COMPLIANCE WITH AND OUTCOMES OF CD4-BASED NATIONAL GUIDELINES FOR PREVENTION OF MOTHER-TO-CHILD TRANSMISSION OF HIV FOR THAILAND, 2006-2007

Nipunporn Voramongkol[1], Thananda Naiwatanakul[2], Niramon Punsuwan[3], Nareeluck Kullerk[1], Rangsima Lolekha[2], Pattanasin Sarika[2], Somsak Pattarakulwanich[1] and Michelle S McConnell[2,4]

[1]Department of Health, Ministry of Public Health, Nonthaburi; [2]Global AIDS Program, Thailand/Asia Regional Office, Thailand Ministry of Public Health - US CD Collaboration, and CDC/Southeast Asia Regional Office, Nonthaburi; [3]Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, Nonthaburi, Thailand; [4]Global AIDS Program, Centers for Disease Control and Prevention, Atlanta, GA, USA

Abstract. The 2006 Thailand national prevention of mother-to-child transmission of HIV (PMTCT) guidelines recommended antiretroviral (ARV) regimen use during antenatal care (ANC) be based on CD4 results: highly active antiretroviral therapy (HAART) should be used for a CD4 <200 cells/mm^3 and zidovudine/single-dose nevirapine should be used for a CD4 count ≥200 cell/mm^3. We evaluated compliance with and outcomes of these guidelines. We conducted a retrospective chart review of HIV-infected women and their infants born during October 2006 - December 2007 at 27 hospitals in 11 provinces of Thailand. The infant HIV-infection status was determined using laboratory test results and death reports. Mother-infant pairs were classified as fully, partially, or non-compliant with PMTCT guidelines based on CD4 testing history and ARV received. Factors associated with compliance were analyzed using univariate and multivariate generalized estimating equations (GEE). Among 875 mother-infant pairs reviewed, 387 mothers (44%) had ANC CD4 testing done, of whom 75 (19%) had a CD4 count <200 cells/mm^3. Proportions of pairs fully, partially and non-compliant with guidelines were 38, 34 and 28%, respectively. A definitive infant HIV-infection status was determined in 578 infants (66%). The overall mother-to-child transmission (MTCT) rate was 5.1% [95% confidence interval (95%(CI): 3.8-6.9] and the MTCT rates for the fully, partially and non-compliant groups were 1.2% (95% CI: 0.4-3.3), 6.0% (95%CI: 3.7-9.5) and 9.5% (95% CI: 6.2-14.0; p<0.001). Factors associated

Correspondence: Thananda Naiwatanakul, Global AIDS Program, Thailand/Asia Regional Office, Thailand Ministry of Public Health - US CD Collaboration, and CDC/Southeast Asia Regional Office, Nonthaburi, Thailand. E-mail: tdm6@th.cdc.gov

Reprint request: Dr Nipunporn Voramongkol. E-mail: job8018@yahoo.com
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with compliance were: having ANC, awareness of the mothers' HIV status before delivery, and having first ANC prior to 24 weeks gestation. Compliance with the 2006 national PMTCT guidelines was low, and the MTCT rates were high among non-and partially compliant mother-infant pairs. The simplified PMTCT guidelines introduced in 2010, might increase compliance with and improve outcomes for Thailand's PMTCT program.

Keywords: PMTCT, HAART, early infant diagnosis, policy compliance, Thailand

INTRODUCTION

Thailand's national prevention of mother-to-child transmission of HIV (PMTCT) program was established in 1999 (Kanshana and Simonds, 2002). As of October 2010, 886 of 899 government hospitals (98%) were known to offered HIV counseling and routine voluntary HIV testing to all pregnant women (Department of Health, 2010). Services for HIV-infected pregnant women and their newborns included antiretroviral (ARV) therapy, a CD4 cell count test and infant formula for 18 months with counseling regarding the use of clean water and safe infant feeding, including avoidance of breastfeeding, and HIV testing for those infants (Department of Health, 2000). Approximately 800,000 women give birth each year in Thailand and the median HIV seroprevalences among pregnant women in 2008 and 2010 were 0.72% and 0.70%, respectively (Bureau of Epidemiology, 2010).

