Cost-Effectiveness of Integrating PMTCT and MNCH Services:

An Application of the LiST Model for Malawi, Mozambique, and Uganda

DHS OCCASIONAL PAPER NO. 7

SEPTEMBER 2013

This publication was produced for review by the United States Agency for International Development (USAID). The report was prepared by Lori Bollinger and Adebiyi Adesina of the Futures Institute, Glastonbury, CT, USA.

MEASURE DHS assists countries worldwide in the collection and use of data to monitor and evaluate population, health, and nutrition programs. Additional information about the MEASURE DHS project can be obtained by contacting MEASURE DHS, ICF International, 11785 Beltsville Drive, Suite 300, Calverton, MD 20705 (telephone: 301-572-0200; fax: 301-572-0999; e-mail: reports@measuredhs.com; internet: www.measuredhs.com).

The main objectives of the MEASURE DHS project are:

- to provide decision makers in survey countries with information useful for informed policy choices;
- to expand the international population and health database;
- to advance survey methodology; and
- to develop in participating countries the skills and resources necessary to conduct high-quality demographic and health surveys.

DHS Occasional Paper No. 7

Cost-Effectiveness of Integrating PMTCT and MNCH Services: An Application of the LiST Model for Malawi, Mozambique, and Uganda

Lori Bollinger

Adebiyi Adesina

ICF International
Calverton, MD, USA

September 2013

Corresponding author: Lori Bollinger, Futures Institute, 41-A New London Turnpike, Glastonbury, CT, 06033, USA; E-mail: LBollinger@FuturesInstitute.org

This study was carried out with support provided by the United States Agency for International Development (USAID) through the MEASURE DHS project (#GPO-C-00-08-00008-00). The views expressed are those of the authors and do not necessarily reflect the views of USAID or the United States government.

Recommended citation:

Bollinger, Lori, and Adebiyi Adesina. 2013. *Cost-Effectiveness of Integrating PMTCT and MNCH Services: An Application of the LiST Model for Malawi, Mozambique, and Uganda*. DHS Occasional Paper No. 7. Calverton, Maryland, USA: ICF International.

Contents

List of Tables

List of Figures

Preface

One of the most significant contributions of the MEASURE DHS program is the creation of an internationally comparable body of data on the demographic and health characteristics of populations in developing countries.

The *DHS Comparative Reports* series examines these data across countries in a comparative framework. The *DHS Analytical Studies* series focuses on analysis of specific topics. The principal objectives of both series are to provide information for policy formulation at the international level and to examine individual country results in an international context. While *Comparative Reports* are primarily descriptive, *Analytical Studies* comprise in-depth, focused studies on a variety of substantive topics. The studies are based on a variable number of data sets, depending on the topic being examined. A range of methodologies is used in these studies, including multivariate statistical techniques.

The topics covered in all DHS reports are selected by MEASURE DHS staff in conjunction with the U.S. Agency for International Development, with the goal of enhancing the understanding of analysts and policymakers regarding significant issues in the fields of international population and health.

This *Occasional Paper* deals with a topic of interest for family planning programs in many countries, but falls outside the general framework of the other series of DHS reports.

Sunita Kishor
Project Director

Acknowledgements

We gratefully acknowledge USAID for funding this research through the MEASURE III project. Thank you to B. Ryan Phelps for valuable comments, as well as the participants of the DCP3 Quality Meeting on Instruments of Policy to Influence Intervention Access, Uptake and Quality in Washington DC.

Executive Summary

Integrating health care services is thought to result in both cost savings and better outcomes through improving efficiency, quality, uptake and effectiveness of services. Integration is one of the seven core principles guiding the United States Global Initiative, and is recommended by the World Health Organization in its 2013 Consolidated Guidelines for Antiretroviral Therapy.

Although there is evidence on some aspects of the impacts of integration, such as increases in coverage rates for various interventions, there is little evidence regarding actual outcome variables. In this paper we utilize the empirical evidence available on the impact of integration on coverage rates and costs to model the impact of integrating services to prevent mother-to-child transmission with antenatal clinic sites on infant HIV infections averted, and also the impact of integrating family planning services into HIV care facilities. We calculate incremental cost-effectiveness ratios for a number of different scenarios using the LiST model for Malawi, Mozambique and Uganda.

We find that all of the integration strategies are cost-effective, with all of the scenarios except one being highly cost-effective. In fact, a majority of the scenarios examined actually report cost savings, particularly when the interactive and dynamic effects that are modeled across the different modules are included; for example, increasing family planning results in lower costs for providing health care to children, including immunization, because there are fewer children born.

We conclude that, although few empirical results exist regarding the incremental cost-effectiveness ratios associated with integrating HIV and MNCH services, the modeled evidence confirms that there are, indeed, significant benefits to integration.

1 Introduction

Integrating health care services is thought to result in both cost savings and better outcomes through improving efficiency, quality, uptake and effectiveness of services. In particular, integrating HIV services and maternal, neonatal and child health (MNCH) services is hypothesized to lead to more people learning their HIV status and thus beginning treatment as appropriate, practicing safer sex, and being treated for STIs, as well as other outcome variables. Cost savings are thought likely to occur as the use of physical space is better managed, patients save time by attending an integrated facility, and medical records can be standardized and shared more easily. These benefits are thought to be sufficiently large that integration is one of the seven core principles guiding the efforts of the United States Global Health Initiative [U.S. Government 2012]. In addition, for the first time, a number of different integration strategies are recommended in the recently released World Health Organization 2013 Consolidated Guidelines for Antiretroviral Treatment (ART), including integrating HIV services into primary health care facilities (including preventing mother-to-child transmission programs (PMTCT) with MNCH facilities), integrating HIV services with health care for non-communicable diseases, and integrating HIV care into immunization and other well-child services [WHO 2013a].

Although there are many hypotheses regarding the possible benefits of integration, there are few data, particularly with respect to outcome variables of interest. For example, although two recent studies from Zambia found that integrating ART into antenatal clinics (ANC) doubled uptake of ART in pregnant women [Killam et al. 2010] and that the uptake of reproductive health services increased at the same rate as uptake of ART in facilities that offered integrated services [Bratt et al. 2011], no final outcome variables were measured such as infant HIV infections averted or pregnancies averted. Another study from Mozambique found that integrating various HIV services into the primary health care system resulted in increased access to care, higher follow-up rates, and greater system-wide efficiencies [Pfeiffer et al. 2011], but again, the study did not measure the impact on final outcome variables.

To address this gap, this paper evaluates whether integrating services in three countries – Malawi, Uganda and Mozambique – results in cost savings and/or improvements in HIV and reproductive health outcome variables. We utilize a new costing methodology developed for the Lives Saved Tool (LiST) [Adesina and Bollinger 2013] to examine both the cost and impact of integrating HIV and reproductive health services, including the integration of PMTCT into ANC facilities, and the integration of family planning into HIV care. We use empirical evidence from the literature to calculate increased coverage rates as well as decreased costs resulting from integrating facilities, and then utilize these estimates in LiST to calculate the impact on infant HIV infections averted.

The results show that there are significant impacts for both types of integration, with improved incremental cost-effectiveness ratios (ICER) occurring in every country for each of the scenarios examined, and actual cost-savings occurring in most of the scenarios examined. Although this conclusion holds when ICERs are limited to intervention costs only (i.e., PMTCT or family planning), the results strengthen when interaction effects are included. We conclude that, although few empirical results exist regarding the incremental cost-effectiveness ratios associated with integrating HIV and MNCH services, the modeled evidence confirms that there are, indeed, significant benefits to integration.

2 Context and Literature Review

2.1 Integration: Theory and Evidence

Although progress has been made towards reaching the goal of universal health coverage without major financial hardships, the goal has not yet been reached. There have been improvements in various indicators of health coverage goals related to the Millennium Development Goals (MDGs); for example, between 2011 and 2012 the number of people on ART increased from 54 percent to 65 percent of the overall target of 15 million people on ART. This is also a much higher coverage rate for ART than those from a decade before, when ART coverage rates were less than 10 percent. On the financial side, there has been a significant fall in cash payments for health services. Challenges remain, however; one-third of those who are in need of ART have yet to receive it, while it is estimated that 150 million people suffered significant financial difficulties because they had to pay for medical expenses themselves [WHO 2013b and 2013c].

Integrating health services is proposed as one way of making progress towards the goal of universal health coverage without financial hardship, through using resources more efficiently. The primary benefit is hypothesized to be lower incremental cost-effectiveness ratios (ICERs), which would occur either through improved health outcomes due to increasing coverage rates, or through lower costs, which might occur due to more efficient use of resources, exploiting economies of scale and/or benefiting from economies of scope, or both [Warren et al. 2012; Siapka et al. 2013]. There are other potential benefits that are nonmonetary in nature, including a reduction in HIV-related stigma if HIV care is delivered at non-HIV sites [Odeny et al. 2013]; enhancing provider skills through increasing the types of services they deliver, as well as providing more variety and challenge in their work [Lindegren et al. 2012]; and reduced waiting time overall for patients, with associated reductions in out-of-pocket expenditures [Deo et al. 2012]. Integrating services may not result only in benefits, however; for example, significant concerns exist regarding the effect of integration on quality of health care delivery [Chi et al. 2013], and even one of the potential benefits to the health system listed above – increasing provider skills and variety in their work – is not always viewed as a benefit by the providers themselves [Mutemwa et al. 2013].

