Pediatric HIV Testing Following Caregiver Index-Case Identification in Kenya

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A thesis submitted in the partial fulfillment of the
requirements for the degree of

Master of Public Health

University of Washington

2019

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Abstract

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Introduction

In contrast to the estimated 62% of adults living with HIV are on antiretroviral treatment (ART), only 42% of children are on ART. Gaps in pediatric HIV treatment are due to gaps in diagnosis of HIV, particularly among older children born before expansion of prevention of mother-to-child transmission (PMTCT) programs.

Methods

The Counseling and Testing of Children at Home (CATCH) study evaluated index-case pediatric HIV testing. Caregivers receiving HIV care at 7 health facilities were encouraged to test their children of unknown status aged 0-12 years (either with home-based testing [HBT] or in clinic-based testing [CBT]). Detailed maternal HIV testing history, receipt of PMTCT interventions, and child HIV testing history were collected. Uptake and yield of testing was compared between home and clinic, and predictors of HIV-positive diagnosis were identified.

Results

Among 492 caregivers approached, 71% completed HIV testing for 520/850 (61%) children. Most (80%) caregivers who tested children used CBT. HIV prevalence among tested children was 5.8%; higher in CBT (6.8%) than HBT (2.4%) (p=0.06). All 30 children linked to care, and 14 (54%) started ART within a month of linkage. Child unknown HIV status was predominantly (82%) due to mother being untested or HIV negative during pregnancy; younger children (0-5) were 3.33-fold more likely to have received an HIV test in infancy than 6-12 year olds. Older

tested children were less likely to be HIV positive than younger children (PR=0.82 [95%CI: 0.73-0.92]). Children whose mother was diagnosed before pregnancy were 5.76-fold (1.80-18.45) more likely to be HIV-positive than those born to mothers diagnosed after pregnancy.

Conclusion

Index-based pediatric testing was acceptable with CBT preferred over HBT and more likely to yield new diagnoses. Continued efforts to diagnose, link and treat children with HIV are important to address the pediatric HIV treatment gap.

INTRODUCTION

Approximately 1.8 million children (0-14 years) are living with HIV globally, with an estimated 160,000 new cases per year.[1] Over 90% of the global pediatric HIV prevalence and 60% of new infections are in sub Saharan Africa (SSA). [1] Improved access to life-saving antiretroviral treatment (ART) has decreased AIDS mortality. However, only 50% of all children living with HIV globally are on ART, predominantly because they remain undiagnosed.[1, 2]

Since the early 2000s, prevention of mother-to-child transmission (PMTCT) programs have been scaled-up.[3-5] In several countries in East and South Africa, more than 90% of pregnant women living with HIV (WLWH) received ART during pregnancy in 2018.[1, 2, 6] However, in the past, women did not test in late pregnancy and postnatal periods missing new HIV infections acquired in pregnancy and postpartum.[5, 7]

Late diagnosis of HIV-infected children has been associated with high rates of mortality, [8, 9] opportunistic infections, [10] and long-term adverse sequelae. [11, 12] Early infant diagnosis (EID) and provision of antiretroviral (ARV) prophylaxis to HIV-exposed infants are recommended and have been widely implemented. [13, 14] However, in SSA, an estimated 35% of HIV-exposed infants did not receive EID in 2017.[15] To reach older children missed by EID, provider initiated testing and counseling (PITC) in health facilities is advised. [14, 16] Implementation challenges however have resulted in sub-optimal operationalization of PITC. [17, 18] Community-based approaches including door-to-door testing have been utilized to reach children out of health facilities.[14] These approaches are expensive and generally have a low yield. [16, 19]

Index-case testing approaches for pediatric HIV testing are promising. Targeting children of HIV-infected adults in care has relatively high yield (4-18%) [20, 21], with children often diagnosed while asymptomatic [16, 22, 23]. Various approaches have been used to reach children of index clients, including home-based testing (HBT) and clinic-based testing (CBT) [20]. The uptake of testing using the index-case testing approach ranges from 19 to 94%, [16, 20]. In one study, HBT had higher test completion than CBT [24] and HBT reached more children per index case than CBT in other studies. [20, 22]. Conversely, CBT may have higher yield in identifying children infected with HIV [21, 25, 26]. While correlates of pediatric HIV are well described in MTCT cohorts that test HIV-exposed infants, [27-29] correlates of pediatric HIV among children reached through index-case testing are undefined.