National recommendations for ARV prophylaxis regimens have evolved in Thailand. In 2000, zidovudine (ZDV) monotherapy for HIV-infected mothers and babies was recommended (Department of Health, 2000). In 2004, a combination of ZDV/intrapartum single dose nevirapine (SDNVP) was recommended for both mothers and babies (Department of Health, 2004). In 2006, CD4 cell count guided regimens were recommended: triple ARV therapy with nevirapine (NVP)-based highly active antiretroviral therapy (HAART) for a CD4 count <200 cells/mm^3 or ZDV/SDNVP for a CD4 count ≥200 cells/mm^3 with a 7-day post-partum "tail" regimen of ZDV/lamivudine (3TC) to prevent nevirapine (NVP) resistance in SDNVP exposed women (Department of Health, 2000, 2004, 2009). Early infant HIV testing using an in-house, polymerase chain reaction (PCR)-based nucleic acid test at 2 and 4 months of age is available free of charge at 14 reference laboratories throughout the country. HIV antibody tests are also offered at 12 and 18 months of age in hospital laboratories. If children test HIV-positive they are referred to the national antiretroviral therapy (ART) program (Department of Health, 2004).

Data from the national PMTCT program shows 93% of pregnant women had an HIV test and 70% of those who were HIV positive received ARV prophylaxis in 2002 (Amornwichet *et al*, 2002), and 95% of HIV positive pregnant women received ARV prophylaxis in 2008-2009 (UNGASS, 2010). A reduction in the mother-to-child transmission of HIV (MTCT) rate was seen from 19-30% during 1992-1994 (Shaffer *et al*, 1999) to 10% during 2001-2003 (Plipat *et al*, 2007). The MTCT rate for 2004-2008 was 3.1%-5.5% (Thai MOPH, unpublished data). However, there have been no recent systematic surveys to determine national PMTCT program outcomes.

In 2007 there was a change in the PMTCT program administration from the Ministry of Public Health (MOPH) to both the MOPH and the National Health Security Office (NHSO). The MOPH has leadership in policy and guideline development, training of health care personnel, monitoring and evaluation. The NHSO provides administration and funding for CD4 count testing, ARV, HIV PCR testing and medical care costs for HIV positive patients under the universal health care scheme for all Thai citizens. CD4 count testing and ARV reimbursment are also provided through other major health care insurance plans such as Social Security and Civil Service Benefit plans for private and government employees, respectively. These changes in the Thai national PMTCT program prompted a new assessment to inform policy and guideline development.

This study was conducted to determine compliance with and outcomes of national PMTCT guidelines, including CD4 count testing during ANC and ARV prophylaxis. We also assessed the effectiveness of the 2006 PMTCT guidelines.

MATERIALS AND METHODS

A retrospective, cross-sectional survey was conducted of a sampling of Thai HIV-infected pregnant women and their infants who delivered during October 2006 - December 2007 as identified by hospital delivery room logbooks. District, provincial and regional hospitals were convenience sampled from one province each of 11 of 12 health administrative regions in Thailand. The province in each of the 11 regions with the greatest number of HIV positive women who delivered per year was included in the survey. Within the selected provinces, all tertiary care (provincial and/or regional) hospitals and 2-3 community hospitals with the largest number of HIV-infected women delivering infants in that province (based on reports to the national PMTCT monitoring system, Department of Health, MOPH, in 2004) were selected. Twenty-seven public hospitals in 11 provinces of Thailand (Fig 1) were included in the survey.

