

Determinants of Nonadherence to a Single-Dose Nevirapine Regimen for the Prevention of Mother-to-Child HIV Transmission in Rwanda

Thérèse Delvaux, MD, MPH,* Batya Elul, PhD, MSc,† Felix Ndagije, MD, MSc,‡
Elevanie Munyana, BSc,§ Dominique Roberfroid, MD, MSc,* and Anita Asiimwe, MD, MPH§

Objectives: To describe experiences, and identify factors associated with nonadherence to a single-dose nevirapine (SD-NVP) regimen for the prevention of mother-to-child transmission (PMTCT) of HIV in Rwanda.

Methods: In April to May 2006, using a case-control design at 12 PMTCT sites, we interviewed HIV-infected women who did not adhere (n = 111) and who adhered (n = 125) to the PMTCT prophylaxis regimen. Nonadherence was defined as mother and/or infant not ingesting SD-NVP at the recommended time or not at all and adherence as mother–infant pairs who ingested it as recommended.

Results: Only 61% of nonadherent women had received SD-NVP during pregnancy or delivery. Among nonadherent women who received SD-NVP, 80% ingested it at the recommended time, representing 49% of all nonadherent women. Only 7% of their newborns ingested SD-NVP. Multivariate logistic regression showed that unmarried women, less educated women, women who made 2 or less antenatal care visits, and those offered HIV testing after their first antenatal care visit were more likely to be nonadherent to PMTCT prophylaxis. Not disclosing one's HIV status to someone aside from a partner was also associated with nonadherence in mother–infant pairs.

Conclusions: Sociodemographic factors, health services delivery factors, and a lack of communication and social support contributed to nonadherence to PMTCT prophylaxis in Rwanda.

Key Words: Africa, ARV, HIV, prevention of mother-to-child transmission, prophylaxis

(*J Acquir Immune Defic Syndr* 2009;50:223–230)

INTRODUCTION

The demonstration that short and inexpensive antiretroviral (ARV) regimens such as single-dose nevirapine (SD-NVP) administered prophylactically to both mothers and newborns significantly reduces mother-to-child transmission of HIV was a milestone in the HIV prevention field and offered hope for resource-poor countries struggling to combat HIV/AIDS.^{1,2} Since 2000, many resource-poor countries have scaled up prevention of mother-to-child transmission of HIV (PMTCT) programs.^{3–7} However, ensuring ARV prophylaxis uptake by mother and child, facility deliveries, follow-up of HIV-exposed infants, and enrollment of women in HIV care and treatment services remain challenging.^{3,8–12} A number of studies have assessed determinants of acceptance of HIV testing in antenatal care (ANC) settings,^{13–21} and others have explored factors associated to adherence to PMTCT ARV prophylaxis protocols.^{21–25} As these assessments were conducted as part of clinical trials or pilot programs, or were limited to a small number of purposively selected PMTCT sites, further information is needed to understand barriers to successful implementation of national PMTCT programs.

In Rwanda, the national PMTCT program was launched in 1999–2000 at 3 pilot sites.²⁶ Services have since scaled up rapidly with 285 public sector PMTCT sites operating at the end of 2007.⁷ National guidelines recommend that HIV testing and counseling be offered at the first ANC visit and that PMTCT counselors encourage partner testing. Pretest counseling is generally done in groups, whereas all women receive individual posttest counseling. Rapid tests are used at all sites. HIV-infected women are strongly encouraged to deliver in a health facility and to take ARV prophylaxis, which until late 2006 consisted of SD-NVP for women and infants. Women were provided with SD-NVP when they presented for ANC from the third trimester of pregnancy onward and were informed to take it at the onset of labor. SD-NVP for infants was available only at the facility at the time of or after delivery, and thus women who delivered at home were told to bring their

Received for publication May 30, 2008; accepted September 23, 2008.

From the *Department of Microbiology and Department of Public Health, Institute of Tropical Medicine, Antwerp, Belgium; †International Center for AIDS Care and Treatment Programs and Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY; ‡International Center for AIDS Care and Treatment Programs, Kigali, Rwanda; Centers for Disease Control and Prevention/Global AIDS Program, Rwanda (currently); and §Treatment and Research AIDS Center, Kigali, Rwanda.

Supported by a grant from PEPFAR's University Technical Assistance Program to the International Center for AIDS Care and Treatment Programs, Mailman School of Public, Columbia University.

Part of data were presented at the following: Reasons for and determinants of nonadherence to the PMTCT program in Rwanda 2007; HIV/AIDS Implementers' meeting, June 16–19, 2007, Kigali, Rwanda. (Delvaux T, Elul B, Munyana E, Ndagije F, Roberfroid D, Nizeyimana V, Sahabo R) and Factors associated with adherence to PMTCT program in Rwanda; 2nd National Conference on Paediatric Treatment, Care, and Support of children infected and affected by HIV, November 19–21, 2006, Kigali, Rwanda. Abstract 3.2. (Munyana E, Delvaux T, Ndagije F, Roberfroid D, Nizeyimana V, Mugisha V, Sahabo R, Elul B).