There are a number of different ways health services could be integrated. First, and most commonly associated with integration, is the so-called “one-stop shop,” or offering multiple services at the same facility. For example, this might consist of providing HIV and MNCH services at the same site, in particular providing PMTCT at ANC sites. Second, services could be bundled for a specific population, such as integrated management of childhood illness (IMCI). Third, integrating services might consist of coordinating services across different service delivery sites; for example, implementing a referral service so that those identified as HIV positive at an MNCH site can receive HIV care at an HIV site, resulting in increased coverage of ART. Fourth, integrating the management of the health system above the facility level, at either the district, provincial or national level, could result in more efficient uses of personnel [Duffy 2013].

The quantitative evidence on the impact of integrating services on either coverage or cost is limited. We discuss here the literature relating to the integration of PMTCT and MNCH services, although other literature exists regarding other areas of integration such as HIV and tuberculosis, and primary health care services overall. There are a number of ways that MNCH services can be integrated into HIV services; for example, family planning services could be integrated into programs that are HIV-related, such as HIV counseling and testing (HCT) or ART, or child nutrition programs could be integrated into HIV-related services. Integrating HIV services into existing MNCH programs can also take place in several ways; for example, offering HCT for either children or adults in immunization or other MNCH programs, or integrating PMTCT into ANC sites [Dudley and Garner 2011].

We focus here on the available quantitative evidence regarding the impact of integrating family planning services into HIV-related sites, and the quantitative evidence regarding the impact on coverage rates when PMTCT services are integrated into MNCH services such as ANC sites and childbirth wards. The evidence regarding the impact on costs is somewhat less focused, but will be discussed as well. Note that we had very specific requirements regarding the type of data that were useful; there were other studies we identified but were not able to use because the outcome measure reported in the study was not relevant.

We identified seven studies that reported changes in the modern contraceptive prevalence rate (CPR) or related outcome variable after family planning services were integrated into facilities providing HIV-related services. All of the studies were from sub-Saharan Africa; there was one study each from Ethiopia, Malawi and Rwanda, while there were two studies each from Kenya and Nigeria. Some of the studies examined the impact of integrating family planning into HIV-related care, while other programs evaluated integrating family planning services into HCT sites. In Ethiopia, family planning services were integrated into facilities that offered counseling and testing for HIV. The overall need for contraceptives was low; only 29 percent of women had had sex in the last 30 days, and 74 percent of those women were already using contraceptives. After integrating, a further 6 percent of women accepted contraceptives, resulting in a new CPR of 27.5 percent, which translates to an overall increase of 27.9 percent [Bradley et al. 2009].

In Malawi, women were asked about their fertility intentions prior to receiving HCT in an HIV facility. Those women who tested positive for HIV and were not pregnant were offered both HIV and family planning services, and were followed for one year. One week after the initial services were received, the CPR increased among the women provided the service from 38 percent to 52 percent; after one year the increase in CPR had stabilized so that 46 percent of these women were using contraceptives, an overall increase of 21.1 percent [Hoffman et al. 2008].

In Rwanda, an older study examined the impact when family planning services were added to HCT services. Of the 330 HIV-positive women and the 172 HIV-negative women, 80 women continued their hormonal contraceptive use and 16 women switched to another hormonal contraceptive method, while 40 women became new hormonal contraceptive users. This results in an increase in hormonal contraceptive CPR from 15.9 percent to 22.1 percent in the study population, or a 39 percent increase overall [King et al. 1995].

In Kenya, two studies examined the impact of integrating family planning services into sites providing overall HIV care. The first was a controlled study promoting dual contraceptive use by women in HIV-1-serodiscordant couples, and reported a number of different outcome variables for both barrier and non-barrier contraceptive use at both intervention and non-intervention sites. Non-barrier contraceptive use increased at the intervention site from 31.5 percent to 64.7 percent in HIV-positive women, and from 28.6 percent to 46.7 percent in HIV-negative women. At the non-intervention sites, HIV-positive women increased non-barrier contraceptive use from 15.6 percent to 22.3 percent, while HIV-negative women decreased their use from 13.6 percent to 12.7 percent. We calculate the overall impact of an increase of 65.8 percent by subtracting the average change in the non-intervention site (including the decrease in use) from the average change in the intervention site. Note that self-reported condom use remained high in all populations [Ngure et al. 2009]. The second study in Kenya found that integrating family planning services into HIV care increased modern CPR (including condoms) by 12.9 percent, although it did not have a measurable impact on pregnancy incidence [Kosgei et al. 2011].

Finally, there were two studies in Nigeria that evaluated the impact of adding family planning services to HIV care. In the first study, family planning was integrated into sites providing HCT, ART and PMTCT. There were two outcome measures: family planning clinic attendance and couple years of protection (CYPs). The two outcome variables were measured both pre-integration and post-integration; here we use the impact on average CYPs, which increased from 32.3 to 38.2, an 18.3 percent increase [Chabikuli et al.

2009]. In the second study, there were two integration groups, one with a “basic” intervention and the other with an “enhanced” intervention. Compared to the control group, the modern CPR increased by 13 percent in the enhanced group and increased by 12 percent in the basic group, resulting in an average impact of 12.5 percent [McCarraher et al. 2011].

We also searched the literature for evidence on the impact of integrating PMTCT into facilities that provided ANC services and childbirth wards. We identified 11 studies that calculated an outcome indicator that quantitatively measured the impact of intervention using results from 14 interventions; with the exception of one observation from Jamaica in a meta-analysis that used observations from four countries, all of the observations were from sub-Saharan Africa. One caveat in advance: the outcome measures used in some of these studies were not as directly comparable as in the studies discussed above. For example, a study in Côte d’Ivoire found that integrating PMTCT into ANC sites resulted in an uptake of HIV tests by 42 percent of women, although none had been offered an HIV test before, an outcome measure that we will not be using here [Delvaux et al. 2008]. In addition, one of two studies in South Africa estimated the impact of integration by measuring a decrease in the median treatment initiation time from 56 days to 37 days [van der Merwe et al. 2006], while one of three studies in Zambia measured the impact of integration by an increase of 250 percent in RPR screening [Potter et al. 2008], again, outcome measures we will not use here. Finally, a study from Tanzania measured the impact of integrating PMTCT services into ANC sites on the utilization of human resources. The study found that no further personnel were required to provide the additional PMTCT services, as the existing personnel were not being fully utilized while providing ANC services. Instead, the percentage of personnel time utilized at the ANC facilities increased from 37.8 percent before integration took place to 50.5 percent after integration [Simba et al. 2010]. Although this result is interesting, we cannot use it in this analysis.

Most studies, however, measured the impact of integrating PMTCT into ANC or childbirth services in more useful ways for our purposes. The second study from South Africa found that after integrating PMTCT into ANC services, the uptake of ART increased by 33 percent during pregnancy, after adjusting for age and gestation [Stinson et al. 2013]. The second of three studies from Zambia, which evaluated the impact of adding PMTCT services to ANC sites, estimated that the uptake of ART for eligible pregnant women was 32.9 percent in the intervention group versus 14.4 percent in the control group, an increase of 128 percent [Killam et al. 2010]. The third study from Zambia, which examined the impact of adding PMTCT services to childbirth wards, measured an increase of ten percentage points in the uptake of PMTCT, or a 37 percent increase in the uptake of PMTCT services even after controlling for general demographic characteristics [Megazzini et al. 2010]. One of two studies in Kenya found that there was an increase of 23 percent in PMTCT uptake when both ANC sites and labor wards added PMTCT services, from a 57 percent uptake level to 70 percent uptake [van’t Hoog et al. 2005]. The second study in Kenya did not have a pre-intervention measure, but only reported that adding PMTCT to current ART sites in western Kenya resulted in a 67.4 percent coverage rate of PMTCT services [Ayuo et al. 2013]. There was one study that did not find an impact of integration on service delivery; an evaluation of a Malawi labor ward that added PMTCT found a statistically insignificant increase in the uptake of nevirapine for PMTCT, from 92 percent to 97 percent. It was hypothesized that the lower effect compared to the first Kenya study cited above was because that study added PMTCT services to both labor wards and ANC sites, whereas the Malawi intervention added PMTCT services only to labor wards [Kasenga et al. 2009]. Finally, a meta-analysis of the impact of integrating ART provision into ANC sites in Jamaica, Zambia, Mozambique and Rwanda examined the uptake of ART services and found the that ART uptake had more than doubled after controlling for several variables, calculating an odds ratio of 2.09, or a 109 percent increase in uptake [Suthar et al. 2013].

Although there were a number of studies that evaluated the impact of integrating services on the incremental cost of providing those services [Theilman et al. 2006; Homan et al. 2006; Mullick et al. 2008], there were also a few studies that examined the costs associated with integrated sites compared to non-integrated sites. Because the data using comparator sites seemed more relevant to this analysis, we compiled the evidence from those studies to use here. There were three studies, one from Uganda with two observations, one from Kenya and one from India. The Uganda study collected cost information regarding clients receiving HCT from integrated and non-integrated sites. The authors measured the costs in two ways: cost per new HCT client, and cost per HCT client overall. Note that several costs were reported for integrated sites; we use here the highest cost reported, that is, we estimate a lower bound on potential cost savings. The results showed that the cost of providing HCT services for new HCT clients was 50 percent lower at integrated sites compared to non-integrated sites, while the cost of providing HCT services for HCT clients overall was 28 percent lower at integrated sites [Menzies et al. 2009]. The study from Kenya examined the cost of providing MCH and family planning services at integrated versus non-integrated sites; the non-integrated sites had a unit cost of US$18.42 while the unit cost at integrated sites was US$12.77, lower by 31 percent [Twarir et al. 1996]. Finally, a study in India of sexual and reproductive health (SRH) services provided at both integrated and non-integrated sites found the integrated sites had a unit cost of US$3.51 versus US$5.24 at non-integrated sites, a difference of 33 percent [Das et al. 2007].