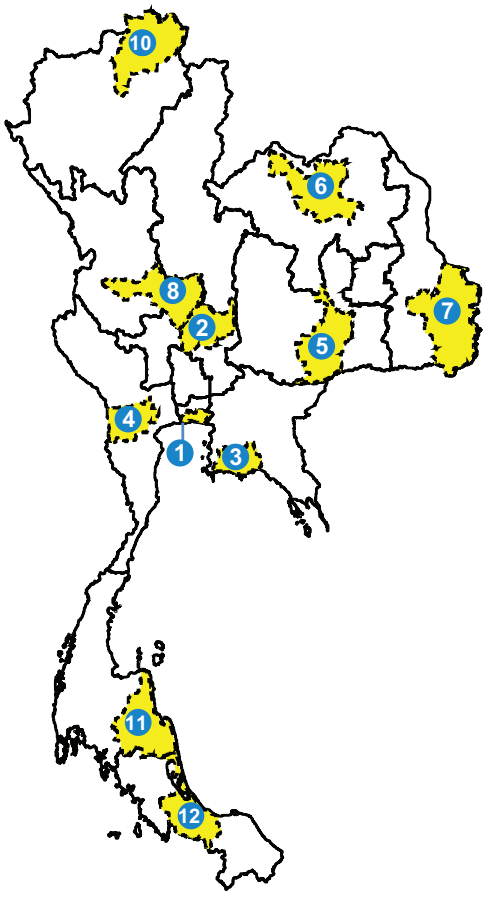

Fig 1–Sampled provinces containing 23 public hospitals included in the survey in 11/12 health administration regions that oversee PMTCT program implementation (dark line indicates boundary of each region and yellow highlight indicates provincial area).

The survey was conducted during March 2008 - July 2008, at least 3 months

after the last birth in the study cohort. This allowed time for at least 1 infant PCR test at 2 months of age to determine HIV status, according to Thai PCR testing guidelines. Data were abstracted from maternal and infant medical records to determine CD4 testing during pregnancy, prescription of ARV, infant HIV testing method and results, and death, if any.

Definition of compliance with the national PMTCT guidelines

Compliance with the national PMTCT guidelines was classified as fully, partially or non-compliance using two key criteria: CD4 cell count and the ARV or HAART regimen. Full compliance required meeting both components: an HIV-infected pregnant woman who had CD4 count testing during pregnancy and received a prescription for either HAART for herself with any CD4 count or ZDV/NVP or other combination regimen for herself and her baby if her CD4 count was ≥200 cells/mm.[3] Partial compliance was defined as an HIV-infected pregnant woman with an unknown CD4 status during pregnancy who received a prescription for either HAART or ZDV/SDNVP for both her and her baby. Women with a CD4 count <200 cells/mm^3 who received a prescription for ZDV/NVP were included in this group. Non-compliance was defined as an HIV-infected pregnant women with either a known or unknown CD4 count who received a prescription for ARV either during the intrapartum period only, during the antepartum period only, or only for the infant (some ARV). Unspecified regimens or no ARV were included in this group.

Classification of infant HIV-infection outcomes

The infant HIV-infection status definitions were modified from pediatric HIV treatment guidelines (National guidelines on HIV/AIDS diagnosis and Treatment: Thailand 2010). A child was diagnosed as HIV-uninfected if the HIV PCR at an age ≥1 month was negative, without any subsequent conflicting test results, or an HIV antibody test was negative. A child was diagnosed as HIV-infected if at least one HIV PCR tests was positive, without subsequent conflicting test results, or an HIV antibody test at age ≥18 months was positive. Children aged <18 months who died before laboratory confirmed HIV was diagnosed were presumed to have been HIV-infected.

Estimation of MTCT rates, number of HIV infections and number of HIV-infected women giving birth

MTCT rates with 95% confidence intervals were calculated using the above criteria. For the imputative analysis, HIV infection rates in infants with unknown HIV outcomes were assumed to be the same as those infants with known HIV outcome based on the same CD4 counts and ARV intervention groups (Plipat *et al*, 2007). Overall transmission rates were calculated as percentages, with 95% confidence intervals, using Microsoft Access and EpiInfo version 6 software. Estimates of HIV-infected women giving birth during the study period were based on the number of live births registered with the Ministry of Interior during the same period. Estimates of HIV prevalence among pregnant women were based on data from the HIV sentinel serosurveillance system of the Bureau of Epidemiology, MOPH, in 2007.

