Original Article

Gaps in the Care Cascade among Human Immunodeficiency Virus-Exposed Infants Born in 2017 in Mashonaland East Province of Zimbabwe

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Abstract

Introduction: Prevention of mother-to-child transmission (PMTCT) is a key strategy for ending the human immunodeficiency virus (HIV) pandemic. Most studies have focused on the mothers' side of the PMTCT cascade or the rate of vertical HIV transmission. Information on child-focused cascade is limited. We aimed to evaluate HIV testing, antiretroviral therapy (ART), and cotrimoxazole prophylaxis uptake and associated factors among HIV-exposed infants (HEIs) born in 2017. **Methods:** This was a record-based descriptive study in Mashonaland East Province, Zimbabwe. We analyzed routinely collected program data abstracted from electronic and paper-based HEI registers. Uptakes were calculated as proportions while associations were measured using adjusted risk ratios (log-binomial regression). **Results:** Of 1028 HEIs, 1015 (98.7%) were commenced on nevirapine prophylaxis, while 915 (89.0%) were commenced on cotrimoxazole prophylaxis. A total of 880 (85.0%) HEIs were tested for HIV by 6 weeks and 445 (44.4%) by 9 months. Overall, 40 (3.9%) were found to be HIV positive, and of them, 34 (85.0%) commenced on ART. Secondary and tertiary health facilities, being born through nonvaginal delivery, and certain districts were significantly associated with not commencing cotrimoxazole prophylaxis or getting tested for HIV. One district was associated with less risk of not having an HIV test by 9 months. **Conclusions:** While nevirapine, cotrimoxazole, and ART uptake were high among the HEIs, HIV testing by 9 months was suboptimal. The vertical HIV transmission rate was 3.9%. There is a need to strengthen HIV testing and antiretroviral and cotrimoxazole prophylaxes, especially at high-level facilities and certain districts.

Keywords: Cotrimoxazole prophylaxis, early infant diagnosis, human immunodeficiency virus-exposed infants, operational research, record-based study, structured operational research and training initiative, vertical human immunodeficiency virus transmission cascade

Introduction

In 2018, an estimated 1.7 million children were living with human immunodeficiency virus (HIV) globally, of whom 180,000 were newly infected.[1] At least 90% of children with HIV acquire the infection through vertical transmission. Prevention of mother-to-child transmission (PMTCT) of HIV intends to reduce the incidence of HIV infection among exposed infants and improve the overall health of these children. For instance, between 2010 and 2017, PMTCT contributed to a 35% reduction in new pediatric HIV infections.[2] Consequently, PMTCT is one of the strategies being used to close the tap of new HIV infections in both adults and children.[3] PMTCT includes HIV testing and antiretroviral therapy (ART) for HIV-infected mothers, prophylaxis for all HIV-exposed infants (HEIs), HIV testing using deoxyribonucleic acid polymerase chain reaction (DNA-PCR), and initiation of ART for all HIV-positive infants.

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With the world envisaging to end the HIV/AIDS epidemic by 2030,[3] only a few countries have thus far been certified to have eliminated mother-to-child transmission (MTCT) of HIV.[4] Zimbabwe has increased its efforts to eliminate MTCT, and the MTCT rate has declined from 25.7% in 2002 to 6.7% in 2019.[5] However, the transmission rate remains high and further optimization of the PMTCT program is required to achieve the elimination of MTCT. Assessment of the PMTCT cascade thus facilitates the evaluation of progress, identification of programmatic gaps, directing quality improvement in PMTCT services as well as fostering accountability to donors and consumers of public health.[6] For instance, attrition from the PMTCT cascade has been attributed to account for 33.8% of MTCT.[7]

Most studies have focused on the mothers' side of the PMTCT cascade or the rate of vertical HIV transmission.[8,9] Information on child-focused cascade is limited. A recent study in Zimbabwe reported that only 16% of the HIV-exposed babies born in 2017 received a DNA-PCR HIV test at 6 weeks of age, though 93% of them received ART prophylaxis.[10] However, this study was done in selected clinics of the capital city, Harare, and may not be representative of the situation elsewhere in the country. Furthermore, it did not examine the predictors for gaps in the cascade of care for HIV-exposed babies.