The Counseling and Testing of Children at home (CATCH) study implemented index-case testing specifically designed to test children. In a pilot study, we found that active referral of adult index clients for child testing resulted in a 4-fold increase in pediatric testing. [22] The CATCH study was designed to extend this model to more facilities. We assessed the gaps in the PMTCT/ EID cascade that contributed to lack of prior child HIV testing. We compared uptake and yield of HBT and CBT, and described linkage to care for the HIV-infected children, and assessed predictors of HIV-positive diagnosis in this index-case tested cohort.

METHODS

Study design and population

The CATCH study was a prospective cohort study conducted between 2013 and 2016. The study recruited HIV-infected caregivers in care (index client) and offered testing for their children ages 0-12, of unknown HIV status (eligible children). The caregivers were offered an option of either HBT or CBT. Male caregivers were enrolled only if the biological mother of the eligible child was dead, not involved with care of the child, or had provided consent to test the children in her absence.

Study sites

The study was conducted in six sites in Nairobi (Kenyatta National Hospital, Mbagathi County Hospital, Mathare North, Baba Dogo, Kariobangi, Dandora II) and the Kisumu County Hospital.

Study procedures

Recruitment and enrollment

Triage nurses or peer counselors positioned either at triage desks or outside clinic pharmacies screened all adults visiting the HIV clinic and referred all adults with eligible children to study staff. All participants provided written consent to join the study and test the children, completed an enrollment questionnaire and selected whether to test their children in clinic on the same day, in clinic at a later date, or at home at a later date. In the enrollment questionnaire, caregivers provided sociodemographic, HIV testing and treatment information. They also provided information on PMTCT procedures they undertook for pregnancies with all their children, EID information for every child known to be HIV-exposed, child hospitalization history and barriers to testing for all children.

Conceptual model

Pediatric HIV testing is a health service whose utilization is influenced by multiple factors. The *Andersen's behavioral model for health services use* was adapted by the CATCH study to describe how various factors including accessibility and guidelines of HIV testing (e.g. PMTCT and EID practices), caregiver and household characteristics, and child characteristics impact the completion of HIV testing for children and their eventual HIV status. [30]

Testing and linkage to care

Testing was conducted by a trained HIV testing counselor. To facilitate tracing of participants' home for HBT, the counselors were accompanied by a community health worker (CHW). As per Ministry of Health guidelines on HIV testing,[14] children <18 months or older but still breastfeeding, received an HIV DNA/ RNA (PCR) test processed at the Molecular and Virology laboratory at the University of Nairobi. Results were delivered to the caregiver in clinic within a week after sample collection. For other children, a rapid HIV test was done. Children with a negative HIV test but still breastfeeding were linked to the facility EID program. All HIV-infected children diagnosed in clinic were linked to care within the same clinic while those diagnosed at home were linked to care by the CHW accompanying the caregiver.

Follow up and study exit

HIV-infected children were followed up either at home, clinic or through a phone call 1 month after diagnosis, and subsequent 3, 6, 9 and 12 months. Caregivers provided information on retention in care and ART initiation. The dates of ART initiation and ART regimen were abstracted from clinic records after the month 12 visit.

Ethical approval
The University of Washington Institutional Review Board and Kenyatta National Hospital/ University of Nairobi Ethics Review Committee provided ethical approval for the CATCH study.

Data collection and analysis
Data collection was completed in some sites on paper and subsequently entered into a cloud-based database using desktop Redcap. In other sites, data was collected using an Open Data Kit (ODK) interfaced mobile phone. We described the sociodemographic characteristics, HIV testing and treatment history of index clients, and gaps in PMTCT using counts, proportions, medians and interquartile range (IQR). We also compared the PMTCT experience of the mother-child pairs during pregnancies of children 0-5 years and 6-12 years old at enrollment using generalized linear models (GLM). We restricted the description of PMTCT gaps to female index clients due to high missingness in PMTCT information among male respondents. In establishing reasons why children remained untested, the first step in the PMTCT cascade that the mother-child pair failed to complete was considered the reason the child remained of unknown HIV status. Each child contributed only once in this gap analysis.

To describe the uptake of testing, we calculated the proportion of caregivers who preferred testing their children at home, in clinic on the same day, and clinic at a later date. We then calculated the proportion of caregivers who completed testing for at least one child following HBT, CBT overall and CBT at a later date. We calculated the mean number of children eligible for testing per family for those who preferred HBT, CBT overall, CBT at a later date, those who eventually completed testing and non-testers. Further, we calculated the mean number of children tested per family following HBT, CBT overall, and CBT at a later date. The overall HIV prevalence and following HBT, CBT, and CBT at a later date was calculated. For the children who tested HIV-positive, we calculated the proportion that linked to care and the proportion that started ART by month 1, 3, 6, 9 and 12 after diagnosis. Chi-squared tests were used to test for differences in proportions and student t-tests for differences in means.

