Optimizing Zimbabwe's National PMTCT Program: Cost-effectiveness of a planned village health worker (VHW)-based intervention to improve linkage to postnatal care

Karen Webb[1], Rachel MacLean[2], Barbara Engelsmann[1], Kenneth Freedberg[2], Angela Mushavi[3], Emily Hyle[2], Andrea Ciaranello[2]

[1]Organization for Public Health Interventions and Development Trust, Harare, Zimbabwe; [2]Medical Practice Evaluation Center, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA.; [3]Ministry of Health and Child Care, National PMTCT Program, Zimbabwe

We gratefully acknowledge support from the President's Emergency Plan for AIDS Relief (PEPFAR) through USAID and Families and Communities for Elimination of Pediatric HIV in Zimbabwe (AID-613-A-12-00003, *FACE Pediatric HIV),* and the US Eunice Kennedy Shriver National Institute of Child Health and Human Development (R01 HD079214) and National Institute of Allergy and Infectious Disease (R01 AI058736) and training support from the HIV Research Trust.

BACKGROUND

- In September 2013, the Zimbabwe Ministry of Health and Child Care (MOHCC) transitioned to Option B+ (lifelong ART).
- Low retention of mother-infant pairs in postnatal care (PNC) reduces the effectiveness of PMTCT programs offering Option B+.
- Village Health Workers (VHWs) are the established community-based cadre supporting MOHCC to strengthen linkages between community and healthcare facilities in Zimbabwe.
- The National PMTCT Program seeks to enhance the VHW program to identify mother-baby pairs defaulting after delivery, trace them, and support their return to care.

OBJECTIVE

- To project the clinical and economic impact of a planned VHW-based intervention to re-engage mother-infant pairs who fail to link to PNC after delivery in Zimbabwe.

METHODS

The Cost-Effectiveness of Preventing AIDS Complications (CEPAC) Model:

- The CEPAC-International model (Monte Carlo simulation of HIV disease) was linked to a validated decision analytic model of MTCT (TreeAgePro).

Population: Pregnant Zimbabwean women and their infants
- Pregnant women identified as HIV-infected during antenatal care and treated with ART
- Mean maternal age: 24 years
- Mean maternal CD4: 451/µL
- Mean gestational age at ANC booking: 26 weeks
- Breastfeeding duration: 18 months

PMTCT strategies:

1. *No antenatal ARVs*: as comparator; with access to Option B+ in postnatal period if in PNC.
2. *Current national program*: Option B+.
3. *Current program plus a planned VHW-based intervention*: to identify and re-engage in care mother-infant pairs who fail to link to PNC by 6 weeks postpartum.

Data inputs: We derived clinical and economic inputs from trials and cohort studies (Table 1).

Table 1. Selected Model Input Parameters

Mother-to-child transmission risks					**Source**
	Intrauterine/intrapartum period (one time risk)		*Postpartum period (monthly risk)*		Published PMTCT trials and cohort studies
	CD4 >350/µL	CD4 ≤350/µL	CD4 >350/µL	CD4 ≤350/µL	
No ART	0.175	0.27	0.24-0.40%	0.76-1.28%	
3-drug ART	0.01	0.033	0.19%	0.33%	
Clinical inputs					
OI risk, children (per month, range)				0.5-11.6%	IeDEA
OI risk, adults (per month, range)				0.025-2.4%	Cape Town AIDS Cohort
ART efficacy (% with RNA <400c/ml at 24 weeks)					
Children (1st-line, 2nd-line ART)				75%, 91%	P1060; PENPACT-1
Adults (1st- and 2nd-line ART)				75%	Gallant, Johnson
Loss to follow-up from HIV care (per year)				2.5%	Sutcliffe
Cost inputs				**Value (2013 USD)**	
Medication costs, per month					
Pediatric ART					
1st-line				6.11-13.66	Clinton Foundation
2nd-line				27.50-41.56	
Adult ART					
1st-line				10.90	
2nd-line				32.60	
Clinical care costs					
Direct treatment, children (per month, range by age)				32.27-45.04	Zimbabwe AIDS Spending
Direct treatment, adults (per month, range by CD4)				31.37-43.78	Report
CD4 assay				5.68	Clinton Foundation

VHW program impact:

Effectiveness: After delivery, 6-week PNC linkage was modelled as:
- *Current program (Option B+)*: 43% (Zimbabwe Demographic Health Survey 2010-11)
- *Current + planned VHW Intervention*: 71.5%
  - 57% of cohort assumed to be traced (100-43%)
  - 50% of these (28.5% of total) assumed to be linked to PNC

Costs: $35 (range, $10-400) per mother-infant pair traced, regardless of linkage to PNC, assumed based on preliminary VHW cost data.

Model outcomes:

Clinical outcomes: Infant HIV infection risk at weaning, maternal life expectancy (LE) from delivery, and pediatric LE from birth.