Correspondence to: Thérèse Delvaux, MD, MPH, HIV/STI Epidemiology and Control Unit, Department of Microbiology, Institute of Tropical Medicine, 155 Nationalestraat, B-2000 Antwerp, Belgium (e-mail: tdelvaux@itg.be).
Copyright © 2009 by Lippincott Williams & Wilkins

newborns to the facility within 72 hours of birth. Routine monitoring data for 2005 showed that of the approximately 200,000 women receiving ANC, 96% were counseled about HIV testing and 90% underwent testing.²⁷ However, nationally, only 47% of HIV-infected women identified in PMTCT had facility deliveries, and only 54% were documented to have taken the drug. Similarly, only 58% of the children born to HIV-infected women were reported to have ingested SD-NVP.²⁷ As more complex PMTCT regimens for mothers and newborns alike are currently being rolled out and are expected to be accompanied by many on-the-ground challenges, it is important to highlight lessons learned with regard to access, uptake, and ultimately adherence to the complete PMTCT package. To this end, we describe experiences, and identify factors associated with nonadherence to a SD-NVP regimen among HIV-positive women receiving ANC services in Rwanda.

METHODS

In April to May 2006, we conducted a case-control study in which HIV-infected women who did not adhere to the PMTCT ARV prophylaxis protocol were considered cases and those who adhered were considered controls. Nonadherence was defined as mother and/or baby not ingesting SD-NVP at all or not at the recommended time. Adherence was defined as mother–infant pairs who ingested SD-NVP at the recommended time.

Study Sites

The study was conducted in 12 public sector health facilities providing PMTCT services. Using 2005 aggregate PMTCT data collected by the Ministry of Health,²⁷ we first selected all PMTCT sites which had been offering PMTCT services since January 1, 2005 or earlier, and were expected to have sufficient numbers of HIV-infected women to meet site sampling requirements of 10 cases and 10 controls, resulting in a site sampling frame of 79 sites. We then randomly selected 4 sites per region (ie, Kigali or capital region, northeast and southwest) stratifying by level of development (ie, urban vs. rural) and performance (ie, higher vs. lower performance) within each region. “Higher” or “lower” performing sites were defined according to the available routine PMTCT indicator collected by the program, “> or ≤80% of women delivering at health facility ingested SD-NVP.”

Study Participants

We aimed to recruit a total of 120 HIV-infected women who did not adhere to the PMTCT ARV prophylaxis protocol (cases) and 120 who adhered to it (controls). Preexisting patient registers available in the PMTCT clinics were used to identify potential cases and controls who were 18 years or older and had either an estimated or confirmed date of delivery in the 12 months preceding data collection. The names of the first 10 nonadherent and 10 adherent women were provided to site staff, otherwise unaffiliated with the study, who contacted women at their homes. When the information in the registers was not adequate to trace women, the assistance of the local association of people living with HIV/AIDS was enlisted. Adherence status was ultimately confirmed during the interviews by women’s self-report. If a selected woman could not

be located ($n = 28$ for cases and $n = 2$ for controls), the next woman in the same adherence subcategory was selected from the patient registers. None of the women invited to participate refused to be interviewed. Participating women received 1000 Rwandan Franc (approximately US \$1.8) to cover transportation costs to the health facility.

Data Collection, Management, and Analysis

Trained interviewers completed closed-ended interviews with HIV-infected women using a pretested questionnaire translated in Kinyarwanda. Issues covered by the questionnaire included sociodemographic characteristics, experiences with ANC services, HIV testing and delivery, and ARV prophylaxis. Data were double entered into an Access database, and analysis was done using SPSS Version 14.0. Bivariate analysis, χ^2 test, Student *t* test, and Mann–Whitney *U* test were used as appropriate to test for differences in sociodemographic factors, ANC, delivery, and prophylaxis uptake experiences between nonadherent and adherent women. For multivariate analysis, we considered receipt of SD-NVP and delivery in a health facility as intermediate variables in the pathway to both maternal and infant adherence and thus did not treat these variables as potential determinants of adherence. Rather, logistic regression models were fit for each of the following dependent variable: receipt of SD-NVP (model 1); delivery in a health facility (model 2); adherence among mother–infant pairs (model 3); adherence among women alone (model 4); and adherence among infants alone (model 5). Variables significant at the 0.10 level in bivariate analyses were entered in each multivariate model, which also controlled for respondent’s age and study site, after testing for colinearity and for interaction terms. Model fit was assessed with the likelihood ratio test using a stepwise backwards procedure.

Ethical Considerations

The study protocol was approved by the Research Committee of the Commission Nationale de Lutte contre le SIDA (CNLS) and by the Institutional Review Boards at Columbia University and the Institute of Tropical Medicine, Antwerp, Belgium. All participants provided written informed consent before interview.