We thus aimed to evaluate the cascade of HIV care among the HEIs born in Mashonaland East Province of Zimbabwe between January and December 2017. The specific objectives were to determine (i) the proportion initiated on nevirapine and cotrimoxazole prophylaxes and their timing; (ii) the proportion tested for HIV within 6 weeks and 9 months, found HIV positive, and started on ART; and (iii) the demographic and clinical factors associated with not being tested for HIV within 6 weeks and 9 months and not starting cotrimoxazole prophylaxis.

Materials and Methods

Study design

This was a record-based descriptive study involving analysis of routinely collected secondary data. Data were abstracted from electronic and paper-based HEI registers. HEIs were followed up from birth until the time when the first HIV antibody results were entered on the registers. Censoring was done when the infant was recorded as lost to follow-up, transferred out, or dead.

Setting

General setting

Zimbabwe is a landlocked, low-income country in Southern Africa. The country is divided into two urban provinces and eight rural provinces. Our study site Mashonaland East Province is a rural province and home to ~10% of the 17.3 million national population.[11]

Zimbabwean prevention of mother-to-child transmission program

PMTCT is offered at more than 1 560 sites which include private and public primary, secondary, and tertiary health facilities. The child-focused PMTCT cascade includes giving antiretroviral prophylaxis (nevirapine and/or zidovudine) for 6–12 weeks, HIV testing using DNA-PCR within 6 weeks of birth, cotrimoxazole prophylaxis from 6 weeks of age, and subsequent antibody HIV testing at 9 months or 6 months after stopping breastfeeding when the final HIV status is determined. If any of the antibody tests is positive, they are confirmed using DNA-PCR.

Children who are found to be HIV positive are enrolled in pediatric care preferably using abacavir (ABC) + lamivudine (3TC) + lopinavir/ritonavir for children below 3 years of age.[12]

Patient population

All HEIs born between January and December 2017 in Mashonaland East Province, Zimbabwe, were included in the study. Duplicate records, particularly arising from transfers to other sites, were omitted.

Data variables, sources of data, and data collection

We abstracted data from paper-based and electronic HEI registers at PMTCT sites by the health information officers in Mashonaland East Province between 1 October and 8 November 2019. HEI registers are completed by nurses after attending to the children. The information is then verified and abstracted onto the electronic patient monitoring system, at 14 centers, by data entry clerks or health information officers. The other centers in the province use paper-based HEI records.

We used an *a priori* data collection form with items on mother's serial number and date when mother started taking ART and the following items about the HEI: infant ID, date of birth, sex, place of birth, mode of delivery, birth weight, date of initiation on cotrimoxazole and nevirapine prophylaxes, date and type of first HIV test, date and type of subsequent HIV tests, date of ART initiation, ART regimen, follow-up outcome, and immunization code. The abstraction was done by data entry clerks, supervised by a contracted Senior Health Information Officer who also assisted verifying data using the mother and infant's serial numbers. Verification was done by comparing the abstracted data with OI/ART booklets.

Data variables included the district name, sex of infant, infant's date of birth, place of birth, place of residence, whether cotrimoxazole and antiretroviral prophylaxes were started or not, and the respective dates. The infant's weight was classified into low birth weight (below 2500 g), normal birth weight (2500–3999 g), and overweight (4000 g and above). Owing to a small number of participants, Chikomba, Goromonzi, Marondera, Mudzi, and Wedza districts were classified as "other districts" while the rest were retained as independent categories. We considered an infant to have been tested for HIV or been started on nevirapine or cotrimoxazole prophylaxis if there was documentation in the HEI registers.

Analysis and statistics

We entered data into a database created using the IBM Statistical Package for the Social Sciences software (version 20, Illinois,

USA). We then cleaned and analyzed the data using Stata version 15 (Stata Corp, College Station, Texas, USA). The proportions of children receiving nevirapine and cotrimoxazole prophylaxes or getting tested for HIV were calculated. Predictors for not receiving cotrimoxazole or not getting tested for HIV were identified by including all available factors in log-binomial regression models. We presented the strength of associations as unadjusted and adjusted risk ratios (RR) with their 95% confidence intervals (CIs). Levels of significance were set at 5%.