We assessed caregiver-level and child-level characteristics for association with pediatric HIV. The cofactors were selected *a priori*, among variables collected in the CATCH study. Child age, maternal age during pregnancy, maternal years of education and number of months child was breastfed were modelled as continuous variables while other factors, all presented in the results section, were modelled as categorical variables. Bivariate analysis was completed using binomial regression to provide PR and 95% CI. Clustering within family and site was accounted for in the GLM models. Analysis was conducted using R Studio (Version 1.1.456, 2009-2018)

RESULTS

Caregiver characteristics

The CATCH study enrolled 493 caregivers of whom 394 (80%) were in Nairobi. Most caregivers were female (84%), and 75% were on ART. Of those with a current partner, 55% had a known HIV-infected partner (Table 1). Caregivers were diagnosed recently, a median of 1 year prior to enrollment (interquartile range (IQR) 0-4 years), Approximately one-third (28%) of caregivers were diagnosed in PMTCT programs, 29% in VCT clinics, and 24% in outpatient clinics. Reasons for testing included feeling sick (45%) and PMTCT testing (28%). Few caregivers (5.5%) were diagnosed because partner was diagnosed HIV positive or child was diagnosed HIV positive (2.5%).

Missed opportunities for child HIV testing

Of the 850 children eligible for testing, 631 (74%) had a female caregiver as the index client. Of those, 67% had mothers who received a HIV test during pregnancy and 4% had mothers diagnosed HIV-positive before pregnancy. Twenty-two percent of children were known to be HIV-exposed at birth, of whom 74% had mothers who enrolled in PMTCT, 80% received ARV prophylaxis, and 50% had a HIV test before cessation of breastfeeding. Only 9% of the children had ever been hospitalized. Mothers of younger children (ages 0-5 years) were 1.18 (95% CI: 1.06-1.31) more likely to have received a HIV test, and 1.40 (1.07-1.87) times more likely to have used ARVs if HIV-infected than mothers with older children (ages 6-12 years). Younger children were 3.33 (1.82-6.10) times more likely to have received a HIV test before cessation of breastfeeding than the older children (Figure 1).

Relative contribution of pediatric HIV testing gaps

Of 678 children included in the health-system gap analysis, 586 had complete PMTCT information. The first step in the PMTCT cascade that the mother-child pair failed to complete was considered the reason the child was of unknown HIV status. Approximately 31% of children were untested because their mothers did not test for HIV during pregnancy while 51% had mothers who tested HIV-negative during pregnancy. For 5% of the children, their mothers despite being known HIV-positive were not followed up in PMTCT program while 3% were not followed up in EID program after birth. Further, 1% were initiated on ARV prophylaxis but never tested. For 9%, HIV testing was done during infancy but had no confirmatory testing after cessation of breastfeeding (Figure 2).

Completion of testing at home and clinic

Of 493 caregivers, 115 (23%) caregivers initially preferred HBT, 105 (21%) CBT on the same day, 272 (55%) CBT at a later date, while 1 preferred not to test. Of the 115 who initially preferred HBT, 65 (57%) completed testing at home, 13 (11%) completed testing in clinic, while 37 (32%) did not complete testing. Among the 377 who initially preferred CBT, 266 (71%) tested in clinic, while 5 (1%) tested at home, while 106 (28%) did not complete testing. Overall, 349/492 (71%) caregivers completed testing for 520/ 850 (61%) eligible children. There was no difference in test completion between those who preferred HBT versus CBT overall (68% vs 72%, p=0.4), and HBT versus CBT at a later date (68% vs 61%, p=0.2). The mean number of eligible children per caregiver who preferred HBT was higher than those who preferred CBT overall (1.94 vs 1.66, p=0.006), and CBT at a later date (1.94 vs 1.67, p=0.015). There was no difference in the mean number of eligible children per caregiver between the testers and non-testers (1.69 v 1.64, p=0.6). The mean number of children tested per family at home was greater than in clinic overall (1.76 vs 1.42, p=0.0007), and in clinic at a later date (1.76 vs 1.43, p=0.0025) (Table 2).

HIV prevalence at home and clinic

Thirty of the 520 children tested were HIV-positive, a prevalence of 5.8% (95%CI: 4.0-8.3). In co mparison, HIV prevalence was 2.4% (0.6-7.5) among children who received HBT, 6.8% (4.6-9.9) among children who received CBT either on the same day or later, 7.1% (3.9-12.5) among those who received same day CBT, and 6.5% (3.8-10.7) among those who received CBT at a later dat e (Table 2). The HIV prevalence varied considerably by site, ranging from 1.9-8.9% (Supplemen tary table 4).