Proportional odds logistic regression was used to determine possible predictors of a three-level ordinal compliance scale (non-, partial- and full-compliance). The proportional odds assumption or parallel regression assumption was tested with the Brant test and had no violations in

our model. Potential factors associated with compliance with PMTCT guidelines (type of delivery hospital, history of ANC, awareness of the mother's HIV status, health insurance coverage, number of prior pregnancies, nationality, prior ARV treatment history, and gestational age at first ANC visit) were analyzed with proportional odds logistic regression with generalized estimating equations approach (GEE) using STATA v.11.0 (STATA Corp, College Station, TX) (Stata Data Analysis Examples Ordered Logistic Regression, 2013). All analyses were adjusted for type of delivery hospital, as there might be a cluster effect of providers' experiences and health care facilities. Potential associated variables with a *p*-value <0.10 were included in multivariate analysis using GEE to generate adjusted proportional odds ratios. Variables with a *p*-value <0.05 considered statistically significant.

This study was approved by the ethical review committees of the Thai MOPH and the US Centers for Disease Control and Prevention.

RESULTS

Demographic data and general information

During the survey period, an estimated 8,750 HIV-infected pregnant women gave birth in Thailand. We surveyed the cases of 875 HIV-infected women giving birth (approximately 10%) and their infants during this same period. The characteristics of the women sampled are shown in Table 1. Only 7% of HIV-infected pregnant women received ARV treatment before their pregnancy.

Overall compliance with the PMTCT program

Among the 875 HIV-infected pregnant women, 800 (91%) had ANC. During pregnancy, 387 (44%) were tested for CD4. The median antenatal CD4 count was 364 cells/mm^3 [(interquartile range (IQR), 236–539 cells/mm^3]. Seventy-five women (19%) who had a CD4 count tested had <200 cells/mm^3. ARV were given to 834 of the 875 HIV-infected mothers (95%) and 866 of the 872 live born babies (99%). Four hundred eighty-four of the HIV-infected pregnant women (55%) and their infants received ZDV/SDNVP, 148 (17%) received HAART, and 243 (28%) received other ARV during the intrapartum period only, during the antepartum period only, or for the infant only (some ARV).

Compliance with CD4 and ARV regimen recommendations for PMTCT 2006 national guidelines and factors associated with compliance

Three hundred thirty-four woman-infant pairs (38%) were fully compliant with the national PMTCT guidelines, 298 (34%) were partially compliant and 243 (28%) were non-compliant (Fig 2). Among the 148 women who were prescribed HAART, 61 (41%) had initiated treatment before their pregnancy. On GEE analysis adjusted for hospitals type, 8 factors were analyzed for possible association with compliance with the PMTCT guidelines. Of these, ANC at the delivery hospital, a maternal awareness of HIV status prior to or during pregnancy, having health insurance, being of Thai nationality and initiating ANC prior to 24 weeks gestation were associated with compliance. On proportional logistic regression analysis 4 factors remained associated with compliance. The odds of being in full compliance rather than in partial or non-compliance were significantly increased by having ANC at the delivery hospital, maternal awareness of HIV status prior to or during pregnancy, having health insurance and initiating ANC prior to 24 weeks gestation (Table 2).

Table 1
Characteristics of HIV-infected mothers (*N*=875) who delivered during October 2006 - December 2007 in 11 provinces, Thailand.

	No.	%
Median age (years)	28	
IQR age (years)	24-32	
Nationality		
Thai	836	95.7
Non-Thai (13 Burmese, 11 Lao, 11 Hill tribe, 4 Cambodian)	39	4.3
Marital status		
Married	799	91.3
Single (separation, husband died, single mother)	71	8.1
Unknown	5	0.6
Number of prior marriages (partners) including current one		
Median (min-max)	1 (1-5)	
Number of children		
Median (min-max)	2 (0-7)	
Health insurance coverage		
Yes	704	80.5
No	171	19.5
First pregnancy		
Yes	241	26.5
No	634	72.5
Antenatal care (ANC) history		
Had ANC	761	86.9
Had ANC but not at delivery hospital	39	4.5
No ANC/unknown	75	8.6
Antiretroviral treatment history before this pregnancy		
Yes	64	7.3
No/unknown	811	92.7
Gestational age at first ANC visit (weeks)		
Median	19	
IQR	12-26	
Place of delivery		
Tertiary care hospital	718	82.1
Community hospital	157	17.9
Mode of delivery		
Vaginal	625	71.4
Cesarean section	250	28.6
Delivery status		
Live birth	872	99.7
Still birth	3	0.3
Maternal awareness of HIV status		
Before this pregnancy	264	30.2
During ANC for this pregnancy	471	53.8
During delivery or postpartum	87	9.9
Unspecified	53	6.1