RESULTS

Characteristics of Participants

A total of 236 HIV-infected women—111 who did not adhere to the SD-NVP protocol and 125 who did—were interviewed (Fig. 1). HIV-infected women interviewed averaged 30 years of age and 3 living children (Table 1). About three quarters of women were married or in a consensual union at the time of data collection and were agricultural workers, as were 69% of their partners. About half were affiliated with Catholic and Protestant churches. Only 3% of respondents had electricity at home and 36% had a functioning radio. No significant differences in respondents’ age, number of living children, marital status, occupation, religious affiliation, and socioeconomic status were observed between adherent and nonadherent women. Nonadherent women, however, were less educated than adherent women (32% vs.

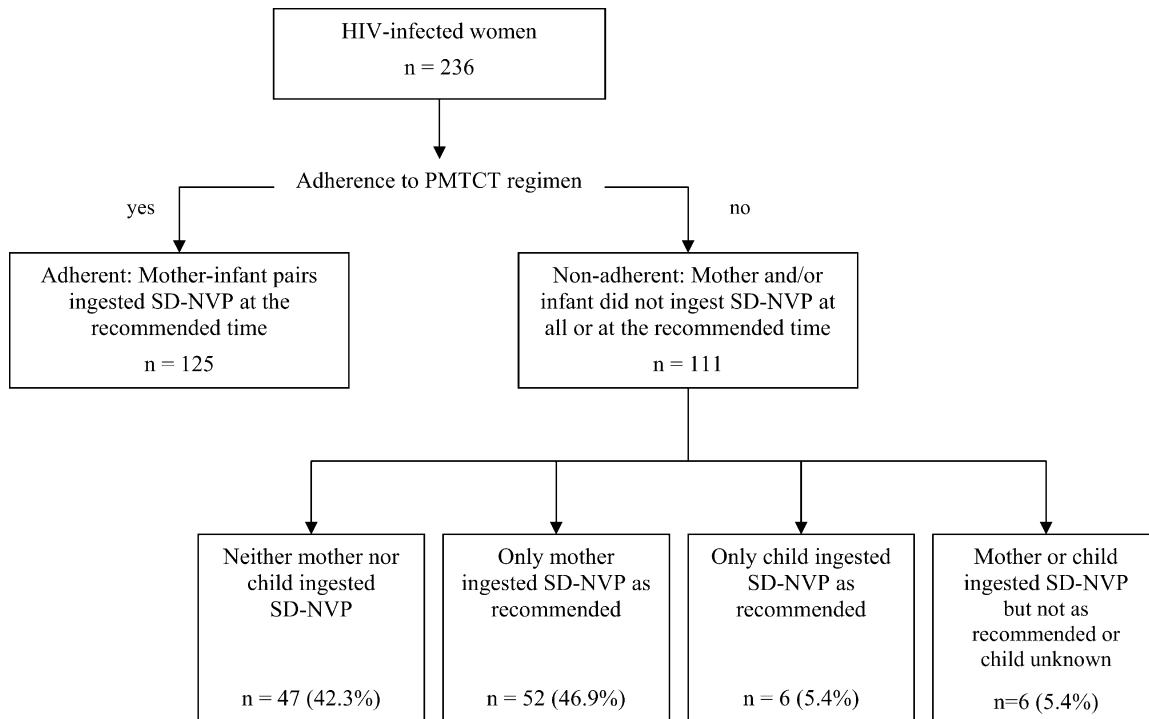


FIGURE 1. Number of women by adherence status and types of nonadherence.

17% had no schooling, $P = 0.02$) and were also more likely to live in smaller households (5.1 vs. 5.7, $P = 0.02$).

Experiences With Antenatal Care and HIV Testing

Nonadherent women made fewer ANC visits (2.5 vs. 3.1, $P < 0.001$) and were more likely to present at later gestational ages (6.0 vs. 5.0 months, $P = 0.05$) than adherent women (Table 2). Although nonadherent women were marginally less likely to be offered HIV testing at their first ANC visit (88% vs. 95%), most women (97%) in both groups were encouraged to return for additional ANC. About 10% of both groups reported feeling pressured to get tested by health facility staff. Disclosure rates to partners were high in both groups but tended to be lower among nonadherent women (79% vs. 88%, $P = 0.07$). Disclosure rates to family, friends, or others were significantly lower (62% vs. 82%, $P < 0.001$) among women who did not adhere to the SD-NVP protocol. Only 39% of partners of nonadherent women were tested during the index pregnancy compared with 54% of adherent women. Nonadherent women more often reported being unaware of their partner's HIV status (47% vs. 34%) and having an HIV-uninfected partner (25% vs. 17%) than adherent women ($P = 0.004$). The majority of all women (>87%) were well aware that HIV could be transmitted from mother-to-child during labor, delivery, and breastfeeding regardless of their adherence status. Most women (>95%) reported that a health worker discussed the risks of mother-to-child-transmission when they received their HIV test results and/or at another ANC visit. Nonadherent women, however,

were less likely to report that they trusted the ANC staff “very much” compared with adherent women (84% vs. 93%, $P = 0.01$).