Economic Outcomes: PMTCT program costs, maternal HIV-related healthcare costs, and pediatric healthcare costs (2013 USD).
- Incremental cost-effectiveness ratios (ICERs) using combined antenatal, maternal and pediatric care costs, discounted at 3%/year.
- We defined "very cost-effective" as ICER <US $950/YLS (Zimbabwe 2013 per-capita GDP).

RESULTS

Table 2: Results of model-based analysis: impact of planned VHW intervention in Zimbabwe

Strategy	Pediatric outcomes after birth (all HIV-exposed)			Maternal outcomes after delivery (HIV-infected women)		
	MTCT risk (18m, %)	Lifetime cost/ person (USD)	Life expectancy (years)	Antenatal care + VHW cost/ person (USD)	Lifetime cost/ person (USD)	Life expectancy (years)
I. Base-case model results: impact of planned VHW intervention in Zimbabwe						
No antenatal ARVs	26.0	3,110	48.79	245	8,230	15.38
Current program	8.8	1,270	57.36	280	8,230	15.38
VHW intervention	7.2	1,100	58.11	300	10,000	17.24
II. Selected Sensitivity analyses (Comparison of current program to current + VHW program[c])						
Lower efficacy: 20% return to care	8.1	1,360	57.66	300	8,940	16.13
Higher cost: $100/ mother-infant pair traced	7.2	1,100	58.11	340	10,000	17.24
Increased late-LTFU (10%/year)	7.2	500	57.69	300	5,410	12.56

Impact of current national program Option B+ (Table 2, Section I):

- Compared to no antenatal ARVs, the current national program was projected to:
  - Reduce MTCT and increase pediatric LE among all exposed infants.
  - Reduce total costs, due to averted healthcare costs for HIV-infected infants.

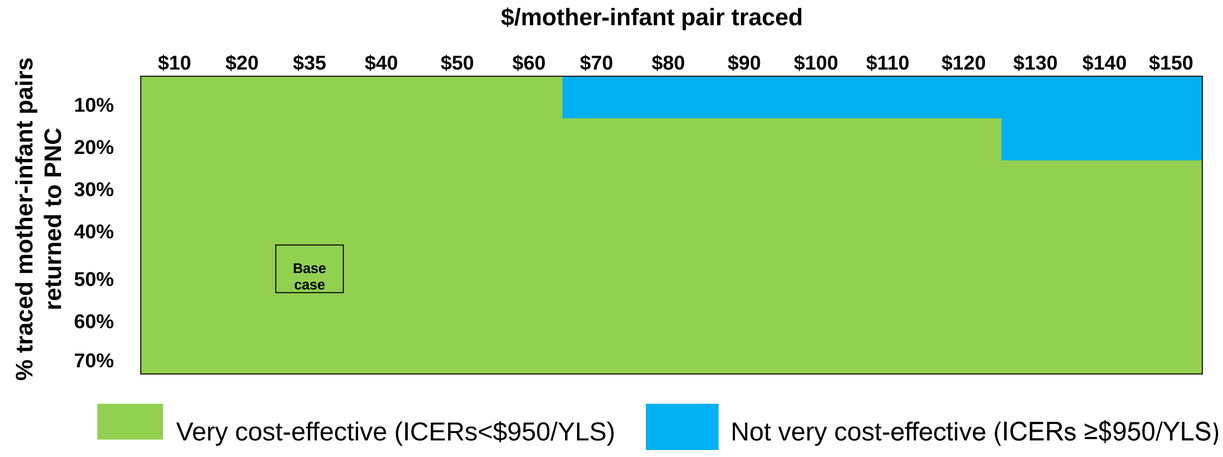
Impact of possible VHW-based intervention (Table 2, Section I):

- Compared to the current national program, the VHW program was projected to:
  - Further reduce MTCT and increase pediatric LE among all exposed infants.
  - Increase maternal LE after delivery by 1.86 years.
  - Further reduce pediatric care costs (due to averted HIV infections), but increase maternal care costs (due to greater participation in care), leading to higher total costs.
  - Lead to an **ICER of $840/YLS**, considered "very cost-effective" by WHO standards for Zimbabwe.

Sensitivity analyses (Table 2, Section II):

- The VWH program remained "very cost-effective" (ICERs <$950/YLS) **when program efficacy decreased** from 50% to 20% return to care, or **program cost increased** from $35 to $100 per mother-infant pair traced.
- The VHW program was not effective or "very cost-effective" when **loss to follow-up after linkage to PNC** increased to 10% per year for mother-infant pairs. Although program cost was lower because fewer people remained in care, pediatric and maternal LE both decreased substantially.

Figure 1. Two-way sensitivity analysis: VHW program effectiveness and cost



- The VHW program remained "very cost-effective" under a wide range of cost and efficacy values (Figure 1).

CONCLUSIONS

- Our pre-program analysis demonstrates that a one-time intervention that improves retention in care and use of ART among HIV-infected mothers is very cost effective.
- VHW-based interventions to improve linkage to postnatal care in Zimbabwe will increase maternal and pediatric life expectancy, and will provide good value for investment by the national PMTCT program.
- Long-term retention of mother-infant pairs in care is critical to realize the benefits of early linkage and to optimize outcomes of Option B+.