it compares to treatment outcome, for all patients who initiated treatment during the study period:

Age	
Death	Average age = n/a Std. dev. = n/a n = 0
Lost to follow-up	Average age = 2.72 Std. dev. = 3.77 n = 18
On treatment—Not responding	Average age = 6.38 Std. dev. = 5.30 n = 13
On treatment—Responding	Average age = 5.50 Std. dev. = 3.15 n = 6

Time to Treatment Initiation (days)	
Death	Average time = n/a Std. dev. = n/a n = 0
Lost to follow-up	Average time =249.56 Std. dev. = 462.74 n = 18
On treatment—Not responding	Average time = 306.46 Std. dev. = 722.36 n = 13
On treatment—Responding	Average time = 628 Std. dev. = 912.59 n = 6

CD4 Count at Start of Treatment Initiation	
Death	Average CD4 count = n/a Std. dev. = n/a n = 0
Lost to follow-up	Average CD4 count = 897.50 Std. dev. = 717.08 n = 14
On treatment—Not responding	Average CD4 count = 611.83 Std. dev. = 806.28 n = 12
On treatment—Responding	Average CD4 count = 463.80 Std. dev. = 281.34 n = 5

Number and percentage of patients, by regimen type and treatment outcome:

	First Line		Second Line		Non-standard		No Treatment		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*
Death	0	0	0	0	0	0	0	0	0	0
Lost to follow-up	13	46	0	0	1	100	4	57	18	49
On treatment—Not responding	10	36	1	100	0	0	2	29	13	35
On treatment—Responding	5	18	0	0	0	0	1	14	6	16
Total	**28**		**1**		**1**		**7**		**37**	

* Percentage of regimen type.

Number and percentage of patients, by WHO stage at time of treatment initiation, and treatment outcome:

	Death		Lost to Follow-up		On Treatment—Not Responding		On Treatment—Responding		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*
Stage 0	0	n/a	6	33	2	15	0	0	8	22
Stage 1	0	n/a	1	6	4	31	3	50	8	22
Stage 2	0	n/a	6	33	2	15	2	33	10	27
Stage 3	0	n/a	5	28	4	31	1	17	10	27
Stage 4	0	n/a	0	0	1	8	0	0	1	3
Total	**0**		**18**		**13**		**6**		**37**	

Pregnant women

Correlation of age, time to treatment initiation, and CD4 count at the time of treatment initiation, as compared to cost, for patients who were on treatment at the 12-month mark:

	Age	Time to Treatment Initiation (days)	CD4 Count at Time of Treatment Initiation
Cost	r = -0.0478 n = 107 p = 0.6252	r = 0.0621 n = 92 p = 0.5565	r = -0.0652 n = 103 p = 0.5127

Average cost as it compares to regimen type and WHO stage at the start of treatment, for patients on treatment at the 12-month mark:

Regimen Type	
First line	Average cost = CFA64,806.09 (US$131.04) Std. dev. = 75.45 n = 53
Second line	Average cost = CFA146,590.16 (US$296.41) Std. dev. = 173.28 n = 3
Non-standard	Average cost = CFA12,457.76 (US$25.19) Std. dev. = n/a n = 1
No treatment	Average cost = CFA23,481.33 (US$47.48) Std. dev. = 14.10 n = 50

WHO Stage	
0	Average cost = CFA52,373.06 (US$105.90) Std. dev. = 89.23 n = 9
1	Average cost = CFA48,545.22 (US$98.16) Std. dev. = 93.82 n = 40
2	Average cost = CFA41,601.71 (US$84.12) Std. dev. = 65.42 n = 43
3	Average cost = CFA62,986.14 (US$127.36) Std. dev. = 71.44 n = 13
4	Average cost = CFA20,172.78 (US$40.79) Std. dev. = 8.94 n = 2

Average age, time to treatment initiation, and CD4 count at the start of treatment initiation, as it compares to treatment outcome, for all patients who initiated treatment during the study period:

Age	
Death	Average age = 32.00 Std. dev. = n/a n = 1
Lost to follow-up	Average age = 29.97 Std. dev. = 5.74 n = 97
On treatment—Not responding	Average age = 30.43 Std. dev. = 5.33 n = 79
On treatment—Responding	Average age = 28.21 Std. dev. = 5.37 n = 28

Time to Treatment Initiation (days)	
Death	Average time = 1,530.00 Std. dev. = n/a n = 1
Lost to follow-up	Average time = 617.84 Std. dev. = 606.02 n = 81
On treatment—Not responding	Average time = 811.42 Std. dev. = 703.99 n = 67
On treatment—Responding	Average time = 606.20 Std. dev. = 847.31 n = 25

CD4 Count at Start of Treatment Initiation	
Death	Average CD4 count = 649 Std. dev. = n/a n = 1
Lost to follow-up	Average CD4 count =509.59 Std. dev. = 294.35 n = 86
On treatment—Not responding	Average CD4 count = 449.33 Std. dev. = 223.93 n = 75
On treatment—Responding	Average CD4 count = 400.79 Std. dev. = 194.51 n = 28

Number and percentage of patients, by treatment outcome and regimen type:

	First Line		Second Line		Non-standard		No Treatment		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*
Death	0	0	0	0	0	0	1	1	1	0
Lost to follow-up	34	39	2	40	1	50	60	54	97	47
On treatment—Not responding	41	47	3	60	1	50	34	31	79	39
On treatment—Responding	12	14	0	0	0	0	16	14	28	14
Total	**87**		**5**		**2**		**111**		**205**	

* Percentage of regimen type.

Number and percentage of patients, by WHO stage at time of treatment initiation, and treatment outcome:

	Death		Lost to Follow-up		On Treatment—Not Responding		On Treatment—Responding		Total	
	n	%*	n	%*	n	%*	n	%*	n	%*
Stage 0	0	0	19	20	9	11	0	0	28	14
Stage 1	1	100	35	36	25	32	15	54	76	37
Stage 2	0	0	33	34	30	38	13	46	76	37
Stage 3	0	0	9	9	13	16	0	0	22	11
Stage 4	0	0	1	1	2	3	0	0	3	1
Total	**1**		**97**		**79**		**28**		**205**	

ANNEX E. DETAILED RESULTS OF THE POPULATION PROJECTION

Number of People Living with HIV, by Scenario, Year, and Age Subgroup (adults and children)

Scenario 1: Status Quo

Year	Adults	Children	Total
2016	342,537	50,652	393,189
2017	335,158	45,952	381,110
2018	325,458	41,248	366,706
2019	314,446	36,857	351,303
2020	302,852	32,714	335,566

Scenario 2: 90-90-90

Year	Adults	Children	Total
2016	342,527	50,188	392,715
2017	337,389	44,789	382,178
2018	334,636	39,059	373,695
2019	334,476	34,547	369,023
2020	336,440	31,037	367,477

Number of People on HIV Treatment, by Scenario, Year, and Age Subgroup (adults and children)

Scenario 1: Status Quo

Year	Adults	Children	Total
2016	145,022	6,624	151,646
2017	167,999	9,486	177,485
2018	195,968	13,183	209,151
2019	230,363	18,197	248,560
2020	272,517	25,336	297,853

Scenario 2: 90-90-90

Year	Adults	Children	Total
2016	125,711	4,923	130,634
2017	125,014	5,167	130,181
2018	123,674	5,230	128,904
2019	121,376	5,170	126,546
2020	119,021	5,032	124,053

Number of Pregnant Women Accessing PMTCT, by Scenario, Method, and Year

Year	Scenario 1: Status Quo		Scenario 2: 90-90-90	
	Option B	Option B+	Option B	Option B+
2016	14,101	2,752	10,110	6,869
2017	12,268	4,490	4,745	12,232
2018	10,622	5,903	0	16,894
2019	9,151	7,013	0	16,840
2020	7,849	7,849	0	16,820