Adherence to the ARV Prophylaxis and Place of Delivery

With regard to the type of nonadherence to PMTCT prophylaxis, about half (47%) of nonadherent women reported that they had ingested SD-NVP but that their infants had not (Fig. 1). Another large group (42%), however, reported that neither they nor their newborns ingested it. Just more than 5% of cases women noted that only their child had taken it. A similar proportion indicated that either they or their child had taken it but not at the recommended time or that child uptake was unknown.

Although all adherent women received SD-NVP from a health worker either during their pregnancy (92%) or at delivery (8%), just 60% of nonadherent women reported receiving it before the expected delivery and only an additional 1% at delivery (Table 3). A number of nonadherent women did not return to ANC and/or reportedly delivered before they were able to obtain the ARV prophylaxis. Even among the nonadherent women who delivered in a health facility, however, only 39% received it, with a great variability per site (0%–100%). Most women (94%) who received SD-NVP during pregnancy or delivery, whether they adhered or not to the PMTCT protocol, indicated that the health worker's explanation regarding drug ingestion was clear. A majority (>75%) discussed whether or not to take it with their partners. Discussion about PMTCT prophylaxis with family, friends, or others was less common among nonadherent women (53% vs. 71% among adherent women, $P = 0.01$). About two thirds

TABLE 1. Sociodemographic Characteristics of Study Participants by Adherence Status

	Nonadherent n = 111		Adherent n = 125		P
	n	%	n	%	
Age in years, mean (SD)	29.8 (6.0)		30.7 (5.7)		0.200
No. living children					
0–1	18	16.2	20	16.0	0.789
2–3	55	49.5	57	45.6	
≥4	38	34.2	48	38.4	
Marital status					
Married/consensual union	78	70.3	95	76.0	0.136
Single	17	15.3	9	7.2	
Divorced/separated/widowed	16	14.4	21	16.8	
Education level (yrs)					
None (0)	36	32.4	21	16.8	0.022
Very low (0–3)	24	21.6	24	19.2	
Primary school (4–6)	34	30.6	54	43.2	
Higher (>6)	17	15.3	26	20.8	
Occupation					
Housewife/unemployed	12	10.9	18	14.6	0.800
Unskilled labor	12	10.9	11	8.9	
Subsistence agricultural worker	82	74.5	91	74.0	
Skilled labor/professional	4	3.6	3	2.4	
Partner occupation					
Unemployed	1	1.3	0	0.0	0.630
Unskilled labor	13	16.7	18	19.4	
Subsistence agricultural worker	52	66.7	56	60.2	
Skilled labor/professional	12	15.4	19	20.4	
Religion					
Catholic/Protestant	56	50.5	53	42.4	0.230
Evangelical churches (Pentecostal)	31	27.9	37	29.6	
Adventist/Muslim	18	16.2	31	24.8	
None	6	5.4	4	3.2	
Number of people in household (including respondent), mean (SD)	5.1 (1.5)		5.7 (2.4)		0.023
Socioeconomic status*					
Lower	57	52.8	57	47.5	0.426
Higher	51	47.2	63	52.5	

*Score combining means of lighting and ownership of functioning radio.

(66%) of women reported waiting for their husband's permission before making a decision regarding ARV prophylaxis uptake, and most women noted that their partners were supportive (~85%) of their taking it. However, a larger proportion of nonadherent women reported that their partners were not supportive (9% vs. 1% among adherent women, $P = 0.053$).

Although almost all (>99%) adherent and nonadherent women were advised to deliver in a health facility, far fewer nonadherent than adherent women did so (28% vs. 86%, $P < 0.001$). Ultimately, all adherent women (per definition) ingested SD-NVP at the recommended time, and 80% of nonadherent women who received SD-NVP did so, representing 49% of all nonadherent women. Nonadherent women who received the ARV prophylaxis but did not take it said this was because they forgot (30%) or were afraid (30%), their labor had progressed too quickly (20%), or their husband or someone else was present (and presumably was unaware of their HIV status) (20%). Among women who ingested SD-NVP, the

majority, but significantly fewer nonadherent than adherent women, reported taking it at the onset of labor (58% vs. 70%, $P = 0.04$). Women who ingested the drug at another point before, during, or after their delivery explained that this was because they had been instructed to do so by a health worker (40%), their labor occurred too quickly or they had not realized they were in labor (25%), they had not received specific instructions about when to take the ARV prophylaxis (17%), or because they had simply forgotten to take it then (14%).