Ethics

Ethics approval was granted by the Medical Research Council of Zimbabwe (MRCZ/E/251) and the Union Ethics Advisory Group, Paris, France (49/19). Permission for the study was sought from the Provincial Medical Director, Mashonaland East Province. Since this was a retrospective review of records with no direct interaction with human participants, a waiver of informed consent was granted by the ethics committees.

Table 1: Demographic and clinical characteristics of human immunodeficiency virus-exposed infants born in Mashonaland East Province, Zimbabwe, 2017

Variable	*n* (%)*
Total	1028 (100.0)
Sex[+]	
Male	502 (48.8)
Female	525 (51.1)
Place of birth[±]	
Hospital	896 (87.2)
Nonhospital	128 (12.5)
Birth weight (grams)	
Underweight (1000-2499)	116 (11.3)
Normal (2500-3999)	836 (81.3)
Overweight (≥4000)	36 (3.5)
Not recorded	40 (43.9)
Mode of delivery	
NVD	966 (94.0)
Non-NVD	62 (6.0)
Place of residence	
Urban	201 (19.6)
Rural	823 (80.1)
Type of health facility	
Primary	520 (50.6)
Secondary	456 (44.4)
Tertiary	51 (5.0)
District	
Murewa	240 (23.4)
Mutoko	205 (20.0)
Seke	175 (17.0)
UMP	83 (8.1)
Wedza	125 (12.2)
Other districts[§]	199 (19.4)

*Row percentages used, [+]1 missing record, [±]Nonhospital delivery: Delivery at home and born before arrival at a health facility, 4 missing records, [§]Other districts include Chikomba, Goromonzi, Marondera, Mudzi, and Wedza districts. UMP: Uzumba Maramba Pfungwe District, NVD: Normal vertex delivery

Results

To determine the cascade of care for HEIs, we extracted 1028 records from the entire province of Mashonaland East, Zimbabwe.

The demographic and clinical characteristics of the HEI are summarized in Table 1. There were 2.3% more girls than boys in the cohort. Most of the infants (896 [87.2%]) had been born at a health facility through normal vertex delivery (NVD).

Of the HEIs, 1015 (98.7%) were commenced on nevirapine prophylaxis, while 915 (89.0%) were commenced on cotrimoxazole prophylaxis. The HIV testing cascade showed a progressive decline in the proportion of children who went through the steps. For instance, 880 (85.6%) had a DNA-PCR test by 6 weeks, but only 445 (44.4%) had an antibody test by 9 months and beyond. Ultimately, 40 (3.9%) of the children were found to be HIV positive at the end of the follow-up period of whom 34 (85.0%) were commenced on ART. The cascade is summarized in Figure 1.

Factors associated with not having started cotrimoxazole prophylaxis

Table 2 shows the factors associated with not starting cotrimoxazole prophylaxis by 6 weeks among the HEIs. Type

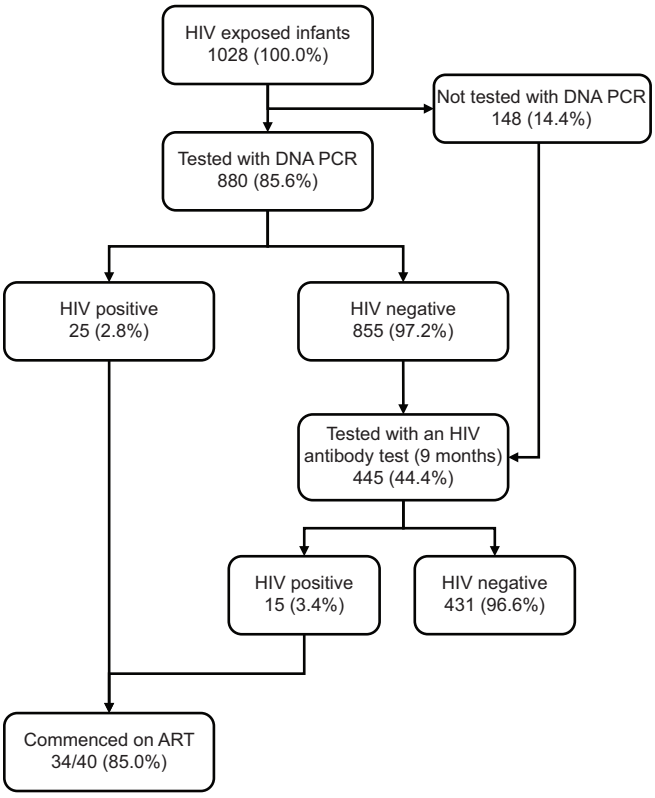

Figure 1: The HIV care cascade for HIV-exposed infants in Mashonaland East province, Zimbabwe, 2017. ART: Antiretroviral therapy, HIV: Human immunodeficiency virus, DNA-PCR: Deoxyribonucleic acid polymerase chain reaction