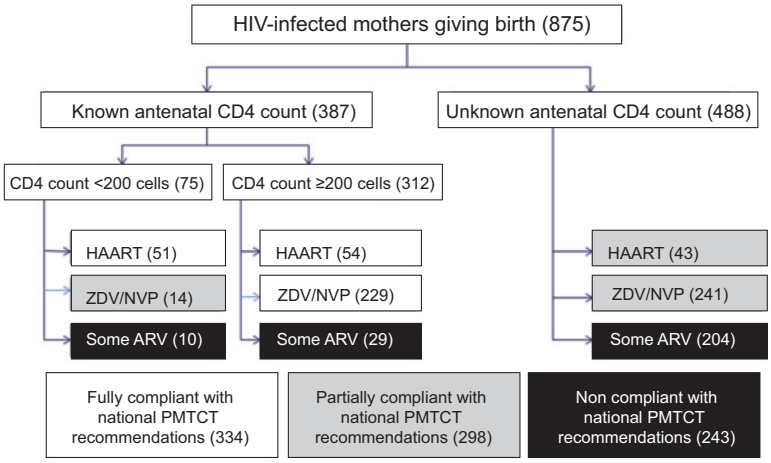

Fig 2–Compliance with 2006 national PMTCT guidelines by doctors caring for HIV-infected mothers and their infants during October 2006-31 December 2007 from 11 provinces in Thailand.

PMTCT program outcomes, effectiveness and MTC transmission of HIV rates

Of the 875 HIV-exposed infants, 578 (66%) had laboratory testing: 16 were HIV-positive and 562 were HIV-negative. Of the 297 infants who did not get laboratory testing, 11 (1%) were given a presumptive diagnosis of HIV because they died, 286 (33%) had an unknown HIV status due to loss to follow-up (94%) or inconclusive test results (6%). Of those 286 children, 18 were presumed to be HIV-infected based on clinical presentation. The MTCT rate was 4.6% (95% CI: 3.1-6.7) based on laboratory testing and deaths and was 5.1% (95%CI: 3.8-6.9) based on the above as well as a clinical diagnosis (Fig 3). The MTCT of HIV rates were significantly different among the fully, partially and non-compliant groups (Table 3). The MTCT rates among women with unknown CD4 count, a CD4 count <200 cells/mm^3 and a CD4 count ≥200 cells/mm^3 were significantly different (Table 3). The transmission rate among women who received HAART was not significantly different from those who received ZDV/SDNVP (2.0% *vs* 3.9%, p=0.27), but these were significantly lower (p<0.01) than those who received ARV during the intrapartum period only, during the antepartum period only or for the infant only.

DISCUSSION

This study assessed compliance with and outcomes of PMTCT guidelines that recommended CD4-based selection of ARV regimens for HIV-infected pregnant women. We found low compliance and high MTCT rates among mother-infant pairs who were not treated according to guidelines. A high use of PMTCT services at MOPH hospitals being associated with high ARV prophylaxis rates in HIV-infected mothers and their newborn babies has been reported previously (Amornwichet *et al*, 2002), but MTCT rates in non- and partially compliant women were higher than in fully compliant women in our study.

About half the HIV-infected pregnant

Table 2
Factors associated with level of compliance to national PMTCT guidelines.