Only 7% of infants born to nonadherent women ingested SD-NVP. Among the nonadherent women who delivered outside a health facility, only 15% said that they or a family member brought the newborn to the health facility for SD-NVP ingestion, and in most of these cases (67%), this occurred beyond the recommended period for infant ingestion. As reasons for the child not being brought to health facility, nonadherent women most often indicated that they were not aware the child was supposed to come to the health facility

TABLE 2. ANC, HIV Testing, and PMTCT Counseling Experiences by Adherence Status

	Nonadherent n = 111		Adherent n = 125		P
	n	%	n	%	
ANC					
No. ANC visits					
1	23	20.7	10	8.0	0.008
2–3	68	59.5	76	60.8	
≥4	22	19.8	39	31.2	
Gestational age at first ANC visit in months, median (range)	6.0 (2–9)		5.0 (1–6)		0.050
HIV testing					
Timing of HIV test					
First ANC visit	98	88.3	119	95.2	0.051
Other ANC visit	11	9.9	2	1.6	
Tested before index pregnancy	2	1.8	4	3.2	
Felt pressured to get tested	16	14.4	12	9.6	0.250
Disclosed results to husband/partner	88	79.3	110	88.0	0.070
Disclosed results to someone else	69	62.2	103	82.4	<0.001
Was asked to bring husband/partner for testing	104	94.5	118	95.9	0.600
Husband/partner tested during pregnancy	43	38.7	68	54.4	0.016
Husband's/partner's HIV status					
Infected	31	27.9	61	48.8	0.004
Uninfected	28	25.2	21	16.8	
Not tested/unknown	52	46.8	43	34.4	
PMTCT counseling					
Health worker discussed MTCT risks	105	95.5	119	95.2	0.927
Knowledge regarding MTCT risks*					
During pregnancy	38	34.2	46	36.8	0.170
During labor and delivery	97	87.4	112	89.6	0.280
Through breastfeeding	98	88.3	116	92.8	0.230
Don't know/wrong answer	8	7.2	11	8.8	—
Trusted ANC staff "very much"	93	83.8	116	92.8	0.012

MTCT, mother-to-child transmission.

*May sum to more than 100% because of multiple responses.

(34%), were either ill, too weak, or did not have any assistance to bring the child (30%), or did not think the child could get HIV (27%). Only 15% of women mentioned that this was because the health facility was too far from their home.

In multivariate analysis, socioeconomic factors seemed to have little effect on women not receiving SD-NVP during pregnancy (model 1) or not delivering in a health facility (model 2) but exerted a stronger influence on nonadherence to the ARV prophylaxis protocol (Table 4). Unmarried women, women with no or little education, were significantly more likely to report that they or their child did not ingest SD-NVP at all or at the recommended time (model 3). Low education level was similarly associated with maternal nonadherence (model 4). Women making 2 or less ANC visits during pregnancy (as opposed to making 3 or more visits) were more likely to not receive SD-NVP during pregnancy, not deliver in a health facility, and adhere as well as their child to ARV prophylaxis (models 1–4). Women who were not offered HIV testing at first ANC visit were significantly more likely to not receive SD-NVP before delivery and to report that they and/or their newborn had not adhered to the PMTCT protocol or that they alone had not adhered (models 1, 3, and 4). Women whose partners were not tested during their pregnancy were

less likely to receive SD-NVP and to ingest it (models 1 and 4). Not disclosing one's HIV status to someone other than a partner was associated with nonadherence in mother–infant pairs and in newborns alone (models 3 and 5). Reporting that one's partner was uninfected was marginally significantly associated with mother–infant pair adherence (model 3). Maternal nonadherence was also strongly predictive of newborn nonadherence.

DISCUSSION

In this study, we described experiences with PMTCT services among HIV-infected women in 12 public sector PMTCT sites in Rwanda and examined determinants of nonadherence to a SD-NVP ARV prophylaxis regimen. To our knowledge, this is the first study to explore determinants of adherence/nonadherence to PMTCT ARV prophylaxis in the context of a national program.

Our data suggest several bottlenecks in adherence to the ARV prophylaxis. First, over one third of nonadherent women never received the ARV prophylaxis from a health worker during their pregnancy despite all consulting for ANC at a site that provides PMTCT services. Multivariate analysis indicates that, among other factors, women who made 2 or less ANC