Note that there was a fifth costing study that evaluated costs at both integrated and non-integrated sites, but because the non-integrated site costs were from a previous study, that is, they were not gathered concurrently with the integrated site costs, we did not include these results, which showed a relatively larger reduction of 65 percent in the integrated sites [Liambila et al. 2008].

The evidence discussed above on the impact of integration on coverage rates and costs is summarized in Table 1 below, including full citations for the literature cited above. The use of these data in constructing scenarios for this analysis is described below in the Data and Methods section.

Table 1. Summary of impacts from integration

Panel A: Family planning services added to HIV care facilities			
Country	**Change in cost/coverage**	**Type of integration**	**Source - citation**
Ethiopia	Change of 27.9%: 6% of clients received contraceptives, up from 21.5%	VCT adding FP	Bradley H, Gillespie D, Kidanu A, Bonnenfant YT, Karklins S: **Providing family planning in Ethiopian voluntary HIV counseling and testing facilities: client, counselor and facility-level considerations.** *AIDS* 2009 Nov;23 Suppl 1:S105-14. doi: 10.1097/01.aids.0000363783.88698.a2.
Malawi	Change of 21.1%: Increase from 38% to 46% in contraceptive use	HCT + FP	Hoffman IF, Martinson FE, Powers KA, Chilongozi DA, Msiska ED, Kachipapa EI, Mphande CD, Hosseinipour MC, Chanza HC, Stephenson R, Tsui AO. **The year-long effect of HIV-positive test results on pregnancy intentions, contraceptive use, and pregnancy incidence among Malawian women.** *J Acquir Immune Defic Syndr.* 2008 Apr 1;47(4):477-83. doi: 10.1097/QAI.0b013e318165dc52.
Rwanda	Change of 39%: Increase in hormonal CPR of 39% or 6.2 percentage points	HCT adding FP	King R, Estey J, Allen S, Kegeles S, Wolf W, Valentine C, Serufilira A: **A family planning intervention to reduce vertical transmission of HIV in Rwanda.** *AIDS*. 1995 Jul;9 Suppl 1:S45-51.

(Continued...)

Table 1. – *Continued*

Country	Change in cost/coverage	Type of integration	Source - citation
Nigeria	Change of 18.3%: Mean CYP increased from 32.3 to 38.2%	HIV tx/secondary prevention adding FP	Chabikuli NO, Awi DD, Chukwujekwu O, Abubakar Z, Gwarzo U, Ibrahim M, Merrigan M, Hamelmann C: **The use of routine monitoring and evaluation systems to assess a referral model of family planning and HIV service integration in Nigeria**. *AIDS* 2009 Nov;23 Suppl 1:S97-S103. doi: 10.1097/01.aids.0000363782.50580.d8.
Kenya	12.9% increase of FP use including condoms	HIV care adding FP	Kosgei RJ, Lubano KM, Shen C, Wools-Kaloustian KK, Musick BS, Siika AM, Mabeya H, Carter EJ, Mwangi A, Kiarie J: **Impact of integrated family planning and HIV care services on contraceptive use and pregnancy outcomes: a retrospective cohort study.** *J Acquir Immune Defic Syndr.* 2011 Dec 15;58(5):e121-6. doi: 10.1097/QAI.0b013e318237ca80.
Nigeria	12.5% increase in modern CPR (mostly condoms)	HIV care adding FP	McCarraher DR, Vance G, Gwarzo U, Taylor D, Chabikuli ON. **Changes in contraceptive use following integration of family planning into ART Services in Cross River State, Nigeria**. *Stud Fam Plann*. 2011 Dec;42(4):283-90.
Kenya	Change of 65.8%: Difference of the average increase in the intervention sites (105% for HIV+, 63% for HIV-: Avg=84%), and average increase in non-intervention (43% for HIV+, -6.6% for HIV-: Avg=18.2%)	HIV adding FP	Ngure K, Heffron R, Mugo N, Irungu E, Celum C, Baeten JM: **Successful increase in contraceptive uptake among Kenyan HIV-1-serodiscordant couples enrolled in an HIV-1 prevention trial.** *AIDS* 2009 Nov;23 Suppl 1:S89-95. doi: 10.1097/01.aids.0000363781.50580.03.

Panel B: PMTCT services added to ANC/Childbirth facilities

Country	Change in cost/coverage	Type of integration	Source - Citation
Cote d'Ivoire	42% had an HIV test (and were not offered it before)	ANC adding PMTCT services	Delvaux T, Konan JP, Aké-Tano O, Gohou-Kouassi V, Bosso PE, Buvé A, Ronsmans C: **Quality of antenatal and delivery care before and after the implementation of a prevention of mother-to-child HIV transmission programme in Cote d'Ivoire**. *Trop Med Int Health* 2008 Aug;13(8):970-9.
Jamaica, Zamiba, Mozambique, Rwanda	Doubled ART uptake (RR 2.09) in meta-analysis	ANC adding ART	Suthar AB, Hoos D, Beqiri A, Lorenz-Dehne K, McClure C & Duncombee C: **Integrating antiretroviral therapy into antenatal care and maternal and child health settings: a systematic review and meta-analysis.** *Bull World Health Organ* 2013;91:46–56
Kenya	70% vs. 57% uptake of NVP (23%)	ANC/labor ward adding PMTCT	van't Hoog AH, Mbori-Ngacha DA, Marum LH, Otieno JA, Misore AO, Nganga LW, Decock KM: **Preventing mother-to-child transmission of HIV in Western Kenya: operational issues.** *J Acquir Immune Defic Syndr.* 2005 Nov 1;40(3):344-9.

(Continued...)

Table 1. – *Continued*

Country	Change in cost/coverage	Type of integration	Source - Citation
Kenya	67.4% coverage of PMTCT	ART adding PMTCT	Ayuo P, Musick B, Liu H, Braitstein P, Nyandiko W, Otieno-Nyunya B, Gardner A, Wools-Kaloustian K: **Frequency and factors associated with adherence to and completion of combination antiretroviral therapy for preventing mother-to-child transmission in western Kenya.** *J Int AIDS Soc.* 2013 Jan 2;16(1):17994. doi: 10.7448/IAS.16.1.17994.
Malawi	Insignificant change to 97% vs. 92%	Labor ward adding PMTCT	Kasenga F, Byass P, Emmelin M, Hurtig AK: **The implications of policy changes on the uptake of a PMTCT programme in rural Malawi: first three years of experience.** *Glob Health Action.* 2009 Jan 23;2. doi: 10.3402/gha.v2i0.1883.
Zambia	Increase of 10 percentage points (RR=1.37) in PMTCT uptake	Childbirth wards adding PMTCT	Megazzini KM, Sinkala M, Vermund SH, Redden DT, Krebs DW, Acosta EP, Mwanza J, Goldenberg RL, Chintu N, Bulterys M, Stringer JS: **A cluster-randomized trial of enhanced labor ward-based PMTCT services to increase nevirapine coverage in Lusaka, Zambia**. *AIDS* 2010 Jan 28; 24(3):447-55. doi:10.1097/QAD.0b013e328334b285.
South Africa	33% higher ART initiation in pregnancy	ANC adding ART for eligible pregnant women	Stinson K, Jennings K, Myer L: **Integration of antiretroviral therapy services into antenatal care increases treatment initiation during pregnancy: a cohort study.** *PLoS One*. 2013 May 16;8(5):e63328. doi: 10.1371/journal.pone.0063328. Print 2013.
South Africa	Time-to-treatment initiation was reduced from a median of 56 days to 37 days	ANC adding ART for eligible pregnant women	van der Merwe K, Chersich MF, Technau K, Umurungi Y, Conradie F, Coovadia A: **Integration of antiretroviral treatment within antenatal care in Gauteng province, South Africa**. *J Acquir Immune Defic Syndr* 2006 Dec 15;43(5):577-81.
Tanzania	Capacity utilization was 37.8% in non-PMTCT and 50.5% in PMTCT	ANC adding PMTCT services	Simba D, Kamwela J, Mpembeni R, Msamanga G: **The impact of scaling-up prevention of mother-to-child transmission (PMTCT) of HIV infection on the human resource requirement: the need to go beyond numbers.** *Int J Health Plann Manage* 2010 Jan-Mar;25(1): 17-29.
Zambia	Doubled the proportion of treatment-eligible women initiating ART while pregnant - change of 128%	ANC adding ART for eligible pregnant women	Killam WP, Tambatamba BC, Chintu N, Rouse D, Stringer E, Bweupe M, Yu Y, Stringer JS: **Antiretroviral therapy in antenatal care to increase treatment initiation in HIV-infected pregnant women: a stepped-wedge evaluation.** *AIDS* 2010 Jan 2:24(1): 85-91. doi:10.1097/QAD.0b013e32833298be
Zambia	With research+service, 250% increase in RPR screening	ANC adding PMTCT services	Potter D, Goldenberg RL, Chao A, Sinkala M, Degroot A, Stringer JS, Bulterys M, Vermund SH: **Do Targeted HIV Programs Improve Overall Care for Pregnant Women?** *J Acquir Immune Defic Syndr* 2008 January 1;47(1): 79-85.