	Compliance						OR (95% CI)[a]	*p*-value	AOR[b] (95% CI)[a]	*p*-value
	Non		Partial		Full					
	n	%	*n*	%	*n*	%				
Total (*N* = 875)	243		298		334					
Place of delivery										
Regional hospital	140	57.6	174	58.4	239	71.6	1.3 (0.7-2.4)	0.42	1.5 (0.8-3.0)	0.20
General hospital	57	23.5	70	23.5	38	11.4	0.7 (0.3-1.5)	0.33	0.6 (0.2-1.4)	0.21
Community hospital	46	18.9	54	18.1	57	17.1	1		1	
Antenatal care (ANC) history										
Yes, at delivery hospital	152	62.6	279	93.6	330	98.8	23.6 (10.9-51.2)	<0.001	8.8 (3.5-22.1)	<.001
Yes, at other hospitals	27	11.1	10	3.4	2	0.6	2.5 (1.1-5.6)	0.02	1.5 (0.6-3.8)	0.35
No ANC/unknown	64	26.3	9	3.0	2	0.6	1		1	
Awareness of maternal HIV status										
Previously known HIV status/during ANC	146	60.1	265	88.9	324	97.0	9.3 (6.3-13.6)	<0.001	3.9 (2.7-5.8)	<0.001
Knew during or after delivery/unspecified	97	39.9	33	11.1	10	3.0	1		1	
Health insurance coverage										
Yes	164	67.5	230	77.2	292	87.4	2.4 (1.6-3.6)	<0.001	1.6 (1.1-2.4)	0.02
No	79	32.5	68	22.8	42	12.6	1		1	
First pregnancy										
Yes	70	28.8	84	28.2	87	26.0	0.9 (0.7-1.2)	0.44		
No	173	71.2	214	71.8	247	74.0	1			
Nationality										
Thai	225	92.6	286	96.0	325	97.3	2.2 (1.2-4.1)	0.01	1.5 (0.9-2.4)	0.09
Non-Thai	18	7.4	12	4.0	9	2.7	1		1	
Prior ARV history before pregnancy										
Yes	195	80.2	217	72.8	261	78.1	1.0 (0.7-1.3)	0.80		
No/unknown	48	19.8	81	27.2	73	21.9	1			
Gestational age at first ANC visit										
<24 weeks	54	22.2	107	35.9	206	61.7	5.4 (2.7-10.7)	<0.001	2.6 (1.7-4.0)	<0.001
≥24 weeks	40	16.5	83	27.8	65	19.5	2.6 (1.3-5.1)	0.01	1.2 (0.8-1.9)	0.37
Unknown first gestation age	149	61.3	108	36.2	63	18.9	1		1	

[a]Genralized estimating equation (GEE) with exchangeable correlation structure, adjusted for hospital type.
[b]GEE adjusted for hospital type, antenatal care (ANC) history, awareness of maternal HIV status, health insurance coverage, nationality and gestational age at first ANC visit.
AOR, adjusted odds ratio
PMTCT, prevention of maternal to child transmission.

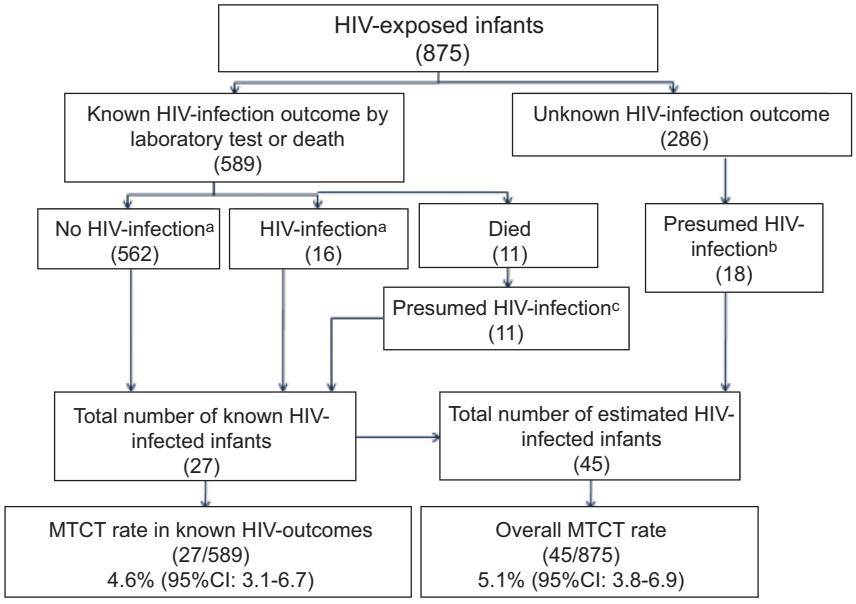

Fig 3–Outcomes among 875 HIV-exposed infant study subjects.