TABLE 3. Experiences With PMTCT Prophylaxis and Delivery by Adherence Status

	Nonadherent n = 111		Adherent n = 125		P
	n	%	n	%	
Receipt of and decision making regarding SD-NVP					
Received SD-NVP from health worker during pregnancy or delivery	68	61.3	125	100.0	<0.001
If received drugs, timing of receipt					
Upon receipt of HIV results	39	57.4	55	44.0	0.070
At another ANC visit/when husband was tested	28	41.2	60	48.0	
At/during delivery	1	1.5	10	8.0	
Among women who received SD-NVP during pregnancy	n = 67		n = 123		
Discussed taking PMTCT drugs with husband/partner	47	70.1	97	78.9	0.180
Discussed taking PMTCT drugs with someone else	36	52.9	89	71.2	0.010
Waited for husband's/partner's permission before making a decision	28	63.6	62	66.7	0.727
Husband's/partner's reaction regarding PMTCT drugs					
Supportive	39	82.2	81	85.3	0.053
Not supportive	4	8.9	1	1.1	
Indifferent	4	8.9	13	13.7	
Place of delivery					
Health facility	31	28.2	108	86.4	<0.001
Respondent's or family member's home	72	65.4	15	12.0	
En route to health center	8	6.4	2	1.6	
Maternal ingestion of SD-NVP					
Ingested at recommended time					
Among all women	54	48.6	125	100.0	<0.001
Among those who received it at any point during pregnancy/delivery	54	79.8	125	100.0	<0.001
If woman ever ingested SD-NVP, timing of ingestion					
When labor started	33	57.9	88	70.4	0.036
Later during labor	21	36.8	37	29.6	
After delivery	1	1.8	0	0.0	
Before labor started	2	3.5	0	0.0	
Newborn ingestion of SD-NVP					
Ingested at recommended time	8	7.2	125	100.0	<0.001
If woman delivered outside healthy facility, newborn brought to health facility for SD-NVP	n = 79		n = 17		
If newborn brought to health facility for SD-NVP, timing of newborn's visit					
Day of delivery	2	16.7	9	52.8	<0.001
1 day after delivery	1	8.3	8	47.1	
2 days after delivery	1	8.3	0	0.0	
≥3 days after delivery	8	66.7	0	0.0	

visits were less likely to receive SD-NVP before their expected date of delivery. Second, despite universal recommendations to deliver in a health facility where ingestion of the ARV prophylaxis can be monitored, only 28% of nonadherent did so. Home birth was also shown as a factor associated with maternal nonadherence to SD-NVP among women participating in a PMTCT program in Zambia.²² Multivariate analysis suggests that socioeconomic factors had little effect on the ultimate place of delivery. Making 2 or fewer ANC visits, however, was strongly associated with not delivering in a health facility. Women who made few ANC visits had indeed fewer opportunities for health workers to reinforce the importance of delivering in a health facility. It might also reflect suboptimal utilization of all formal health care services

among nonadherent women. Problematic interactions between providers and clients were previously cited as a barrier to adherence to the complete PMTCT protocol for some HIV-infected women in Côte d'Ivoire.²⁸ In our study, although nonadherent women were somewhat less likely to report that they highly trusted ANC staff, this factor was not significantly associated with adherence after adjusting for confounders in logistic regression. Third, even among women who delivered in a health facility, ingestion of SD-NVP by mother and child was not fully achieved. It is important to understand the circumstances of such missed opportunities.¹⁰

Multivariate analysis suggests that in addition to health-seeking behaviors and service delivery factors, socio-demographic factors and social support also impacted whether

TABLE 4. Adjusted Odds Ratios of not Receiving SD-NVP During Pregnancy, not Delivering in a Health Facility, and not Adhering to the PMTCT Protocol (ie, Ingesting SD-NVP)

Model	1		2		3		4		5	
	Did Not Receive SD-NVP Before Expected Date of Delivery (n = 236)		Did Not Deliver in a Health Facility (n = 226)		Mother and/or Infant Did Not Ingest SD-NVP at All or at the Recommended Time (n = 236)		Mother Did Not Ingest SD-NVP at All or at the Recommended Time (n = 236)		Infant Did Not Ingest SD-NVP at All or at the Recommended Time (n = 233)	
Outcome	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Covariates										
Marital status										
Unmarried (vs. married)	—	—	—	—	2.3	1.1 to 4.8	—	—	—	—
Education										
None/<3 years (vs. more)	—	—	—	—	2.3	1.2 to 4.4	2.7	1.3 to 5.6	—	—
Religious affiliation										
Catholic/Protestant (vs. other)	—	—	2.5	1.3 to 5.0	—	—	—	—	—	—
No. ANC visits										
≤2 (vs. ≥3)	2.2	1.1 to 4.6	3.0	1.5 to 5.8	4.5	2.3 to 8.8	4.2	2.0 to 8.8	—	—
Time HIV test was offered										
After first ANC visit (vs. at first ANC visit)	4.6	1.3 to 15.4	—	—	3.9	1.2 to 12.9	8.6	2.5 to 29.7	—	—
Partner tested during pregnancy										
No (vs. yes)	2.1	1.03 to 4.4	—	—	—	—	2.7	1.3 to 5.8	—	—
Partner's HIV status										
Negative (vs. positive or unknown)	—	—	—	—	2.2	1.0 to 4.7	—	—	—	—
Disclosed test results to someone other than partner										
No (vs. yes)	—	—	—	—	2.8	1.4 to 5.8	—	—	2.7	1.3 to 5.6
Received SD-NVP before expected date of delivery										
No (vs. yes)	—	—	2.7	1.2 to 5.8	—	—	—	—	—	—
Mother ingested SD-NVP at the recommended time										
No (vs. yes)	—	—	—	—	—	—	—	—	17.1	6.8 to 42.6
Age										
<30 (vs. ≥30)	1.3	0.7 to 2.7	0.9	0.5 to 1.7	0.7	0.4 to 1.3	0.8	0.4 to 1.6	0.9	0.5 to 1.7
Health facility	0.012	—	0.041	—	0.4	—	—	0.7	0.4	—