(Continued...)

Table 1. – *Continued*

Panel C: Changes in costs between integrated and non-integrated sites			
Country	**Change in cost/coverage**	**Type of integration**	**Source - Citation**
India	33%	Integrated vs. non-integrated SRH	Das R, Biswas K, Panda P, et al. Strengthening Financial Sustainability through Integration of Voluntary Counseling and Testing Services with Other Reproductive Health Services, 2007.
Uganda	28%	Integrated vs. non-integrated HCT	Menzies N, Abang B, Wanyenze R, et al. The costs and effectiveness of four HIV counseling and testing strategies in Uganda. AIDS 2009;23(3):395-401 doi: 10.1097/QAD.0b013e328321e40b[published Online First: Epub Date]|.
Uganda	50%	Integrated vs. non-integrated HCT	Menzies N, Abang B, Wanyenze R, et al. The costs and effectiveness of four HIV counseling and testing strategies in Uganda. AIDS 2009;23(3):395-401 doi: 10.1097/QAD.0b013e328321e40b[published Online First: Epub Date]|.
Kenya	31%	Integrated vs. non-integrated MCH/FP	Twarir A, Maggwa BN, Askew I. Integration of STI and HIV/AIDS Services with MCH-FP Services: Case Study of the Mkomani Clinic Society in Mombasa, Kenya. In: Council TP, ed.: The Population Council, 1996.
AVERAGE	**36%**		

2.2 PMTCT: Background and Country Context

Remarkable progress has been made in providing PMTCT services to pregnant women in low- and middle-income countries. Most recently, the percentage of women receiving ARVs to prevent vertical transmission increased from 48 percent in 2010 to 56 percent in 2011 (excluding single-dose nevirapine regimens); in sub-Saharan Africa, this percentage increased from 50 percent in 2010 to 58 percent in 2011. These are substantial increases from 2005, when only 14 percent of women received ARVs for PMTCT in low- and middle-income countries, while only 13 percent received them in sub-Saharan Africa; note these percentages include single-dose nevirapine (SD NVP) regimens, so the increase is actually even higher when compared to the percentages in 2010 and 2011. This progress is reflected in the reduction of the number of HIV infant infections, which decreased from approximately 540,000 in 2005 to fewer than 300,000 in 2011 [Abrams 2013].

These statistics speak to the efforts countries have made in reducing vertical HIV transmission since the UNGASS declaration of 2001. In that declaration, four prongs were identified to provide a comprehensive strategy for PMTCT [UNGASS 2001]:

- Primary prevention of HIV
- Prevention of unintended pregnancies in HIV positive women
- Reduction of vertical HIV transmission through providing services such as ARVs
- Provision of support and mitigation services to mother, infant and family

In addition, in 2011, UNAIDS released a new Global Plan setting updated goals for low- and middle-income countries, focusing on 22 high-burden countries in sub-Saharan Africa. The goals included providing ARVs to 90 percent of pregnant women to reduce vertical transmission, providing ART to 90 percent of pregnant women who are eligible to receive ART, and protecting women and their infants from transmission via breastfeeding by providing either ARVs or formula [UNAIDS 2011]. The overall goal of the Global Plan was to eliminate new infant HIV infections entirely by 2015.

Over time, the specific recommendations for which ARV regimen to use in preventing vertical transmission have changed (see Box 1).

Box 1: Evolution of ARV and ART recommendations for PMTCT

2001: *For women with ANC*: (1) Short-course ZDV beginning at approximately 36 weeks' gestation, *and/or* (2) SD NVP to the mother at onset of labor and to the infant at 2-3 days of life, *or* (3) ZDV/3TC intrapartum to the mother and one week postpartum to the infant. *For women with no ANC*: (1) immediate postpartum ZDV (6 weeks) to the infant *or* (2) immediate postpartum nevirapine (1-2 doses) to the infant. No recommendation regarding initiating ART.

2004: Start ARV prophylaxis in the third trimester (28 weeks) of pregnancy, using a regimen of twice daily ZDV, SD NVP at onset of labor. ART for pregnant women with CD4 cell counts below 200.

2006: Add to the 2004 recommendations a combination of ZDV+3TC during delivery and one week postpartum, as well as infant prophylaxis for one week after birth.

2010: Choice of either (1) Option A: Twice daily ZDV as early as 14 weeks plus SD NVP at labor onset; ZDV + 3TC during labor and delivery, and ZDV + 3TC for seven days postpartum if ZDV began less than four weeks before delivery; infant receives daily NVP from birth to one week after breastfeeding ceases, or ZDV or NVP for 6 weeks if not breastfed, or (2) Option B: Triple ARVs as early as 14 weeks until delivery and one week after breastfeeding ceases; infant receives ZDV or NVP from birth until four to six weeks of age. ART for pregnant women with CD4 cell counts equal to or less than 350.

2013: Choice of either (1) Option B+, ART for all pregnant and breastfeeding HIV positive women for life, *or* (2) Option B (above), when Option B+ is not feasible. Infant receives daily NVP from birth to six weeks if breastfed, or ZDV *or* NVP for 6 weeks if not breastfed. ART for pregnant women with CD4 cell counts equal to or less than 500.

Initially ARVs were recommended for all HIV-positive women during pregnancy and immediate postpartum and breastfeeding periods, but not beyond those periods. In 2001, the PMTCT regimen consisted of either four weeks of zidovudine (ZDV) leading up to birth, *and/or* either ZDV + lamivudine (3TC) or SD NVP at birth and immediately postpartum, with no recommendation for ART initiation. By 2004, these recommendations had evolved to recommending ZDV from 28 weeks gestation plus SD NVP at birth and immediately postpartum, along with beginning ART when CD4 cell counts were below 200. When the guidelines were revised in 2006, ZDV + 3TC for seven days postpartum were added to the recommended regimen from 2004. The next stage of WHO Guidelines, released in 2010, recommended starting all women with CD4 cell counts below 350 on ART, or those who were in WHO clinical stages 3 or 4, avoiding efavirenz in the first trimester of pregnancy and following either Option A (a combination of drugs for the mother and infant, see Box 1) or Option B (triple ARVs, see Box 1) for pregnant women with CD4 cell counts above 350. The most recent guidelines, released in 2013, call for all countries to move to Option B+, which provides ART for life (see Box 1), regardless of CD4 cell count, or Option B when Option B+ is not feasible [Abrams 2013]. Note that the new 2013 guidelines add 0.7 million women to the overall target population for PMTCT ARV programs, which in 2011 was 1.47 million [WHO 2013a].

Malawi, Mozambique and Uganda are 3 of the 22 high-burden countries in the Global Plan. Malawi was the first country to adopt Option B+, primarily because of a lack of laboratory and infrastructure capacity to perform CD4 cell count tests. The Ministry of Health (MOH) there formally adopted Option B+ in 2011, and began rolling out the program in the third quarter of 2011. A recent report evaluated the first year of the program, and found that the number of pregnant and breastfeeding women receiving ART increased dramatically from 1,257 in the second quarter of 2011 to 10,663 in the third quarter of 2012, an increase of 748 percent. In addition, the retention rate on ART was 77 percent at 12 months postpartum, similar to the 80 percent retention rate in other Malawi ART programs. Several strategies were followed to encourage uptake of ART through Option B+ during that year, including (1) integration of PMTCT services into all ANC sites, and (2) following existing policies that allowed task-shifting of ART initiation to clinical officers, medical assistants and nurses, including training 4,839 workers [Centers for Disease Control 2013].

In both Mozambique and Uganda, the Ministries of Health have formally adopted Option B+, and are currently making plans for rolling it out. Although integrating services will be part of the roll-out strategy, other factors may have an impact on its success. For example, a recent study in Mozambique found that although integrating HIV care after birth increased early infant diagnosis (EID), there were substantial health systems limitations, such as stock-outs of key commodities and high staff absenteeism, that had negative impacts on service delivery [Geelhoed et al. 2013]. Concerns about health system capacities also exist in Uganda. In eastern Uganda, with assistance from USAID, Option B+ will begin to be piloted in 12 districts. The intervention includes training an additional 1,000 health workers, as well as providing them with mentors, educational radio programs and printed materials, training health management and information systems (HMIS) personnel, and planning to avert potential stock-outs of ARVs [Sera 2013].

For this paper, we examine the cost and impact of the second and third prongs of the 2011 UNGASS comprehensive strategy on PMTCT (see above), separately, with some implicit modeling of the first prong, to the extent that Option B+ is adopted in countries. Note that although many times counseling is provided as part of the PMTCT intervention, any effect of counseling on behavior change as part of the first prong, e.g., increasing consistent condom use, is not included explicitly in the scenarios here.