All (30) HIV-infected children were linked to care. Of the 26 children with confirmed ART initiation, 14 (54%) initiated ART within a month after testing, 6 (23%) within 3 months, 4 (15%) within 6 months, 1 (4%) within 9 months, and 1 (4%) within 1 year.

Predictors of a child being HIV positive

Older children were less likely to be HIV-positive (PR 0.82 for one-year older age, 95%CI: 0.73-0.92). Additionally, compared to children whose mothers tested HIV-negative during pregnancy, children whose mothers were known HIV-positive before pregnancy were 5.76 times more likely to be HIV-infected, 95%CI: 1.80-18.45 (Table 3).

DISCUSSION

In this study of index-based pediatric HIV testing, we found that 71% of caregivers accepted pediatric HIV testing and most chose CBT over HBT. Overall uptake of pediatric testing was moderate, and while CBT had higher completion of testing and HIV prevalence, HBT resulted in testing of more children per household. Lack of maternal HIV test or HIV-negative maternal test during pregnancy were the main reasons children had not received complete testing to confirm HIV status. Gaps in PMTCT contributed to lack of child testing, particularly during pregnancies with older children. Linkage to care for newly diagnosed HIV-infected children was optimal but only half of children were started on ART within a month after diagnosis. Children who tested positive in index testing were younger and likely to have mothers who were known to be HIV positive before pregnancy.

Our study found a relatively high rate of test completion (71%), higher than in other index-case testing studies targeting children in Kenya [31-33] and Cameroon[34] but lower than in Malawi [21] and Uganda [24] studies. While all these studies were conducted in similar populations, the study designs differed. The CATCH study and the study in Cameroon focused on only reaching children of index cases while the others targeted all household members. Further, while some of the index-case testing studies included both CBT and HBT [21, 24, 34], some exclusively employed CBT [31, 33] or HBT [32, 35]. Similar to Cameroon, caregivers preferred CBT to HBT.[34]

The study demonstrated an easy but often missed opportunity for pediatric index case testing – 21% of caregivers who had an accompanying child at their HIV care visit agreed to same-day testing of an untested child. Standardized offer of testing for untested children accompanying adults in HIV care is inexpensive and efficient and had a high yield (7.1%). Providing caregivers with a choice of testing location helps in test completion as demonstrated in this study and studies in Malawi [21] and Cameroon [34]. Further, the preference for testing location can be dynamic as shown by 15% of the caregivers who tested their children in a location initially not preferred. Excluding caregivers who tested the same day in clinic, those who preferred HBT in our study had slightly higher test completion than CBT (68% versus 61%), consistent with the Uganda study that made a similar comparison [24]

The diagnostic yield of 5.8% that we observed is consistent with other pediatric index-case testing studies in SSA. [16, 20] We found substantially higher prevalence with CBT than HBT's (6.8% versus 2.4%). This is consistent with other studies comparing pediatric CBT and HBT. [21, 24, 34] Overall, the yield from our study is higher than what is typically reported following universal testing [16, 20, 36, 37] but lower than PITC especially in inpatient settings [16]. Despite the lower caregiver preference and yield, HBT is relevant for caregivers with multiple untested children, and in reaching more children in a household. In the CATCH study, experienced HIV testing counselors were accompanied by CHW to facilitate identification of homes especially in peri-urban areas and linkage to care of HIV-infected children. To reduce the intervention cost in a program setting, CHW could themselves complete HBT as was done in Malawi and Cameroon [21, 34].

Linkage to care in this study was complete which may be a reflection of the resources dedicated in the study for tracing and follow up for HIV-infected children, including home visits, regular phone calls by study counselors and linkage to CHW. However, ART initiation was sub-optimal, which is partially explained by the evolution of ART guidelines for children. Before 2016, children above 10 years did not initiate ART until they fulfilled clinical or immunological criteria for ART initiation. [38, 39]

We used an approach to establish health systems gaps that led to children being of unknown HIV status that had been previously used to characterize delays in diagnosis of HIV-infected children [17]. One third of children in our study had mothers not tested for HIV during pregnancy, and over half had mothers had tested HIV-negative during index pregnancy. Consequently, these children were not considered for testing after birth. All these caregivers tested HIV-positive at some point after pregnancy, some may have acquired HIV during late pregnancy and breastfeeding periods but were undiagnosed due to challenges in the implementation of repeat testing and postnatal HIV testing [7, 40]. This context is important since more than half of pediatric HIV infections occur during the breastfeeding period. [41, 42] Optimizing postnatal testing for mothers and their children is likely to have the highest impact in closing the testing and diagnosis gaps for children of HIV-infected caregivers. All caregivers in this study who had an untested child had experienced at least one gap in the PMTCT cascade. Children were ages 0-12 years, reflecting participants' experiences with PMTCT services during the years between 2001 to 2016. During this period, Kenya expanded antenatal testing, ART provision during pregnancy and EID [42, 43], and this progress was demonstrated in this study as younger children were significantly more likely to have had maternal HIV diagnosis during pregnancy, maternal ART during pregnancy, infant prophylaxis and EID than older children.