Number of Newborns Infected with HIV Due to Mother-to-Child Transmission, by Scenario and Year

Year	Scenario 1: Status Quo	Scenario 2: 90-90-90
2016	3,705	4,278
2017	2,539	3,682
2018	1,425	3,086
2019	1,070	2,514
2020	764	1,984

Number of HIV-related Deaths, by Scenario, Year, and Age Subgroup (adults and children)

Scenario 1: Status Quo

Year	Adults	Children	Total
2016	12,602	3,139	15,741
2017	15,486	2,680	18,166
2018	17,258	2,309	19,567
2019	18,015	1,978	19,993
2020	18,023	1,658	19,681

Scenario 2: 90-90-90

Year	Adults	Children	Total
2016	12,602	3,065	15,667
2017	13,240	2,446	15,686
2018	10,286	2,067	12,353
2019	7,062	1,726	8,788
2020	4,280	1,221	5,501

Number of HIV Infections, by Scenario, Year, and Age Subgroup (adults and children)

Scenario 1: Status Quo

Year	Adults	Children	Total
2016	7,030	5,376	12,406
2017	6,753	5,017	11,770
2018	6,460	4,628	11,088
2019	6,161	4,233	10,394
2020	5,823	3,846	9,669

Scenario 2: 90-90-90

Year	Adults	Children	Total
2016	7,030	3,705	10,735
2017	6,753	2,539	9,292
2018	6,460	1,425	7,885
2019	6,161	1,070	7,231
2020	5,823	764	6,587

ANNEX F. REPORT COST TABLES AND FIGURES IN U.S. DOLLARS

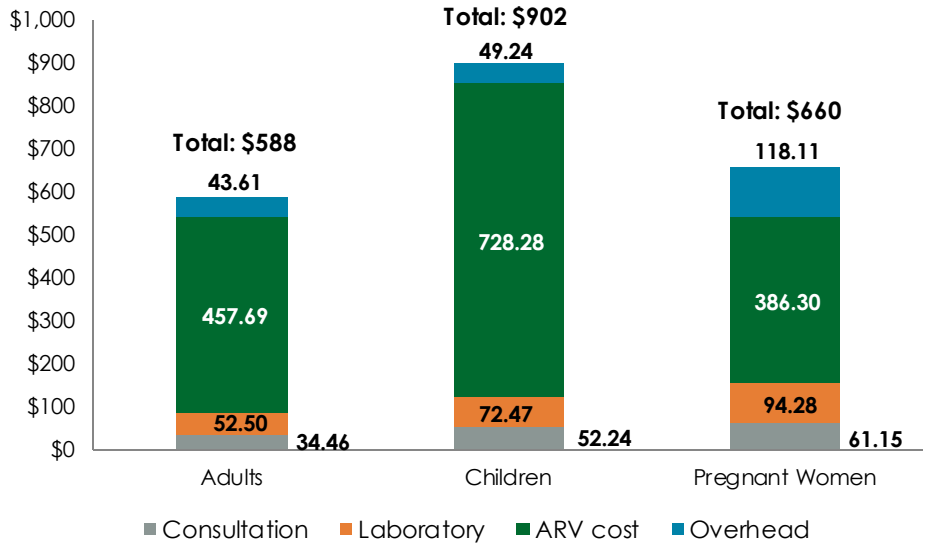
U.S. Dollar Conversion of Table 7: Annual Treatment Cost of Study Sample, Disaggregated by Cost, Treatment Outcome, and Patient Type