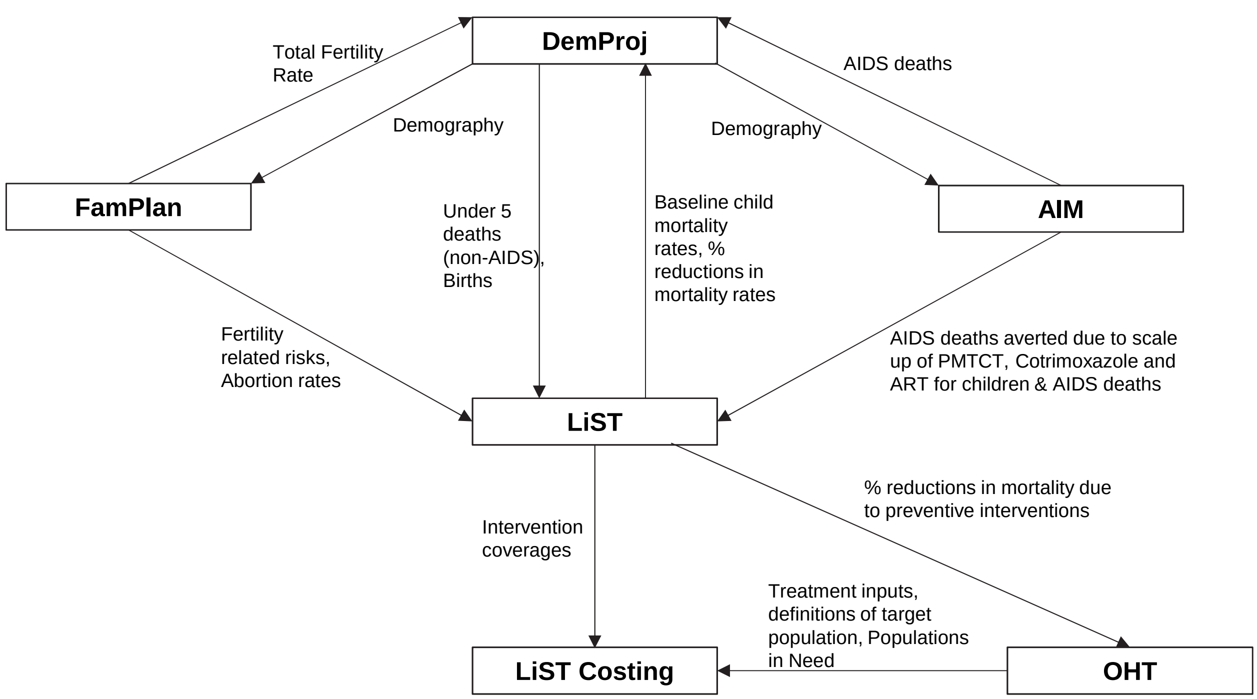
3 Data and Methods

We combine the evidence from the integration literature described above with data and methodology contained in the LiST module, part of the Spectrum family of modules, to estimate ICERs for a number of different scenarios regarding integration, described below. The Lives Saved Tool (LiST) is a computer program developed by Futures Institute, Johns Hopkins University and the Child Health Epidemiology Reference Group (CHERG) to estimate the impact of scaling up proven child and maternal health interventions on child and maternal mortality. It is used to project the future annual number and rate of child and maternal deaths up to 100 years, stratifying by cause of death as well as by health interventions. These projections are used in policy presentations to enhance knowledge of child and maternal health issues among policymakers and to build support for effective prevention and care interventions [Winfrey et al. 2011; Stover et al. 2010].

Recently the LiST module was augmented to include a mechanism for estimating the cost of providing child and maternal health interventions, as well as a mechanism for costing integrated, or "bundled," services [Adesina and Bollinger 2013]. In that paper, we adapted data from both the WHO CHOosing Interventions that are Cost-Effective (CHOICE) database and the OneHealth Tool (OHT) to develop unit costs for delivering child and maternal health services, delivered both alone and using an integrated approach. In addition, similar to the exercise here, we utilized the current LiST and other Spectrum modules to evaluate the effect of increased coverage on maternal and child health outcomes.

Here, we utilize a number of different Spectrum modules to calculate the ICERs for integrating PMTCT services with ANC sites, and integrating family planning services at HIV care delivery sites. In order to explain where the impacts on coverage rates and cost are implemented, and to understand the final results, it is important to understand the interactions of the various Spectrum modules (see Figure 1).

Figure 1. Schematic of interactions of the LiST module with other Spectrum modules



The demographic projection model, DemProj, is the basis for all of the modules in Spectrum, providing demographic data including births and mortality of children under age five from non-AIDS causes. The AIM module utilizes these demographic estimates and adds data on the HIV epidemic and various program variables, such as PMTCT coverage, to calculate HIV-related variables, including mortality to children under age five from AIDS, which it then feeds back to DemProj. The FamPlan module incorporates initial demographic data from DemProj, then re-calculates fertility-related variables (such as the CPR) based on defined scenarios, and feeds these variables back to DemProj. The LiST module then utilizes all of these data and incorporates the coverage rates of various interventions as defined by the various scenarios; these coverage rates are then transmitted to the LiST costing module, which calculates the total cost of interventions that are implemented. The LiST costing module, in turn, receives information on default data from the OneHealth Tool (OHT) in order to calculate the costs of the interventions in the various scenarios.

Each of these modules contains default data for a number of different countries; all of them contain default data for Malawi, Mozambique and Uganda. A list of the primary default data source for each module is below; further complete details can be found in the individual manuals for each module at: www.futuresinstitute.org/spectrum.aspx. Note, however, that the default data for the cost of drug(s) (i.e., ARV prophylaxis or ARV regimens) were updated separately; they were calculated as the price of the daily dosage of drug(s) multiplied by the recommended number of days on the treatment option (SD NVP, Dual ARV, Option A, Option B, and ARV treatment regimen). The ARV drug prices were updated using the Clinton HIV/AIDS Initiative ARV price list from August 2013 [CHAI 2013].

- DemProj: United Nations Population Fund
- AIM: UNAIDS, country-validated estimates of their HIV epidemic
- FamPlan: Demographic and Health Surveys (or similar)
- LiST: Literature on proven interventions as defined by the CHERG, Demographic and Health Surveys (or similar)
- LiST costing: OneHealth Tool (OHT), WHO
- OHT: WHO, UNICEF

We use 2011 as the base year for the projections, as it is the most recent year for which there are publicly available HIV epidemic projections. We increase coverage rates and decrease costs in a linear fashion to reach their new values by 2015, and continue the projections using those new values through 2020. After careful and considered examination of the results presented in Table 1 above regarding the potential impact of integration, we created four different scenarios, each of which were executed for the three countries (see Table 2).

Table 2. Scenario space by type of integration

		Change in coverage rates	
Type of integration	**Change in cost**	**Low**	**High**
Family planning services integrated into HIV care facilities	-36.0%	12.5%	39.0%
PMTCT services integrated into ANC/childbirth sites	-36.0%	33.0%	100.0% *

* Capped at 96% actual coverage where relevant.

Based on Table 1, we created lower and upper boundaries for increases in modern CPR in FamPlan of 12.5 percent and 39 percent, respectively; we felt that the 65.8 percent increase from the Ngure et al. study was probably too high, and so did not use that as the upper boundary. Note that the modern contraceptive method mix remains the same throughout the time period. We also created lower and upper boundaries for increases in coverage rates for Option B+ in PMTCT programs in the AIM module of 33 percent and 100 percent, respectively, although we capped overall coverage rates at 96 percent if that level is reached, as 100 percent coverage is unlikely to happen; all three countries reached 96 percent coverage in the High PMTCT scenario. For the base case, we use the initial PMTCT regimen mix in 2011 provided by the countries and continue with this same mix through 2020. In addition to increasing coverage rates for the two PMTCT scenarios, we move any regimens present in 2011 other than Option B over to Option B+ by 2015, maintaining Option B at 2011 levels through 2015. We also add a third PMTCT scenario where we change the regimen mix over to Option B and Option B+ by 2015, without increasing coverage rates, for comparison purposes (see Table 3, especially the line item labelled "Total on treatment").

Table 3. PMTCT coverage rates and regimen mixes, 2011 and 2015, by country

	Malawi		Mozambique		Uganda	
	2011	**2015**	**2011**	**2015**	**2011**	**2015**
Base case						
Single dose nevirapine	11.2%	11.2%	23.6%	23.7%	0.0%	0.0%
Dual ARV	33.8%	33.8%	38.0%	38.0%	0.0%	0.0%
Option A - maternal	0.0%	0.0%	12.3%	12.3%	42.9%	42.9%
Option B - triple prophylaxis from 14 weeks	0.0%	0.0%	0.0%	0.0%	4.3%	4.3%
Triple ART started before current pregnancy	6.8%	6.8%	0.0%	0.0%	4.5%	4.5%
Triple ART started during current pregnancy	18.1%	18.1%	10.4%	10.4%	0.0%	0.0%
TOTAL ON TREATMENT	69.9%	69.9%	84.3%	84.3%	51.6%	51.7%
Low scenario (increase coverage by 33%)						
Single dose nevirapine	11.2%	0.0%	23.6%	0.0%	0.0%	0.0%
Dual ARV	33.8%	0.0%	38.0%	0.0%	0.0%	0.0%
Option A - maternal	0.0%	0.0%	12.3%	12.3%	42.9%	0.0%
Option B - triple prophylaxis from 14 weeks	0.0%	0.0%	0.0%	0.0%	4.3%	4.3%
Triple ART started before current pregnancy	6.8%	6.8%	0.0%	0.0%	4.5%	4.5%
Triple ART started during current pregnancy	18.1%	86.2%	10.4%	83.8%	0.0%	59.8%
TOTAL ON TREATMENT	69.9%	93.0%	84.3%	96.0%	51.6%	68.6%
High scenario (increase coverage by 100%)						
Single dose nevirapine	11.2%	0.0%	*	*	0.0%	0.0%
Dual ARV	33.8%	0.0%	*	*	0.0%	0.0%
Option A - maternal	0.0%	0.0%	*	*	42.9%	0.0%
Option B - triple prophylaxis from 14 weeks	0.0%	0.0%	*	*	4.3%	4.3%
Triple ART started before current pregnancy	6.8%	6.8%	*	*	4.5%	4.5%
Triple ART started during current pregnancy	18.1%	89.2%	*	*	0.0%	87.2%
TOTAL ON TREATMENT	69.9%	96.0%	*	*	51.6%	96.0%

* Not calculated as the low scenario already reached the maximum coverage of 96%

Regarding changes in costs, because the four studies were fairly uniform in their effects, we implemented one scenario regarding costs, using the average change of 36 percent in costs between integrated versus non-integrated sites, and phasing in linearly over the four years between 2011 and 2015. As mentioned above, there was a fifth study that measured a decrease in cost of 65 percent from integrating services, but we felt the impact might have been overstated because the non-integrated comparator cost was from an earlier time period. It does suggest, however, that the 36 percent reduction is fairly reasonable.