Younger tested children were more likely than older children to be diagnosed with HIV infection. This suggests that caregivers were recently infected, after the time that older children would have been at risk for transmission. Additionally, the mortality rate following undiagnosed pediatric HIV is high [8-10, 44, 45] leading to survival bias among older children. Children whose mothers were known HIV-positive before pregnancy had a higher risk of being HIV infected that those whose mothers tested HIV-positive during the pregnancy, likely for the same reason as the younger age association in this cohort. Children whose mothers were not known HIV-positive in pregnancy likely had mothers who acquired HIV after the child stopped bresatfeeding.

Strengths of our study included collection of detailed caregiver HIV testing and treatment history, and caregiver-child PMTCT history. This enabled estimation of PMTCT gaps, a comprehensive description of children reached by the intervention. Having the caregivers choose the testing location enabled us to optimize uptake. Since the time of the study, new pediatric testing initiatives, including adoption of index-case testing in the national guidelines [14] and short-term HIV testing campaigns [46] have further reduced the gap in testing for children. Additionally, caregivers could have opted to test their children elsewhere resulting in an under-estimation of test completion. We however do not think that this differentially affected either home or clinic testers.

Conclusion

As the number of new pediatric HIV infections continue to decline in high burden countries [1], more efficient and cost-effective HIV testing approaches are required to reach children that fall through cracks in the PMTCT cascade. A high proportion of HIV-infected adults are now accessing care, [1, 2] and targeting them to reach children at high risk of being HIV-infected will continue to play an important role. Strengthening repeat testing during late pregnancy and postnatal testing, will reduce the number of children whose HIV status is unknown. Finally, further studies are required to understand differences in pediatric HIV testing and linkage to care when index-case testing is conducted within broader family testing.

Acknowledgements

We wish to thank the CATCH study participants without whom this research would not have been possible. We also thank participating site staff, County Directors of Health in Nairobi and Kisumu, and their HIV management teams, Kenya National AIDS and STI Control Programme for their

support and constant engagement in the study. I also thank UW Global Center for Integrated Health of Women, Adolescents and Children (Global WACh), and International AIDS Research and Training Program (IARTP) for providing sponsorship to complete my graduate studies at the University of Washington, support and mentorship opportunities.

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TABLES AND FIGURES

Table 1: Caregiver and household characteristics

Characteristic	N	n (%) or median (IQR)
Socio-demographic		
Site receiving care	493	
Nairobi City Council Clinics*		210 (43)
Mbagathi County Hospital		61 (12)
Kenyatta National Hospital		123 (25)
Kisumu County Hospital		99 (20)
Female	493	414 (84)
Age	493	32 (28-38)
Years of school completed	493	
≤ 4 years		16 (3)
5-8 years		181 (37)
9-12 years		207 (42)
>12 years		89 (18)
Marital status	493	
Never married, no current partner		36 (8)
Previously married, no current partner		145 (29)
Currently married/ steady partner		312 (63)
Partner HIV status	312	
Positive		172 (55)
Negative		48 (15)
Unknown		92 (30)
Has a paying job	493	275 (56)
Monthly income ($) (among those with income)	263	63 (42-126)
Crowding (≥3 people per room)	491	267 (54)
HIV testing and treatment history		
Years since HIV diagnosis	493	1 (0-4)
Location of HIV diagnosis	493	
PMTCT		142 (29)
VCT		140 (28)
Hospital outpatient		120 (24)
Hospital inpatient		75 (15)
Home-based testing		16 (3)
Reason tested for HIV	493	
Felt sick		223 (45)
PMTCT		137 (28)
Routine VCT		63 (13)
Suspected partner was HIV-positive		30 (6)
Partner diagnosed HIV-positive		27 (5.5)
Child diagnosed HIV-positive		13 (2.5)
Currently on ART	492	367 (75)

***** Mathare North Health Center - 59 (28); Baba Dogo Health Center - 36 (17); Kariobangi Health Center - 29 (14); Dandora Health Center - 86 (41)