	Adult US$ (%)	Pediatric US$ (%)	PMTCT US$ (%)
All patients initiated on ART	n = 1,043	n = 37	n = 212
Consultations	6 (4%)	8 (5%)	8 (6%)
Laboratory	12 (7%)	13 (7%)	13 (9%)
ARV cost	134 (83%)	141 (83%)	109 (75%)
Overhead	9 (6%)	8 (5%)	16 (11%)
Total cost	161	169	145
Patients on treatment*	n = 634	n = 19	n = 86
Consultations	6 (3%)	10 (6%)	9 (8%)
Laboratory	15 (8%)	17 (9%)	14 (12%)
ARV cost	161 (86%)	144 (82%)	113 (69%)
Overhead	6 (3%)	6 (3%)	15 (11%)
Total cost	188	176	151
Patients on treatment and responding*	n = 222	n = 6	n = 23
Consultations	6 (3%)	14 (7%)	12 (6%)
Laboratory	18 (9%)	19 (10%)	19 (9%)
ARV cost	179 (86%)	151 (80%)	106 (75%)
Overhead	6 (3%)	5 (3%)	16 (10%)
Total cost	210	190	152

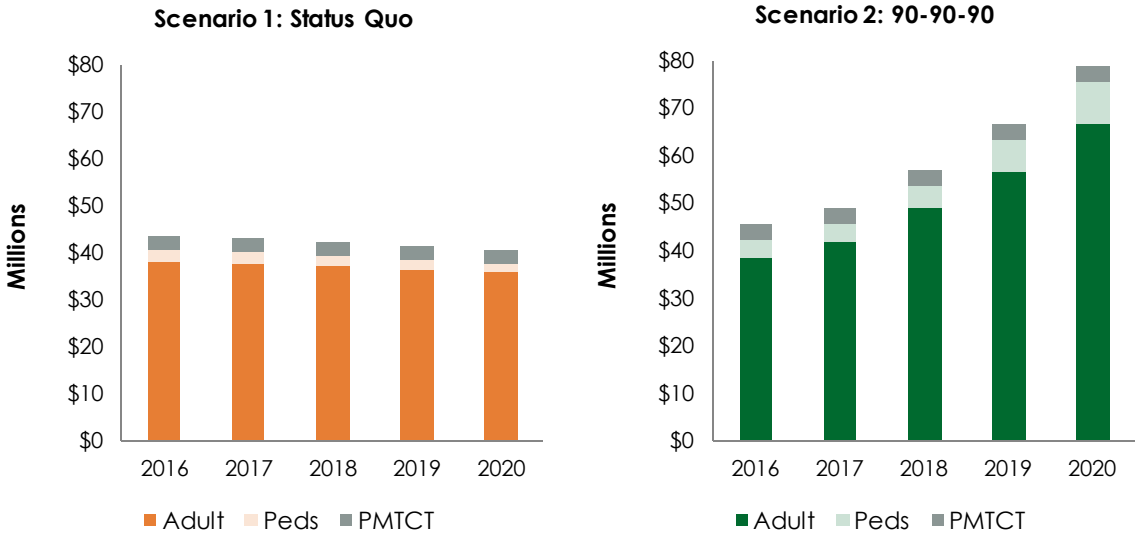
U.S. Dollar Conversion of Table 8: True Annual Treatment Cost for First Year and Assumptions, Disaggregated by Cost Type and Patient Type

	Adult US$ (%)	Pediatric US$ (%)	PMTCT Option B US$ (%)	PMTCT Option B+ US$ (%)
Breakdown of annual cost of treatment				
Consultation	7 (2%)	10 (4%)	10 (6)	10 (5)
Laboratory	69 (24%)	70 (25%)	38 (22)	38 (18)
ARV cost	202 (70%)	353 (69%)	106 (62)	141 (68)
Overhead	11 (4%)	7 (2%)	19 (11)	19 (9)
Total cost	288	440	172	207

U.S. Dollar Conversion of Figure 2: Positive Outcome Production Cost, by Patient Type



U.S. Dollar Conversion of Figure 5: Year-on-Year Total Treatment Cost, by Scenario



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