Note that the outcome measure compared across all scenarios is infant HIV infections averted, so that the ICER is calculated as the incremental cost per infant HIV infection averted. We calculate two sets of ICERs for each of the coverage scenarios, first for incremental costs associated with scaling-up the intervention only (i.e., PMTCT costs or family planning costs), and second for total incremental costs, which includes consideration of the interaction and dynamic effects between modules.

4 Results

Results are presented below in Table 4, with each panel reporting results for the three countries separately: Malawi, Mozambique and Uganda.

Within each panel, results are reported for two different incremental costs, identified in the first column as either “Intervention costs only,” that is, the incremental costs consist of the extra costs of implementing the increased coverage of PMTCT or family planning, or as “Total costs,” which include the change in costs associated with the interaction between modules, for example fewer children needing ARVs due to infant HIV infections averted, and fewer births due to increased family planning use. In addition, within the two different types of incremental costs, three different types of integration are examined and listed in the second column: None (switching to Option B+ only), integrating PMTCT into ANC sites, and integrating family planning into HIV care facilities. Finally, the third set of columns lists the ICERs calculated according to either “Option B/B+ only,” that is, changing the 2011 PMTCT regimen mix to either Option B or Option B+, but with no increase in coverage of PMTCT, while the columns labeled “Low” and “High” present the ICERs resulting from the coverage rate changes in Table 2 above. Recall that there is only one scenario for changes in costs; these reductions are included in the ICERs displayed in the “Low” and “High” columns, but not in the “Option B+ only” column.

Using the standardized definitions developed by the Commission on Macroeconomics and Health and utilized by the WHO CHOICE network, we define an intervention as highly cost- effective if the ICER is less than the country’s annual gross national income (GNI) per capita, cost-effective if the ICER is between one and three times the country’s annual GNI per capita, and not cost-effective if the ICER is greater than three times the country’s annual GNI per capita [Commission on Macroeconomics and Health 2001; WHO 2013c]. Note that the most recent GNI per capita using the Atlas method for the three countries was $320 for Malawi, $510 for Mozambique, and $440 for Uganda. The most recent figures for GNI per capita adjusted for purchasing power parity (PPP) were $880 for Malawi, $1,020 for Mozambique, and $1,140 for Uganda [World Bank 2013]. In the analysis below, we use the figures for GNI per capita adjusted for PPP, as many of the default costs are based on international prices.

Overall, with one exception, the ICERs show that integrating services is a highly cost-effective intervention when using GNI per capita figures adjusted for PPP, and in many cases is actually cost-savings. The one exception is still cost-effective; when examining the total costs per infant HIV infections averted for Malawi under the “High” scenario for scaling-up PMTCT coverage; integration in this case results in an ICER of $2,482, which is slightly less than three times Malawi’s GNI per capita adjusted for PPP. Interestingly, because of the increased efficacy from moving to Option B/B+, the ICERs reported in the first column show that moving to that PMTCT regimen mix is highly cost-effective for all countries.

Table 4. Incremental cost-effective ratios (ICERs) from integration, by scenario and country

Type of cost used in the numerator of the ICER calculation	Type of integration	Change in coverage: Option B+ only	Low	High
Malawi				
Intervention costs only: PMTCT or Family planning costs per infant HIV infection averted	None	$154		
	PMTCT into ANC sites		$29	$41
	Family planning into HIV care facilities		($1,806)	$534
Total costs per infant HIV infection averted	None	($525)		
	PMTCT into ANC sites		($634)	$2,482
	Family planning into HIV care facilities		($7,862)	($5,538)
Mozambique				
Intervention costs only: PMTCT or Family planning costs per infant HIV infection averted	None	$155		
	PMTCT into ANC sites		$11	*
	Family planning into HIV care facilities		($1,129)	($136)
Total costs per infant HIV infection averted	None	($304)		
	PMTCT into ANC sites		($439)	*
	Family planning into HIV care facilities		($4,378)	($3,364)
Uganda				
Intervention costs only: PMTCT or Family planning costs per infant HIV infection averted	None	$117		
	PMTCT into ANC sites		$7	$63
	Family planning into HIV care facilities		($2,274)	($397)
Total costs per infant HIV infection averted	None	($526)		
	PMTCT into ANC sites		($609)	($536)
	Family planning into HIV care facilities		($6,586)	($4,472)

* Not calculated as the low scenario already reached the maximum coverage of 96%

In Malawi, moving to Option B/B+ only without changing coverage of either PMTCT or family planning through integrating services results in an ICER of $154 per infant HIV infection averted when PMTCT costs only are evaluated, while the change is actually cost-savings when total costs are examined, with an ICER of ($525). When PMTCT services are integrated into ANC sites, and the PMTCT coverage rate increases by 33 percent (in addition to the change in regimen mix and decreases in costs), the ICER is even lower at $29 per infant HIV infection averted when calculated using PMTCT intervention costs only, with further cost savings when total costs are used to calculate the ICER, decreasing to ($634) from ($525). When PMTCT coverage rates increase at a higher rate due to integration, the ICER increases slightly to $41 per infant HIV infection averted, but the integration is still highly cost-effective. The ICER calculated using total costs per infant HIV infection averted is also higher than the lower coverage rate scenario, at $2,482 versus the actual cost-savings that was calculated before, ($634) per infant HIV infection averted, but is still a cost-effective intervention as it is less than three times the GNI per capita in Malawi, adjusted for PPP, of $880.

Turning to examining the impact of integrating family planning into HIV care facilities in Malawi, we see that increasing coverage by 12.5 percent, along with decreasing costs by 36 percent, by 2015 results in actual cost-savings of ($1,806) per infant HIV infection averted, due to lower births and associated other costs related to family planning. The spillover effects for integrating family planning services into HIV care facilities is even greater than the spillover effects from integrating PMTCT into ANC sites; the ICER calculated using total costs shows a cost-savings in the Low scenario of ($7,862) per infant HIV infection averted. Although further increasing coverage to reach 39 percent by 2015 results in an increase in the calculated ICER, which turns positive at $534 per infant HIV infection averted, the integration intervention is still highly cost-effective. When total costs are used in the numerator to calculate the ICER for the High scenario, integrating family planning into HIV care facilities becomes cost-savings, with an ICER of ($5,538) per infant HIV infection averted.

In Mozambique, the results for integrating services are even more striking. Moving to Option B/B+ only from the 2011 PMTCT regimen mix, without any changes in coverage rates or costs, results in approximately the same ICER as Malawi when evaluated using PMTCT costs alone in the ICER calculation, $155 versus $154 in Malawi. When total costs are used to calculate the ICER, simply moving to more efficacious PMTCT regimens results in cost-savings of ($304) per infant HIV infection averted. Note that of the 84.3 percent of women receiving some PMTCT regimen in Mozambique in 2011, the vast majority (73.9 percent of women) were receiving either SD NVP, dual ARVs, or Option A – that is, less efficacious regimens. When coverage of PMTCT increases as part of the Low integration scenario, and costs decrease by 36 percent, both by 2015, the incremental cost of the PMTCT program per infant HIV infection averted is only $11, a highly cost-effective intervention. Note that coverage can only increase by 14 percent from the base of 84.3 percent coverage, rather than 33 percent, at which point the maximum coverage rate of 96 percent is reached. When total costs are used to calculate the ICER, the intervention becomes cost-savings, with an ICER of ($439) per infant HIV infection averted.. Note that the High coverage scenario for PMTCT integrated into ANC sites is not calculated, as the ceiling coverage was already reached in the Low PMTCT coverage scenario. Regarding the integration of family planning services into HIV care facilities, the ICERs displayed in Table 4 for Mozambique show that there are cost-savings for all of the scenarios, ranging in magnitude from a minimum savings of ($136) per infant HIV infection averted for the High coverage scenario when evaluated using family planning incremental costs alone, to a maximum savings of ($4,378) per infant HIV infection averted when the impact of the Low scenario is calculated using total costs in the numerator.

In Uganda, moving from the 2011 PMTCT regimen mix to the WHO-recommended mix of Option B/B+ incurs incremental costs of only $117 per infant HIV infection averted when evaluating the ICER using PMTCT intervention costs only, and becomes cost-savings when total costs are used to calculate the ICER, with a savings of ($526) per infant HIV infection averted. When the PMTCT program is integrated into ANC sites, resulting in an increase in coverage of 33 percent and a decrease in costs of 36 percent, the incremental cost of the PMTCT program alone per infant HIV infection averted is only $7, a highly cost-effective intervention. Incorporating the interactive and dynamic effects across modules results in cost-savings of ($609) per infant HIV infection averted with the Low PMTCT coverage scenario. When the effects of the High PMTCT coverage scenario are evaluated, the ICER for the PMTCT program costs alone increases slightly to $63 per infant HIV infection averted, but this is still highly cost-effective. As with the Low PMTCT coverage scenario, the ICER calculated using total costs for the High PMTCT coverage scenario is also cost-savings, saving ($536) per infant HIV infection averted. When the impact of integrating family planning services into HIV care facilities is examined for Uganda, results similar to those in Mozambique can be seen. All of the scenarios have negative ICERs, that is, are cost-savings, and range in magnitude from a minimum savings of ($397) per infant HIV infection averted in the High coverage scenario using family planning incremental costs only, to a maximum savings of ($6,586) per infant HIV infection averted in the Low coverage scenario using total costs to calculate the ICER.