of health facility and district were significantly associated with not getting cotrimoxazole prophylaxis. On adjusted analysis, we found that infants at secondary health facilities had a 3.6 times higher risk of not getting cotrimoxazole compared to primary health facilities (95% CI: 2.30–5.70, $P < 0.001$). The risk was even higher for children at tertiary health facilities (adjusted RR: 23.33, 95% CI: 7.52–72.33, $P < 0.001$). The risk of not getting cotrimoxazole prophylaxis was also higher for children in Murewa, Uzumba Maramba Pfungwe, and Wedza districts, while lower in Seke district, compared to Mutoko district.

Factors associated with not being tested for human immunodeficiency virus using deoxyribonucleic acid polymerase chain reaction by 6 weeks

A slightly different trend was observed for not having HIV testing using DNA-PCR by 6 weeks [Table 3]. After adjusting, there was a small but significantly higher risk of not having an HIV test for children born through non-NVD methods (adjusted RR: 1.19, 95% CI: 1.01–1.40, $P = 0.03$) when compared to children born through NVD.

Factors associated with not being tested for human immunodeficiency virus using antibody test by 9 months or beyond

Predictors for not getting an HIV antibody test by 9 months and beyond are summarized in Table 4. Facility-based predictors showed that being managed at a secondary health center, compared to primary health center, was associated with a higher risk for not getting a 9-month HIV test (aRR: 1.54, 95% CI: 1.34–1.77, $P = 0.001$). Moreover, when compared to Mutoko district, Murewa, UMP, Wedza, and other districts were associated with higher risk not testing for HIV at 9 months of age.

Discussion

Key results

This study confirmed gaps in HIV prophylaxis and testing among HEIs. Nevirapine, which is normally given at birth, was commenced in almost all of the participants. More than 85% of HEIs were tested using DNA-PCR by 6 weeks. However, less than half of eligible babies were subsequently tested using an

Table 2: Demographic and clinical predictors of not having started cotrimoxazole prophylaxis at birth among human immunodeficiency virus-exposed infants born in 2017, in Mashonaland East Province, Zimbabwe

Variable	Total	No CPT, *n* (%)	RR (95% CI)	
			Crude	Adjusted
Total	1028	113 (11.0)		
Sex				
Male	502	48 (9.6)	Reference	Reference
Female	525	65 (12.4)	1.29 (0.91-1.84)	1.14 (0.81-1.59)
Place of birth				
Hospital	896	102 (11.4)	Reference	Reference
Nonhospital*	128	11 (8.6)	0.75 (0.42-1.37)	0.83 (0.46-1.49)
Birth weight (grams)[+]				
Normal (2500-3999)	836	80 (10.2)	Reference	Reference
Underweight (1000-2499)	116	18 (17.2)	**1.69 (1.08-2.65)**	1.48 (0.94-2.33)
Overweight (≥4000)	36	3 (8.3)	0.82 (0.27-2.47)	0.88 (0.30-2.57)
Mode of delivery				
NVD	966	106 (11.0)	Reference	Reference
Non-NVD[±]	62	7 (11.3)	1.03 (0.50-2.11)	0.74 (0.37-1.50)
Place of residence[§]				
Urban	201	24 (11.9)	Reference	Reference
Rural	823	87 (10.6)	0.89 (0.58-1.35)	1.83 (0.82-4.06)
Type of health facility				
Primary	520	37 (7.1)	Reference	Reference
Secondary	457	56 (12.3)	**1.73 (1.16-2.56)**	**3.59 (2.28-5.65)**
Tertiary	51	20 (39.2)	**5.51 (3.47-8.75)**	**23.21 (7.49-71.94)**
District				
Mutoko	205	13 (6.3)	Reference	Reference
Murewa	240	38 (15.8)	**2.50 (1.37-4.56)**	**3.06 (1.63-5.73)**
Seke	175	7 (4.0)	0.63 (0.26-1.55)	**0.64 (0.23-1.76)**
UMP	83	19 (22.9)	**3.61 (1.87-6.97)**	**10.22 (4.48-23.32)**
Wedza	125	10 (8.0)	1.26 (0.57-2.79)	**2.49 (1.15-5.41)**
Other districts[‖]	199	26 (13.1)	**2.06 (1.09-3.89)**	1.37 (0.52-3.57)