[a] A child was diagnosed as HIV-uninfected if HIV PCR result at age ≥ 1 month was negative, without any subsequent conflicting test results, or an HIV antibody test was negative. A child was diagnosed as HIV-infected if at least one HIV PCR test result was positive, without subsequent conflicting test results, or an HIV antibody test at age ≥ 18 months was positive.

[b] HIV infection rates among infants with unknown HIV outcomes were assumed to be the same as for infants with known HIV outcomes.

[c] Children aged <18 months who died before confirmed laboratory HIV diagnosis were presumed to have been HIV-infected.

women in our study did not have a CD4 count test, placing them in the partial or non-compliant groups. Although CD4 count testing is available through cost reimbursement with all major public health insurance schemes, the low uptake might be due to inadequate provider knowledge or some other reason not defined. In the concurrent study (data not shown), focus group discussions with PMTCT providers found good awareness of CD4 count guided ARV regimen guidelines but there were difficulties in managing the logistics of CD4 testing, obtaining reimbursement for CD4 testing, and getting tests for uninsured women. In 2007 CD4 count testing costs were transferred from a vertical program supported by the Department of Health to a national health insurance-supported system. Some women had other health insurance plans (*eg*, Social Security) or lacked health insurance. These might have contributed to challenges in obtaining reimbursement for CD4 testing.

The fact that some HIV-infected women did not receive HAART might be due to late ANC, late CD4 count testing, and/or lack of or late reporting of CD4 results. This is supported by the finding of women with a known CD4 count presenting earlier in their pregnancy for ANC. However, lack of knowledge among PMTCT care

Table 3
Mother-to-child transmission (MTCT) rates by maternal CD4 status, antiretroviral intervention and compliance with PMTCT guidelines in caring for HIV-positive mothers and their newborn babies delivering during October 2006 - December 2007 in 11 provinces in Thailand.

	N	No. HIV infections[a]	MTCT rates	95%CI	*p*-value
ARV intervention					
HAART	148	3	2.0%	0.5-6.3	<0.001
ZDV/SDNVP	484	19	3.9%	2.5-6.2	
Some ARVs	243	23	9.5%	6.2-14.0	
ANC CD4 (cell/mm^3)					
<200	75	4	5.3%	1.7-13.8	0.006
≥200	312	6	1.9%	0.8-4.4	
unknown	488	35	7.2%	5.1-9.9	
Compliance with PMTCT guidelines					
Fully compliant	334	4	1.2%	0.4-3.3	<0.001
Partially compliant	298	18	6.0%	3.7-9.5	
Non-compliant	243	23	9.5%	6.2-14.0	
Overall	875	45	5.1%	3.8-6.9	

[a]Estimated number of HIV infections from laboratory results, deaths and imputative analysis as described in method section.

providers about ARV regimens based on CD4 results cannot be excluded.

The MTCT rate was relatively low among mothers who received HAART irrespective of CD4 count, confirming the benefits of HAART for preventing MTCT (Cooper *et al*, 2002; Noel *et al*, 2008; Kouanda *et al*, 2012). The MTCT rates among women receiving HAART ranged from 0.5 to 6.3% in our study, similar to a previous study from South Africa (Hoffman *et al*, 2010). That South African study also found each additional week of treatment reduced the odds of transmission by 8% and women who conceived while taking HAART had a lower risk of MTCT than women who initiated HAART during pregnancy (0.7% *vs* 5.7%). The MTCT rate among women receiving HAART in our study suggests a delay in HAART initiation may be resulted from a delay in CD4 count testing and/or reporting. The delay in HAART initiation may also explain the non- significant difference in MTCT rates between the HAART and ZDV/SDNVP treatment groups in our study.