5 Conclusions

Integrating health services in various ways is hypothesized to result in more efficient use of resources, higher coverage rates, and more equitable participation for clients. Using empirical evidence from the literature on the impact of integration on increasing coverage rates and decreasing costs, we estimate incremental cost-effectiveness ratios for the impact of integrating PMTCT services into ANC sites, and integrating family planning services into HIV care sites using the LiST model for Malawi, Mozambique and Uganda. We find that significant cost savings and better outcomes are possible for both types of integration; all of the scenarios examined except one are highly cost-effective, according to the WHO definition of cost-effectiveness, and the one exception is still cost-effective. Many of the scenarios examined are, in fact, cost-savings; this is particularly true when all of the interactive and dynamic effects between modules are included when calculating the various ICERs. Interestingly, although there is a strong drive to integrate PMTCT into ANC services in sub-Saharan Africa, and rightly so, this paper finds that integrating family planning into HIV care facilities results in even greater benefits; this result hopefully will persuade policymakers of the importance of this type of integration, as well.

There are a couple of caveats that should be mentioned. First, the impacts projected above resulting from increased coverage rates can only occur if the health system resources can provide the services, including personnel and infrastructure. As discussed above, part of the success in the Malawi experience with ramping up the provision of PMTCT was due to both task-shifting and training the new health workers to provide ART. Also discussed above, a lack of attention to health systems strengthening caused problems in the integration efforts in Mozambique. Second, the reduction in costs may be overstated, although based on the evidence that was identified, the 36 percent reduction seems reasonable. One question would be whether the studies utilized reflected the services that were analyzed here; if services are highly labor-intensive, fewer benefits can accrue from integration due to economies of scale. Here, the four studies seem to match the integration efforts; two observations were from HCT sites, one was from sexual and reproductive health sites, and the last was from integrated MCH/ANC sites. In addition to the seeming relevancy, the percentage of costs devoted to variable cost factors for those studies is fairly consistent, lending further credibility to the use of the studies.

It does seem that integration is at least one of the key policy instruments to use to increase coverage of PMTCT services. As discussed above, Malawi integrated PMTCT into all of its ANC sites, which helped the program increase coverage by over 700 percent in one year. On the other hand, having the most efficacious PMTCT regimen is also important; a recent study from KwaZulu Natal, South Africa found an almost tenfold reduction in vertical transmission between 2004 and 2012, from 27.5 percent to 2.9 percent at eight weeks postpartum, due to changing PMTCT regimens, starting with SD NVP and ending with ZDV beginning at 14 weeks gestation with SD NVP at birth, along with ART for women with CD4 cell counts below 350 [Moodley et al. 2013].

Finally, it should be noted that it is very important that further data be gathered regarding integration, particularly with respect to the effect of integration on costs. These data are difficult to gather; an example of the difficulties comes from a recent five-year project, the Integra Initiative, which was designed explicitly to gather data on costs and outcomes of integrating in a number of different ways. Although there were some interesting final results released recently, such as the finding that additional equipment and supplies were important when integrating services, as well as training more providers, overall the results did not measure well the impact of integration on costs and outcomes, primarily because of measurement issues [Integra 2013]. Efforts should continue to be made to gather these data, even though it is a difficult task.

References

Abrams, E. 2013. Key Recommendations for ART in Pregnant and Breastfeeding Women: IATT Webinar on the 2013 WHO Consolidated ARV Guidelines. July 30.

Adesina, A, and L.B. Bollinger. 2013. “Estimating the Cost-Savings Associated with Bundling Maternal and Child Health Interventions: A Proposed Methodology.” *BMC Public Health* 13(Suppl 3): S27.

Ayuo, P., B. Musick, H. Liu, P. Braitstein, W. Nyandiko, B. Otieno-Nyunya, A. Gardner, and K. Wools-Kaloustian. 2013. “Frequency and Factors Associated with Adherence to and Completion of Combination Antiretroviral Therapy for Preventing Mother-to-Child Transmission in Western Kenya.” *J Int AIDS Soc.* 16(1): 17994.

Bradley, H., D. Gillespie, A. Kidanu, Y.T. Bonnenfant, and S. Karklins. 2009. “Providing Family Planning in Ethiopian Voluntary HIV Counseling and Testing Facilities: Client, Counselor and Facility-Level Considerations.” *AIDS* 23(Suppl 1): S105-14.

Bratt, J.H., K. Torpey, M. Kabaso, and Y. Gondwe. 2011. “Costs of HIV/AIDS Outpatient Services Delivered through Zambian Public Health Facilities.” *Tropical Medicine and International Health* 16(1): 110-118.

Centers for Disease Control and Prevention (CDC). 2013. “Impact of an Innovative Approach to Prevent Mother-to-Child Transmission of HIV– Malawi, July 2011– September 2012.” *MMWR Morb Mortal Wkly Rep* 62(8): 148-51.

Chabikuli, N.O., D.D. Awi, O. Chukwujekwu, Z. Abubakar, U. Gwarzo, M. Ibrahim, M. Merrigan, and C. Hamelmann. 2009. “The Use of Routine Monitoring and Evaluation Systems to Assess a Referral Model of Family Planning and HIV Service Integration in Nigeria.” *AIDS* 23(Suppl 1): S97-S103.

Chi, B.H., C. Bolton-Moore, and C.B. Holmes. 2013. “Prevention of Mother-to-Child HIV Transmission Within the Continuum of Maternal, Newborn, and Child Health Services.” *Curr Opin HIV AIDS* 8(5): 497-502.

Commission on Macroeconomics and Health. 2001. Report of the Commission on Macroeconomics and Health. Presented to World Health Organization. Available online at: http://whqlibdoc.who.int /publications/2001/924154550x.pdf

Das, R., K. Biswas, P. Panda, et al. 2007. Strengthening Financial Sustainability through Integration of Voluntary Counseling and Testing Services with Other Reproductive Health Services.

Delvaux, T., J.P. Konan, O. Aké-Tano, V. Gohou-Kouassi, P.E. Bosso, A. Buvé, and C. Ronsmans. 2008. “Quality of Antenatal and Delivery Care Before and After rhe Implementation of a Prevention of Mother-to-Child HIV Transmission Programme in Côte d'Ivoire.” *Trop Med Int Health* 13(8) :970-9.

Deo, S., S.M. Topp, A. Garcia, M. Soldner, S.K. Yagci, J. Chipukuma, C.S. Wamulume, S.E. Reid, and J. Swann. 2012. “Modeling the Impact of Integrating HIV and Outpatient Health Services on Patient Waiting Times in an Urban Health Clinic in Zambia.” *PLoS One* 7(4): e35479.

Dudley, L., P. Garner. 2011. "Strategies for Integrating Primary Health Services in Low- and Middle-Income Countries at the Point of Delivery.” *Cochrane Database Syst Rev.* 6(7): CD003318.

Duffy, M. 2013. Practical Information and Guidance for Integration of MNCH and HIV Programs within a Continuum of Health and Social Services. Arlington, Virginia, USA: USAID's AIDS Support and Technical Assistance Resources, AIDSTAR-One, Task Order 1.

Geelhoed, D., Y. Lafort, É. Chissale, B. Candrinho, and O. Degomme. 2013. "Integrated Maternal and Child Health Services in Mozambique: Structural Health System Limitations Overshadow Its Effect on Follow-Up of HIV-Exposed Infants." *BMC Health Serv Res*. 13: 207.

Hoffman, I.F., F.E. Martinson, K.A. Powers, D.A. Chilongozi, E.D. Msiska, E.I. Kachipapa, C.D. Mphande, M.C. Hosseinipour, H.C. Chanza, R. Stephenson, and A.O. Tsui. 2008. "The Year-Long Effect of HIV-Positive Test Results on Pregnancy Intentions, Contraceptive Use, and Pregnancy Incidence among Malawian Women." *J Acquir Immune Defic Syndr*. 47(4): 477-83.

Homan, R., S. Mullick, and T. Maluk. 2006. Cost of Introducing Two Different Models of Integrating VCT for HIV within Family Planning Clinics in South Africa. Presented in conference on Linking Reproductive Health, Family Planning and HIV/AIDS in Africa, Addis Ababa, Ethiopia.

Integra, Initiative. 2013. *Press Release August 19*. Available online at: http://www.integrainitiative.org /projects/integra/index.php?sub=2

Kasenga, F., P. Byass, M. Emmelin, and A.K. Hurtig. 2009. "The Implications of Policy Changes on the Uptake of a PMTCT Programme in Rural Malawi: First Three Years of Experience." *Global Health Action* 2.

Killam, W.P., B.C. Tambatamba, N. Chintu, D. Rouse, E. Stringer, M. Bweupe, Y. Yu, and J.S. Stringer. 2010. "Antiretroviral Therapy in Antenatal Care to Increase Treatment Initiation in HIV-Infected Pregnant Women: A Stepped-Wedge Evaluation." *AIDS* 24(1): 85-91.