Figure 1: A comparison of PMTCT experience for currently HIV-infected caregivers during pregnancy with children ages 0-5 years versus pregnancy with children ages 6-12 years

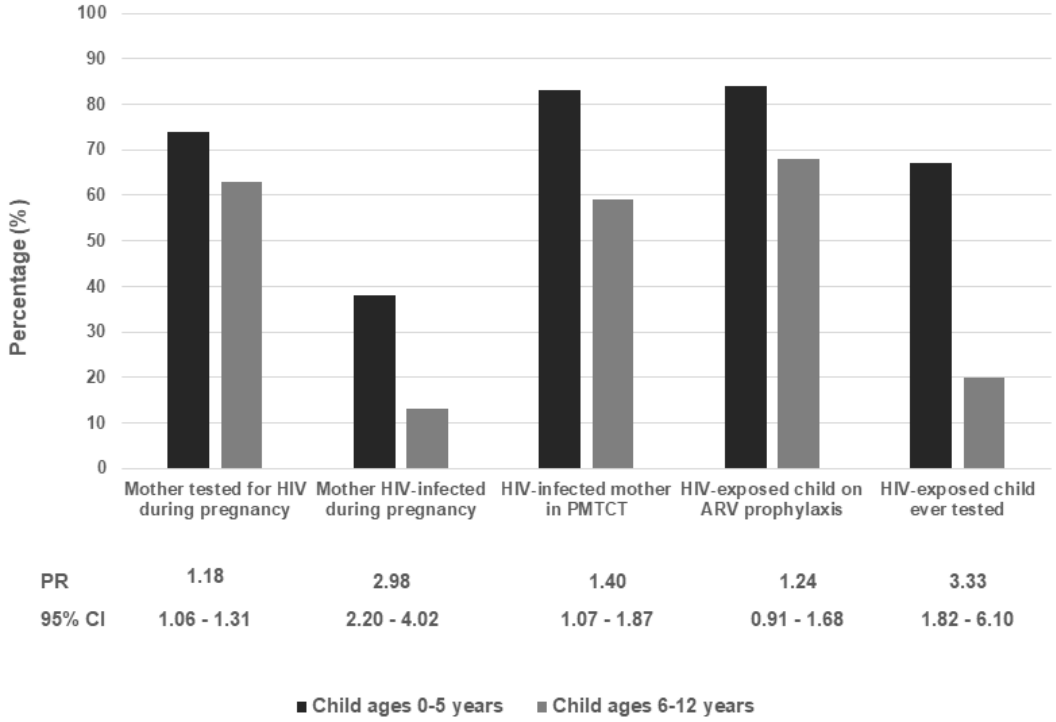
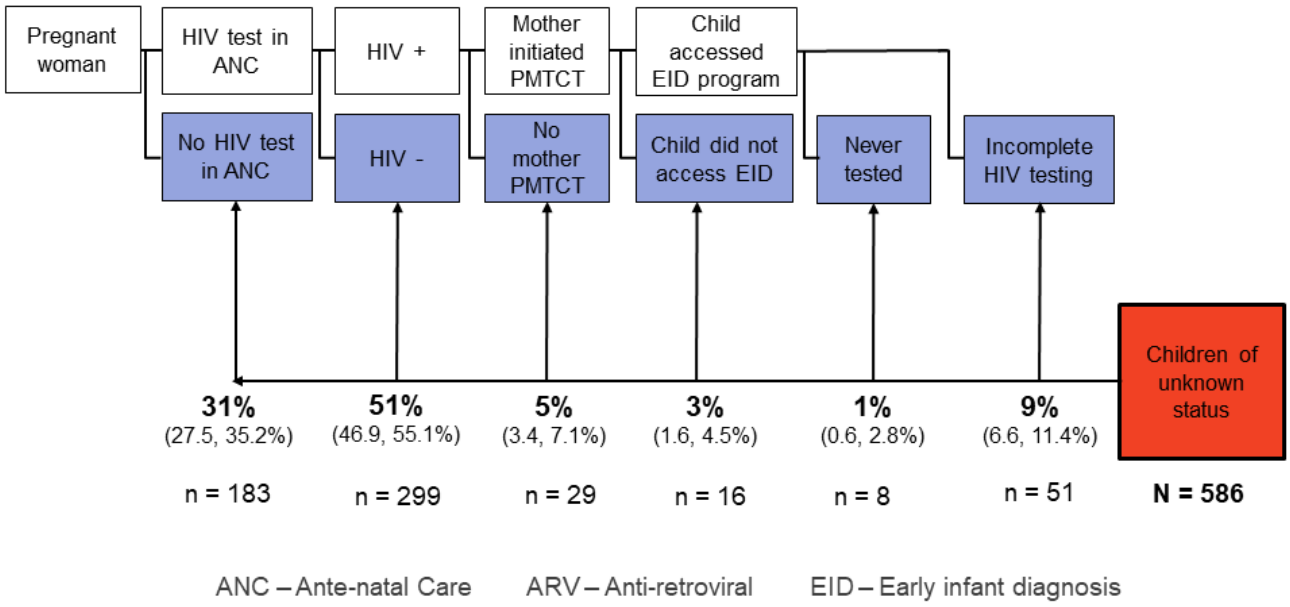