Women who delivered at their ANC hospital, knew their HIV status prior to or during pregnancy, who had their first ANC visit prior to 24 weeks gestation and were of Thai nationality were more likely to receive PMTCT service in compliance with the 2006 national guidelines. Women without ANC obviously had no opportunity to receive PMTCT services. Women who were either self- or hospital-referred might also have experienced gaps in HIV treatment, or access to treatment, before obtaining ANC services. Women who only

discovered their HIV status during or after delivery were more likely to receive care not in compliance with PMTCT policies and were more likely to have no or inadequate ANC. Some studies have found ANC rates among HIV-infected pregnant women are lower (88%) compared to all pregnant women (97-98%) (Amornwichet *et al*, 2002; National Statistic Office, 2008) while other studies found the rates similar between the two previous groups (87-90%) (Teeraratkul *et al*, 2005; Plipat *et al*, 2007). Self-reported major barriers to ANC in one study from Bangkok included financial problems, transportation problems, fear of HIV status disclosure and fear of blame or mistreatment at the clinic (Teeraratkul *et al*, 2005). Non-Thai women were less compliant with PMTCT guidelines in our study, possibly related to health insurance coverage. The NHSO covers only Thai citizens by law; some non-Thai women might also be illegal workers and not eligible to enroll in an insurance plan.

Among the women in our study who received HAART during ANC, 41% initiated HAART prior to their pregnancy; but 32% of eligible women did not receive HAART during their pregnancy. The finding that relatively few treatment eligible women initiated HAART during pregnancy suggests there are challenges in using CD4-guided selection of ARV prophylaxis regimens. This can have a negative impact on a woman's health and risk for MTCT of HIV. Anecdotal reports from ANC health care providers include concerns about administration of HAART in ANC as it is more complex than previous ZDV monotherapy or ZDV/SDNVP administered by ANC providers. Providers reported they were more likely to consult with internal medicine physicians or ARV clinics, delaying HAART initiation.

Findings from this evaluation were presented to key stakeholders, including senior MOPH policy makers, NHSO personnel, national Maternal and Child Health Board members and PMTCT experts (Thai AIDS Society) to address gaps in the program. Following this evaluation and cost-effectiveness studies of HAART among HIV-infected pregnant women, in 2010 the Thai MOPH revised the national guidelines to recommend HAART for all pregnant women, irrespective of CD4 count (Phanuphak *et al*, 2010, 2011). The new policy recommends one simplified regimen for all women, without using CD4 count criteria. This will hopefully reduce delays in ARV prophylaxis or treatment onset due to delays in CD4 count testing. Antenatal CD4 count results are still used to determine whether to continue or discontinue ARVs after delivery.

Limitations of this study include the fact the hospitals used were a convenience sample of regional/provincial, tertiary care and large community hospitals. Findings from this study are more likely to represent the services at tertiary care centers and larger size community hospitals where the majority of HIV-infected women deliver. Compliance with PMTCT guidelines in hospitals with fewer deliveries might be lower than our findings due to less experienced health care providers or limited resources at those facilities. No hospitals in Bangkok, where approximately 100,000 women give birth each year, were included in the study sites due to differences in jurisdiction and a more complex metropolitan health care system. Instead, we selected a province where an urbanized population is located. No private hospitals were included in this survey. Most private hospitals serve middle and high income populations and manage HIV-infected pregnant women with infec-

tious disease specialists or make referrals to government hospitals for PMTCT services. However, no data were obtained from private hospitals on HIV prevalence among pregnant women or use of PMTCT services. Another limitation of this study was a substantial proportion of children in this study (33%) had unknown HIV-infection outcomes. The MTCT rates imputed from a presumptive diagnosis and the ARV intervention group might have overestimated the overall transmission rate, particularly if the infant death was not due to HIV-infection (country infant mortality rate 7.2:1000; Bureau of Health Policy and Strategy, 2008).

In conclusion, recommendations for CD4 count-guided selection of ARV prophylaxis regimens in Thailand were not closely adhered to, and CD4 count testing during ANC was not routinely done, resulting in an overall high MTCT rate. Efforts to increase early access to ANC, HIV testing, and health insurance coverage should be made to ensure CD4 testing for HIV-infected pregnant women. While simplified HAART regimens for PMTCT might reduce the need for CD4-guided ARV regimen selection, effective clinical management and CD4 monitoring of HIV-infected pregnant women are still priorities for maternal and child health. Future studies need to assess the effectiveness of the national PMTCT program under the current, revised national guidelines for HIV-infected pregnant women.

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