King, R., J. Estey, S. Allen, S. Kegeles, W. Wolf, C. Valentine, and A. Serufilira. 1995. "A Family Planning Intervention to Reduce Vertical Transmission of HIV in Rwanda." *AIDS* 9(Suppl 1): S45-51.

Kosgei, R.J., K.M. Lubano, C. Shen, K.K. Wools-Kaloustian, B.S. Musick, A.M. Siika, H. Mabeya, E.J. Carter, A. Mwangi, and J. Kiarie. 2011. "Impact of Integrated Family Planning and HIV Care Services on Contraceptive Use and Pregnancy Outcomes: A Retrospective Cohort Study." *J Acquir Immune Defic Syndr* 58(5): e121-6.

Liambila, W., C. Warren, S. Mullick, et al. 2008. *Feasibility, Acceptability, Effect and Cost of Integrating Counseling and Testing for HIV within Family Planning Services in Kenya.* FRONTIERS final report.

Lindegren, M.L., C.E. Kennedy, D. Bain-Brickley, H. Azman, A.A. Creanga, L.M. Butler, A.B. Spaulding, T. Horvath, and G.E. Kennedy. 2012. "Integration Of HIV/AIDS Services with Maternal, Neonatal and Child Health, Nutrition, and Family Planning Services." *Cochrane Database Syst Rev*. 9: CD010119.

McCarraher, D.R., G. Vance, U. Gwarzo, D. Taylor, and O.N. Chabikuli. 2011. "Changes in Contraceptive Use Following Integration of Family Planning into ART Services in Cross River State, Nigeria." *Stud Fam Plann* 42(4): 283-90.

Megazzini, K.M., M. Sinkala, S.H. Vermund, D.T. Redden, D.W. Krebs, E.P. Acosta, J. Mwanza, R.L. Goldenberg, N. Chintu, M. Bulterys, and J.S. Stringer. 2010. "A Cluster-Randomized Trial of Enhanced Labor Ward-Based PMTCT Services to Increase Nevirapine Coverage in Lusaka, Zambia." *AIDS* 24(3): 447-55.

Menzies, N., B. Abang, R. Wanyenze, et al. 2009. "The Costs and Effectiveness of Four HIV Counseling and Testing Strategies in Uganda." *AIDS* 23(3): 395-401.

Moodley, P., R. Parboosing, and D. Moodley. 2013. "Reduction in Perinatal HIV Infections in KwaZulu-Natal, South Africa, in the Era of More Effective Prevention of Mother to Child Transmission Interventions (2004-2012)." *J Acquir Immune Defic Syndr* 63(3): 410-5.

Mullick, S., M. Menziwa, and N. Mosery. 2008. *Feasibility, Acceptability, Effectiveness and Cost of Models of Integrating HIV Prevention and Counseling and Testing for HIV within Family Planning Services in North West Province, South Africa.* FRONTIERS Final Report.

Mutemwa, R., S. Mayhew, M. Colombini, J. Busza, J. Kivunaga, and C. Ndwiga. 2013. "Experiences of Health Care Providers with Integrated HIV and Reproductive Health Services in Kenya: A Qualitative Study." *BMC Health Serv Res* 13:18.

Ngure, K., R. Heffron, N. Mugo, E. Irungu, C. Celum, and J.M. Baeten. 2009. "Successful Increase in Contraceptive Uptake among Kenyan HIV-1-Serodiscordant Couples Enrolled in an HIV-1 Prevention Trial." *AIDS* 23(Suppl 1): S89-95.

Odeny, T.A., J. Penner, J. Lewis-Kulzer, H.H. Leslie, S.B. Shade, W. Adero, J. Kioko, C.R. Cohen, and E.A. Bukusi . 2013. "Integration of HIV Care with Primary Health Care Services: Effect on Patient Satisfaction and Stigma in Rural Kenya." *AIDS Res Treat* 2013: 485715

Pfeiffer, J., P. Montoya, A.J. Baptista, et al. 2010. "Integration of HIV/AIDS Services into African Primary Health Care: Lessons Learned for Health System Strengthening in Mozambique – A Case Study." *Journal of the International AIDS Society* 13(3).

Potter, D., R.L. Goldenberg, A. Chao, M. Sinkala, A. Degroot, J.S. Stringer, M. Bulterys, and S.H. Vermund. 2008. "Do Targeted HIV Programs Improve Overall Care for Pregnant Women?" *J Acquir Immune Defic Syndr* 47(1): 79-85.

Siapka, M., M. Remme, C.D. Obure, C.B. Maier, K. Dehne, and A. Vassall. 2013. Efficiency in Core HIV Services: A Systematic Review of Costs, Economies of Scale and Scope in Low and Middle Income Countries. Forthcoming in *AIDS*.

Sera, D. 2013. Management Sciences for Health Supports the Roll Out of Option B+ in Uganda. Available online at: http://www.emtct-iatt.org/2013/07/management-sciences-for-health-msh-supporting-the -roll-out-of-option-b-in-uganda

Simba, D., J. Kamwela, R. Mpembeni, and G. Msamanga. 2010. "The Impact of Scaling-Up Prevention of Mother-to-Child Transmission (PMTCT) of HIV Infection on the Human Resource Requirement: The Need to Go Beyond Numbers." *Int J Health Plann Manage* 25(1): 17-29.

Stinson, K., K. Jennings, and L. Myer. 2013. "Integration of Antiretroviral Therapy Services into Antenatal Care Increases Treatment Initiation during Pregnancy: A Cohort Study." *PLoS One* 8(5): e63328.

Stover, J., R. McKinnon, and B. Winfrey. 2010. "Spectrum: A Model Platform for Linking Maternal and Child Survival Interventions with AIDS, Family Planning and Demographic Projections." *Int J Epidemiol* 39(Suppl 1): i7-10.

Suthar, A.B., D. Hoos, A. Beqiri, K. Lorenz-Dehne, C. McClure, and C. Duncombee. 2013. "Integrating Antiretroviral Therapy into Antenatal Care and Maternal and Child Health Settings: A Systematic Review and Meta-Analysis." *Bull World Health Organ* 91: 46–56.

Thielman, N.M., H.Y. Chu, J. Ostermann, D.K. Itemba, A. Mgonja, S. Mtweve, J.A. Bartlett, J.F. Shao, and J.A. Crump. 2006. "Cost-Effectiveness of Free HIV Voluntary Counseling and Testing through a Community-Based AIDS service organization in Northern Tanzania." *Am J Public Health* 96(1): 114-9.

Twarir, A., B.N. Maggwa, and I. Askew. 1996. "Integration of STI and HIV/AIDS Services with MCH-FP Services: Case Study of the Mkomani Clinic Society in Mombasa, Kenya." In *Council TP*, edited by the Population Council. New York, New York, USA: the Population Council.

UNGASS. 2001. *2001 Declaration of Commitment on HIV/AIDS.* Available online at: http://www.unaids.org/en/aboutunaids/unitednationsdeclarationsandgoals/2001declarationofcommitmentonhivaids/

UNAIDS. 2011. *Countdown to Zero: Global Plan towards the Elimination of New HIV Infections among Children by 2015 and Keeping Their Mothers Alive.* Geneva, Switzerland: UNAIDS. Available online at: http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2011/20110609_JC2137_Global-Plan-Elimination-HIV-Children_en.pdf

U.S. Government. 2012. GHI Principle Paper on Integration in the Health Sector. Available online at: http://www.ghi.gov/principles/docs/principlePaperIntegration.pdf

van der Merwe, K., M.F. Chersich, K. Technau, Y. Umurungi, F. Conradie, and A. Coovadia. 2006. "Integration of Antiretroviral Treatment within Antenatal Care in Gauteng Province, South Africa." *J Acquir Immune Defic Syndr* 43(5): 577-81.

van't Hoog, A.H., D.A. Mbori-Ngacha, L.H. Marum, J.A. Otieno, A.O. Misore, L.W. Nganga, and K.M. Decock. 2005. "Preventing Mother-to-Child Transmission of HIV in Western Kenya: Operational Issues." *J Acquir Immune Defic Syndr* 40(3): 344-9.

Warren, C.E., S.H. Mayhew, A. Vassall, J.K. Kimani, K. Church, C.D. Obure, N.F. du-Preez, T. Abuya, R. Mutemwa, M. Colombini, I. Birdthistle, I. Askew, and C. Watts. 2012. "Study Protocol for the Integra Initiative to Assess the Benefits and Costs of Integrating Sexual and Reproductive Health and HIV Services in Kenya and Swaziland." *BMC Public Health* 12:973.

Winfrey, W., R. McKinnon, and J. Stover. 2011. "Methods Used in the Lives Saved Tool (LiST)." *BMC Public Health* 11(Suppl 3) :S32.

World Bank. 2013. *World Development Indicators Database.* Available online at: http://data.worldbank .org/indicator, accessed 15 September 2013

World Health Organization. 2013a. *Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection.* Available online at: http://www.who.int/hiv/pub/ guidelines/arv2013/download/en/

World Health Organization. 2013b. *Global Update on HIV Treatment 2013: Results, Impact and Opportunities.* Available online at: http://www.who.int/hiv/pub/progressreports/update2013/en/index.html

World Health Organization. 2013c. *World Health Report 2013.* Available online at: http://www.who.int/whr/en/

World Health Organization. 2013d. *WHO-CHOICE.* Available online at: http://www.who.int/choice/en/