Figure 2: Health system gap analysis

Child HIV testing first missed when….



ANC – Ante-natal Care ARV – Anti-retroviral EID – Early infant diagnosis

Table 2: Comparing uptake and yield of home-based and clinic-based testing

Characteristic	HBT Mean (range)/ n (%)	CBT Mean (range)/ n (%)	p-value
Caregivers' initial preference of testing location **(N=492)**	**115 (23)**	**377 (77)**	
Eligible children per caregiver	1.94 (1-6)	1.66 (1-8)	0.006
Caregivers with 1 child	46 (46)	205 (56)	
Caregivers with 2 children	46 (39)	118 (31)	
Caregivers with 3+ children	23 (17)	54 (13)	
Caregivers completing testing for at least one child **(N=349)**	***70 (20)**	****279 (80)**	
Children tested per caregiver	1.76 (1-5)	1.42 (1-4)	0.0007
Caregivers with 1 child	35 (50)	186 (67)	
Caregivers with 2 children	23 (33)	69 (25)	
Caregivers with 3+ children	12 (17)	24 (8)	
Children tested **(N=520)**	**123 (24)**	**397 (76)**	
Child age (years)	7.16 (0-12)	6.75 (0-12)	0.19
Prevalence of HIV infection	3 (2.4)	27 (6.8)	0.06

*65 initially preferred HBT and 5 initially preferred CBT

**266 initially preferred CBT and 13 initially preferred HBT

Table 3: Predictors of Pediatric HIV

	ALL		HIV+		HIV-		Bivariate analysis		
	N	**Median (IQR)/ n (%)**	**N**	**Median (IQR)/ n (%)**	**N**	**Median (IQR)/ n (%)**	**PR**	**95%CI**	**P value**
Child characteristics									
Child age	520	7 (5-9)	30	5 (3-7)	490	7 (5-9)	0.82	0.73-0.92	**0.001**
Female child	520	292(56)	30	21 (70)	490	271 (55)	1.82	0.83-3.98	0.13
Has HIV-infected sibling	520	37 (7)	30	4 (7)	490	33 (7)	2.00	0.70-5.75	0.19
Has deceased sibling	520	109 (21)	30	3 (10)	490	106 (22)	0.42	0.13-1.38	0.15
Ever hospitalized	364	24 (6.6)	20	1 (5)	344	23 (6.7)	0.74	0.97-5.67	0.77
Any HIV testing during infancy	443	46 (10)	25	2 (8)	418	44 (10.5)	0.75	0.17-3.19	0.69
Months breastfed	508	13 (8-24)	26	18 (12-24)	482	13 (8-24)	1.03	0.99-1.07	0.13
Caregiver assumes child is HIV-negative	520	307 (59)	30	16 (53)	490	291 (59)	0.79	0.39-1.62	0.53
Caregiver characteristics									
Female caregiver	520	438 (84)	30	23 (77)	490	415 (85)	0.61	0.26-1.43	0.26
Maternal age during pregnancy	438	24 (20-28)	23	24 (23-29)	415	23 (20-28)	1.04	0.98-1.09	0.18
Maternal years of education	438	9 (7-12)	23	9 (7-12)	415	9 (8-12)	1.02	0.89-1.17	0.78
Maternal HIV status during pregnancy	433		23		410		1.02	0.92-1.12	0.76
Negative		216 (50)		10 (44)		206 (50)	Ref	Ref	
Unknown		128 (30)		7 (30)		121 (30)	1.18	0.45-0.14	0.74
Positive									
Diagnosed during pregnancy		74 (17)		2 (9)		72 (17)	0.58	0.13-2.67	0.49
Diagnosed before pregnancy		15 (3)		4 (17)		11 (3)	5.76	1.80-18.45	**0.003**

SUPPLEMENTARY TABLES

Supplementary table 1: Missed opportunities in pediatric HIV testing: Characteristics of pregnancies involving children eligible for testing in CATCH study;