*Nonhospital births: Home delivery or birth before arrival at a health facility, [+]40 missing records, [±]Non-NVD: Breech, vacuum cesarean deliveries, [§]4 missing records, [‖]Other districts: Chikomba, Goromonzi, Marondera, and Mudzi districts. In bold: Statistically significant at $P<0.05$ CPT: Cotrimoxazole, NVD: Normal vertex delivery, UMP: Uzumba Maramba Pfungwe District, RR: Relative risk, CI: Confidence interval

Table 3: Demographic and clinical predictors of not having a deoxyribonucleic acid-polymerase chain reaction human immunodeficiency virus test at 6 weeks among human immunodeficiency virus-exposed infants born in 2017, Mashonaland East Province, Zimbabwe

Variable	Total	HIV not tested, *n* (%)	RR (95% CI)	
			Crude	Adjusted
Total	1028	148 (14.4)		
Sex*				
Male	502	63 (12.6)	Reference	Reference
Female	525	85 (16.2)	1.29 (0.95-1.74)	1.03 (0.94-1.13)
Place of birth[+]				
Hospital	896	136 (15.2)	Reference	Reference
Nonhospital	128	12 (9.4)	0.62 (0.35-1.08)	1.08 (0.99-1.17)
Birth weight (g)[±]				
Normal (2500-3999)	836	113 (13.5)	Reference	Reference
Underweight (1000-2499)	116	24 (20.7)	**1.53 (1.03-2.27)**	1.05 (0.98-1.12)
Overweight (≥4000)	36	6 (16.7)	1.23 (0.58-2.61)	1.08 (0.96-1.20)
Mode of delivery				
NVD	966	132 (13.7)	Reference	Reference
Non-NVD[§]	62	16 (25.8)	**1.88 (1.20-2.96)**	**1.19 (1.01-1.40)**
Place of residence[‖]				
Urban	201	23 (11.4)	Reference	Reference
Rural	823	23 (15.0)	1.31 (0.86-1.98)	1.25 (0.90-1.73)
Type of health facility				
Primary	520	39 (7.5)	Reference	Reference
Secondary	456	92 (20.1)	**2.68 (1.89-3.82)**	1.07 (0.90-1.27)
Tertiary	51	17 (33.3)	**4.44 (2.71-7.27)**	1.16 (0.71-1.92)
District				
Mutoko	205	16 (7.8)	Reference	Reference
Murewa	240	70 (29.2)	**3.74 (2.24-6.22)**	1.18 (0.96-1.47)
UMP	83	19 (22.9)	**2.93 (1.59-5.42)**	1.28 (0.99-1.65)
Seke	175	8 (4.6)	0.59 (0.26-1.34)	1.19 (0.93-1.51)
Wedza	126	11 (8.7)	1.12 (0.54-2.33)	1.21 (0.96-1.53)
Other districts[¶]	199	24 (12.1)	1.55 (0.85-2.82)	1.05 (0.76-1.45)

*1 missing record, [+]4 records missing, Non-hospital births including home delivery or birth before arrival at a health facility, [±]40 Missing records, [§]Includes breech, vacuum cesarean deliveries, [‖]4 missing records, [¶]Other=a combination of Chikomba, Goromonzi, Marondera, and Mudzi districts. In bold - statistically significant at $P<0.05$. NVD: Normal vertex delivery, UMP: Uzumba Maramba Pfungwe District, RR: relative risk, CI: Confidence interval, HIV: Human immunodeficiency virus

antibody test by 9 months or beyond. Ultimately, 3.9% were found to be HIV positive and 85% of them were commenced on ART. High-level facilities and some given districts were consistently associated with increased risk of not being put of cotrimoxazole prophylaxis and being tested for HIV among eligible infants.