CI, confidence interval; OR, odds ratio.

mother–infant pairs ultimately ingested the ARV prophylaxis. Low levels of education, being unmarried, and not having disclosed one’s test results to someone other than a partner were all independently associated with nonadherence among mother–infant pairs. Lower education level has previously been shown as a factor associated with nonacceptability to HIV testing,¹⁸ maternal nonparticipation in, or nonadherence to PMTCT.^{21,22–24} Schooling may impact on adherence in several ways including facilitating communication with health workers, increasing retention of information provided by health workers, and enhancing implementation of the recommendations regarding ingestion of the ARV prophylaxis. The effects of marital status and HIV disclosure to someone aside from one’s partner on maternal–infant adherence highlight the importance of communication and social support. Discussion of HIV screening with partner, partner willingness to have HIV testing, or being effectively tested for HIV have been shown as predictors of acceptance of HIV

testing by pregnant women^{16,20,23} and of compliance with SD-NVP uptake.^{22,23}

Finally, only 15% of infants born at home were brought to a health facility for ingestion of SD-NVP. This is in line with data from rural Malawi showing that although 60% of women who delivered at home ingested SD-NVP, none of their babies were brought to the health facility to receive prophylaxis.²⁵ To overcome this problem, a number of PMTCT programs are providing the SD-NVP infant’s dose during pregnancy and most programs are trying to increase health facility delivery rates.

Our study presented some limitations. First, some of the HIV-infected women believed to be nonadherent to the national PMTCT protocol (according to available information in the site’s registers) could not be located. It is possible that the sociodemographic profiles and health-seeking behaviors of these women differ from those of the women interviewed and thus that our sample of nonadherent women might not be

representative of all such women. Unfortunately, we had no information regarding the women lost to follow-up. Second, as women interviewed had delivered their last pregnancy on average 5.5 months before data collection, we cannot rule out the possibility of recall bias, but if existing, this bias should be balanced among cases and controls.

In light of our findings, we suggest that when SD-NVP is used as PMTCT prophylaxis (alone or coupled with azidothymidine), it should be distributed to mothers at their first ANC visit, regardless of gestational age. Additional training to ensure that gestational dating is accurate and active tracing of women who do not come back to ANC might also help ensure that women do not deliver without receiving any PMTCT prophylaxis. ANC staff should make sure that messages, particularly those regarding timing of drug ingestion, are clear even to less educated women, and that counseling regarding disclosure during pregnancy is enhanced. Providing SD-NVP infant's dose during the pregnancy has also to be considered. Finally, it is important to ensure that pregnant women, including HIV-positive women, attend an adequate number of quality ANC visits and to increase accessibility to delivery in a health facility. To this end, overall improvement in access to and of quality of maternity care services are needed.

ACKNOWLEDGMENTS

We thank Deborah Horowitz, Vianney Nizeyimana, Njero Micheu, and Joseph Ntaganira for assistance with interviewer training and data collection and Jonathan Gordin, Veronica Mugisha, and Cedric Yambabariye for inputs related to data management. We are grateful to Anne Buvé and Joris Menten for helpful comments regarding data analysis and interpretation. We also thank the Titulaires de Santé at the participating clinics and the 12 interviewers for their contributions.