Characteristic	All		0-5 years		6-12 years	
	N	Median (IQR) or n (%)	N	Median (IQR) or n (%)	N	Median (IQR) or n (%)
Child age	678	7 (4-10)	227	4 (2-4)	451	9 (7-10)
Not tested during pregnancy						
Mother was not tested for HIV during pregnancy	631	183 (29)	221	41 (19)	410	142 (35)
Mother was known HIV-positive before pregnancy	631	26 (4)	221	16 (7)	410	10 (2)
Mother was tested for HIV during pregnancy	631	422 (67)	221	164 (74)	410	258 (63)
Mother tested HIV-negative during pregnancy	411	299 (73)	162	93 (57)	249	206 (83)
Mother tested HIV-positive during pregnancy	411	112 (27)	162	69 (43)	249	43 (17)
HIV-positive during pregnancy (newly tested positive and previously known positive)	631	138 (22)	221	85 (38)	410	53 (13)
Mother not in PMTCT	111	29 (26)	70	12 (17)	41	17 (41)
Mother in PMTCT	111	82 (74)	70	58 (83)	41	24 (59)
Child not on ARV prophylaxis	80	16 (20)	58	9 (16)	22	7 (32)
Child on ARV prophylaxis	80	64 (80)	58	49 (84)	22	15 (68)
HIV-exposed child not tested	123	62 (50)	78	26 (33)	45	36 (80)
HIV-exposed child ever tested	123	61 (50)	78	52 (67)	45	9 (20)
No child on ARV prophylaxis among those with a mother in PMTCT	80	16 (20)				
Child tested among those on ARV prophylaxis	59	8 (14)				
Child previously hospitalized						
No	583	533 (91)				
Yes	583	50 (9)				

Supplementary table 2: Health system gap analysis: Step in PMTCT cascade first missed by the mother-child pair was considered the reason child remained of unknown status

Characteristics	**N**	**n (%)**	**Calculation using cumulative %**	**% first missed in each step**	**95% CI**
Mother did not test for HIV during pregnancy	631	183 (29)	29	31*	27.5, 35.2
Mother tested HIV-negative during pregnancy	411	299 (73)	100-29 = 71 71*73%=52	51*	46.9, 55.1
HIV-positive mother with no PMTCT	111	29 (26)	100-52-29=19 19*26%=5	5	3.4, 7.1
HIV-exposed child not recruited into EID program	80	16 (20)	100-5-52-29=14 14*20%=3	3	1.6, 4.5
HIV-exposed child in EID did not receive HIV testing before cessation of breastfeeding	59	8 (14)	100-3-5-52-29=11 11*14%=2	1*	0.6, 2.8
HIV-exposed child in EID received some testing before cessation of breastfeeding		51 (86)	100-2-3-5-52-29=9 9*86%=8	9*	6.6, 11.4
		N=586		100	

*Percentage adjusted after computation of the total number of children included in the analysis. Among 631 children, only 586 had full prevention of mother to child transmission of HIV (PMTCT) information. The percentages were therefore adjusted for each step with 586 as new denominator.

Supplementary table 3: A comparison of PMTCT experience for caregiver-child pairs during pregnancy with children ages 0-5 years versus pregnancy with children ages 6-12 years

Indicator	Child age: 0-5 years		Child age: 6-12 years		RR (95%CI)	P value
	N	n (%)	N	n (%)		
Mother of unknown HIV status tested for HIV during pregnancy	221	164 (74)	410	258 (63)	1.18 (1.06-1.31)	0.004
Mother HIV-infected during pregnancy	221	85 (38)	410	53 (13)	2.98 (2.20-4.02)	<0.0001
HIV-infected mother in PMTCT	70	58 (83)	41	24 (59)	1.4 (1.07-1.87)	0.005
HIV-exposed child on ARV prophylaxis	58	49 (84)	22	15 (68)	1.24 (0.91-1.68)	0.124
HIV-exposed child ever tested for HIV	78	52 (67)	45	9 (20)	3.33 (1.82-6.10)	<0.0001

Supplementary table 4: Prevalence of HIV-positive diagnosis by site

Site	N	HIV+ n (%)	95% CI
KNH	116	8 (6.9)	3.2-13.6
Kisumu	89	7 (7.9)	3.5-16
Mbagathi	56	5 (8.9)	3.3-20.4
Kariobangi	112	5 (4.5)	1.7-10.6
Dandora	60	3 (5.0)	1.3-14.8
Mathare	34	1 (2.9)	0.1-17
Baba Dogo	53	1 (1.9)	0.1-11.4
Total	520	30 (5.8)	4.0-8.3