Limitations

However, since we used secondary data, there were associated missing data in some key variables, for example, the date when the mother or child had commenced ART or the date when the child got a final HIV result. Likewise, we could not collect and analyze some personal and behavioral characteristics such as monthly income or distance to the health center; which can be confounders of PMTCT follow-up outcomes. Missing data may suggest that nurses are either overwhelmed or are not privy to HIV program record entry. These limitations may have resulted in underestimation of the MTCT rate or overestimation of DNA-PCR testing rates.

Interpretation

The proportion of infants tested with DNA-PCR or who were commenced on cotrimoxazole in this study was slightly higher than reported in a 2016 Cambodian cohort study in which 78% were tested with DNA-PCR and 77% received cotrimoxazole prophylaxis.[13] This may be due to enhanced follow-up of mother–baby pairs through community-based lay cadres,[14,15] which is more practiced in rural provinces of Zimbabwe. However, since both DNA-PCR testing and cotrimoxazole prophylaxis are done at or by 6 weeks, our results show that some exposed infants are already lost to follow-up by this time. This gap needs tightening if the envisaged 95% testing rate and universal cotrimoxazole prophylaxis are to be achieved and maintained. Subsequent HIV testing with an antibody test (done by or beyond 9 months) even dropped further to just above 50%. It is quite paradoxical to have lower antibody test which is available at most PMTCT centers compared to the centralized HIV

Table 4: Demographic and clinical predictors of not having an human immunodeficiency virus antibody test at 9 months among human immunodeficiency virus-exposed infants born in 2017, Mashonaland East Province, Zimbabwe

Variable	Total	HIV not tested, *n* (%)	RR (95% CI)	
			Crude	Adjusted
Total	1003	558 (51.7)		
Sex*				
Male	492	261 (53.1)	Reference	Reference
Female	510	297 (58.2)	1.10 (0.98-1.23)	1.06 (0.95-1.19)
Place of birth				
Hospital	871	487 (55.9)	Reference	Reference
Nonhospital[+]	128	69 (53.9)	0.96 (0.81-1.14)	0.97 (0.82-1.16)
Birth weight (g)[±]				
Normal (2500-3999)	819	450 (55.0)	Reference	Reference
Underweight (1000-2499)	109	68 (62.4)	1.14 (0.97-1.33)	1.13 (0.96-1.32)
Overweight (≥4000)	35	14 (40.0)	0.73 (0.48-1.10)	0.73 (0.48-1.10)
Mode of delivery				
NVD	941	525 (55.8)	Reference	Reference
Non-NVD[§]	62	33 (53.2)	0.95 (0.75-1.21)	0.89 (0.70-1.13)
Place of residence[‖]				
Urban	196	109 (55.6)	Reference	Reference
Rural	803	445 (55.4)	1.00 (0.87-1.15)	0.91 (0.78-1.06)
Type of health facility				
Primary	511	251 (49.1)	Reference	Reference
Secondary	441	277 (62.8)	**1.28 (1.14-1.43)**	**1.54 (1.34-1.77)**
Tertiary	51	30 (58.8)	1.20 (0.94-1.53)	1.04 (0.76-1.42)
District				
Mutoko	193	105 (54.4)	Reference	Reference
Murewa	234	134 (57.3)	1.05 (0.89-1.25)	**1.21 (1.01-1.44)**
Seke	172	91 (52.9)	0.97 (0.80-1.18)	1.05 (0.87-1.26)
UMP	80	52 (65.0)	1.19 (0.97-1.47)	**1.73 (1.35-2.20)**
Wedza	124	65 (52.4)	0.96 (0.78-1.19)	**1.25 (1.00-1.54)**
Other districts[¶]	199	111 (55.8)	1.03 (0.86-1.23)	**1.36 (1.10-1.69)**

*1 missing record, [+]4 records missing, Non-hospital births including home delivery or birth before arrival at a health facility, [±]40 missing records, [§]Non-NVD=Breech, vacuum cesarean deliveries, [‖]4 missing records, [¶]1Missing record, Other districts=a combination of Chikomba, Goromonzi, Marondera, and Mudzi districts. In bold - statistically significant at $P<0.05$. NVD: Normal vertex delivery, UMP: Uzumba Maramba Pfungwe District, RR: Relative risk, CI: Confidence interval, HIV: Human immunodeficiency virus

DNA-PCR test. Despite being low, the antibody testing rate is higher than the 12% reported in Nigeria.[16] Despite a comparably higher HIV testing rate, the vertical transmission rate in our study was lower compared to the 8.2% reported in Nigeria, implying better protection through other means such as antiretroviral prophylaxis. The result also confirms that when more infants complete the PMTCT cascade, vertical HIV transmission can be averted.