REFERENCES

- Guay LA, Musoke P, Fleming T, et al. Intrapartum and neonatal single-dose nevirapine compared with zidovudine for prevention of mother-to-child transmission of HIV-1 in Kampala, Uganda: HIVNET 012 randomised trial. *Lancet*. 1999;354:795–802.
- De Cock KM, Fowler MG, Mercier E, et al. Prevention of mother-to-child HIV transmission in resource-poor countries: translating research into policy and practice. *JAMA*. 2000;283:1175–1182.
- WHO, UNAIDS, UNICEF. *Towards Universal Access. Scaling Up Priority HIV/AIDS Interventions in the Health Sector. Progress Report*. Geneva, Switzerland: World Health Organization; 2007.
- Centers for Disease Control and Prevention (CDC). Introduction of routine HIV testing in prenatal care—Botswana, 2004. *Morb Mortal Wkly Rep*. 2004;53:1083–1086.
- Tarwireyi F. Implementation of the prevention of mother-to-child transmission of HIV programme in Zimbabwe: achievements and challenges. *Cent Afr J Med*. 2004;50:95–100.
- Welty TK, Bulters M, Welty ER, et al. Integrating prevention of mother-to-child HIV transmission into routine antenatal care: the key to program expansion in Cameroon. *J Acquir Immune Defic Syndr*. 2005;40:486–493.
- Treatment and Research AIDS Center (Ministry of Health, Rwanda). *Rapport Annuel du TRAC 2007*. Available at: http://www.tracrwanda.org.rw/reports_pdf/TRAC_RAPPORT_ANNUEL_2007.pdf. Accessed on November 21, 2008.
- Stringer EM, Sinkala M, Stringer JSA, et al. Prevention of mother-to-child transmission of HIV in Africa: successes and challenges in scaling-up a nevirapine-based program in Lusaka, Zambia. *AIDS*. 2003;17:1377–1382.
- van't Hoog AH, Mbori-Ngacha DA, Marum LH, et al. Preventing mother-to-child transmission of HIV in Western Kenya: operational issues. *J Acquir Immune Defic Syndr*. 2005;40:344–349.
- Urban M, Chersich M. Acceptability and utilisation of voluntary HIV testing and nevirapine to reduce mother-to-child transmission of HIV-1 integrated into routine clinical care. *S Afr Med J*. 2004;94:362–366.
- Manzi M, Zachariah R, Teck R, et al. High acceptability of voluntary counselling and HIV-testing but unacceptable loss to follow up in a prevention of mother-to-child HIV transmission programme in rural Malawi: scaling-up requires a different way of acting. *Trop Med Int Health*. 2005;10:1242–1250.
- Perez F, Mukotekwa T, Miller A, et al. Implementing a rural programme of prevention of mother-to-child transmission of HIV in Zimbabwe: first 18 months of experience. *Trop Med Int Health*. 2004;9:774–783.
- Kowalczyk J, Jolly P, Karita E, et al. Voluntary counseling and testing for HIV among pregnant women presenting in labor in Kigali, Rwanda. *J Acquir Immune Defic Syndr*. 2002;31:408–415.
- Pignatelli S, Simpore J, Virginio P, et al. Factors predicting uptake of voluntary counselling and testing in a real-life setting in mother-and-child center in Ouagadougou, Burkina Faso. *Trop Med Int Health*. 2006;11:350–357.
- De Paoli MM, Manongi R, Klepp KI. Factors influencing acceptability of voluntary counselling and HIV-testing among pregnant women in Northern Tanzania. *AIDS Care*. 2004;16:411–425.
- Sarker M, Sanou A, Snow R, et al. Determinants of HIV counselling and testing participation in a prevention of mother-to-child transmission programme in rural Burkina Faso. *Trop Med Int Health*. 2007;12:1475–1483.
- Bajunirwe F, Muzoora M. Barriers to the implementation of programs for the prevention of mother-to-child transmission of HIV: a cross-sectional survey in rural and urban Uganda. *AIDS Res Ther*. 2005;2:10.
- Perez F, Zvandziva C, Engelsmann B, et al. Acceptability of routine HIV testing (opt-out) in antenatal services in two rural districts of Zimbabwe. *J Acquir Immune Defic Syndr*. 2006;41:514–520.
- Weistheimer EF, Urassa W, Msamanga G, et al. Acceptance of HIV testing among pregnant women in Dar-es-Salaam, Tanzania. *J Acquir Immune Defic Syndr*. 2004;37:1197–1205.
- Brou H, Djohan G, Becquet R, et al and ANRS 1201/1202/1253 Ditrane Plus Study Group. When do HIV-infected women disclose their HIV status to their male partner and why? A study in a PMTCT programme, Abidjan. *PLoS Med*. 2007;4:e342.
- Ekouevi DK, Leroy V, Viho I, et al. Acceptability and uptake of a package to prevent mother-to-child transmission using rapid HIV testing in Abidjan, Côte d'Ivoire. *AIDS*. 2004;18:697–700.
- Albrecht S, Semrau K, Kasonde P, et al. Predictors of non adherence to single-dose nevirapine therapy for the prevention of mother-to-child HIV transmission. *J Acquir Immune Defic Syndr*. 2006;41:114–118.
- Kiarie JN, Kreiss JK, Richardson BA, et al. Compliance with antiretroviral regimens to prevent perinatal HIV-1 transmission in Kenya. *AIDS*. 2003;17:65–71.
- Painter TM, Diaby KL, Matia DM, et al. Sociodemographic factors associated with participation by HIV positive pregnant women in an intervention to prevent mother-to-child transmission of HIV in Côte d'Ivoire. *Int J STD AIDS*. 2005;16:237–242.
- Kasenga F, Hurtig AK, Emmelin M. Home deliveries: implications for adherence to nevirapine in a PMTCT programme in rural Malawi. *AIDS Care*. 2007;19:646–652.
- Rutenberg N, Baek C, Kalibala S, et al. *Evaluation of United Nations-Supported Pilot Projects for the Prevention of Mother-to-Child Transmission of HIV*. New York, NY: UNICEF; 2003.
- Treatment and Research AIDS Center (Ministry of Health, Rwanda). *TRAC Net Data, 2005*. Kigali, Rwanda: TRAC; 2006.
- Painter TM, Diaby KL, Matia DL, et al. Women's reasons for not participating in follow-up visits before starting short course antiretroviral prophylaxis for prevention of mother to child transmission of HIV: qualitative interview study. *BMJ*. 2004;329:543.