The proportion of children found to be HIV positive at the end of the cascade was 3.9%. This MTCT rate is slightly higher than the 2% reported by an operational research conducted in Myanmar.[17] However, the rate in this study is within the 1.1%–15.1% range reported in many sub-Saharan African countries.[18] The low vertical HIV transmission rate, in the context, may have stemmed from the high uptake of nevirapine prophylaxis which definitely averts acquisition of HIV and also confirms the downward trend in MTCT in the country owing to a robust PMTCT program.[19] This may imply the closeness of the country in eliminating vertical HIV transmission although the rate needs a further reduction to achieve sustained elimination of MTCT.

The risk of not getting cotrimoxazole prophylaxis or not testing for HIV by 6 weeks was higher for children managed at higher levels of health care compared to primary health centers. A cohort study in Zimbabwe showed that low birth weight and maternal lifestyle factors were predictors of gaps along the PMTCT cascade.[20] Secondary and tertiary health facilities are higher volume facilities (compared to primary) and less rural where follow-up may be worse – this may also explain why rural facilities showed a reduced risk of not testing by 9 months and beyond. Urban and less rural follow-up systems may need re-optimization to tally with strong follow-up systems in rural areas of Zimbabwe. A further qualitative inquiry may clarify gaps at centers in Murewa, Uzumba Maramba Pfungwe, and Wedza districts.

This study's strengths include using programmatic data, which reflects implementation issues on the ground. The study also made the use of data from the entire province of Mashonaland

East and likely a representation of the whole province. The conduct and reporting are also based on the STrengthening the Reporting of OBservational studies in Epidemiology guidelines.[21]

Conclusion

Among HEI, a high proportion, 98.7%, was commenced on Nevirapine prophylaxis although cotrimoxazole prophylaxis coverage was suboptimal at 89%. On the other hand, vertical HIV transmission among the HEI was low as 2.8% infants were HIV positive at six weeks and an additional 3.4% were HIV positive at nine months through HIV antibody test. However, ART coverage was sub-optimal as 85% of HIV positive infants were commenced on ART. Having been born through a non-NVD was associated with a higher risk (aRR: 1.19, 95% CI: 1.01-1.40) of not having an HIV test at six weeks. Being managed at Secondary Health Centres compared to Primary Health Centres was associated with increased risk (aRR: 1.54; 95% CI: 1.34-1.77) of not having a nine-month HIV test. Infants managed at secondary health centres (aRR: 3.59, 95% CI: 2.28-5.65) and tertiary health centres (aRR: 23.21, 95% CI: 7.49-71.94) were at increased risk of not having cotrimoxazole prophylaxis. There is need to strengthen nine-month HIV testing and cotrimoxazole prophylaxis at secondary and tertiary health centres and among babies born through non-NVD forms of delivery.

Generalizability

This study has shown that while the uptake of nevirapine prophylaxis is high, gaps still exist in the uptake of cotrimoxazole prophylaxis and HIV testing of HEIs. The cascade of HIV prevention for exposed infants needs more strengthening, particularly concerning follow-up at high-level facilities and particular districts. The study has enough statistical power for generalization to other rural HEI cascades in sub-Saharan Africa or other low-resource settings. Results may not be generalizable in urban settings.

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Research quality and ethics statement

This study was approved by the Institutional Review Board / Ethics Committee approval number (MRCZ/E/251) for the Medical Research Council of Zimbabwe and 49/19 for Union Ethics Advisory Group, Paris, France (49/19). The authors followed applicable EQUATOR Network (http:// www.equator-network.org/) guidelines during the conduct of this research project.

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Conflicts of interest

There are no conflicts of interest.

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