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Antiretroviral Regimens in HIV-Infected Adults Receiving Medical Care in the United States: Medical Monitoring Project, 2009

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ANTIRETROVIRAL REGIMENS IN HIV-INFECTED ADULTS RECEIVING MEDICAL CARE IN THE UNITED STATES: MEDICAL MONITORING PROJECT, 2009

by

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ABSTRACT

Effective antiretroviral therapy (ART) is essential for viral suppression (VS) in HIV-infected patients. However, there is a lack of nationally representative data on types of ART regimens used and their impact on VS. This thesis used self-reported interview and abstracted medical record from 2009 Medical Monitoring Project (MMP) to study ART regimen type and related health outcomes. Results showed that 88.6% of HIV-infected adults in care was prescribed ART, and about half took regimens designated as 'preferred' according to U.S ART guidelines. Among MMP participants prescribed ART, 62.7% achieved durable VS, 77.8% achieved recent VS, 83.5% were 100% dose-adherent, and 17.1% reported side effects. Multivariate regression analyses revealed that although ART was critical for VS, there were minor differences in health outcomes among the major ART classes in the U.S. ART guidelines or six most-commonly used regimens. This study could be potentially useful for future strategic planning of HIV care.

INDEX WORDS: CDC, HIV, AIDS, MMP, Antiretroviral, ART, Survey, Viral load, Viral suppression, side effects, CD4 counts, Adherence, Prevalence ratio, PR

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LIST OF ABBREVIATIONS

3TC	Epivir, Lamivudine
ABC	Abacavir, Ziagen
ABC/3TC	Epzicom
ABC/3TC/AZT	Trizivir
AIDS	Acquired immunodeficiency syndrome
APV	Agenerase, Amprenavir
ATV	Atazanavir, Reyataz
AZT	Azidothymidine, Retrovir, ZDV, Zidovudine
AZT/3TC	Combivir
d4T	Stavudine, Zerit
ddC	Dideoxyinosine, Hivid, Zalcitabine
ddI	Didanosine, Dideoxycytidine, Videx
DLV	Delavirdine, Rescriptor
DRV	Darunavir, Prezista, TMC 114
EFV	Efavirenz, Sustiva
ETV	Etravirine, Intelence, TMC 125, ETR
FEI	Fusion/entry inhibitor
FPV	Fosamprenavir, FOS-APV
FPV	Lexiva
FTC	Emtricitabine, Emtriva
FTC/TDF	Truvada

FTC/TDF/EFV	Atripla
HIV	Human immunodeficiency virus
IDV	Indinavir, Crixivan
INI	Integrase inhibitor
LPVr	Lopinavir with Ritonavir boosted, Aluvia, Kaletra, Meltrex
MMP	Medical Monitoring Project
MVC	Celsentri, Celsentri, Maraviroc, Selzentry, UK-427857
NFV	Nelfinavir, Viracept
NNRTI	Non-nucleoside reverse transcriptase inhibitor
NRTI	Nucleoside analogue reverse transcriptase inhibitor
NTI	Reverse transcriptase inhibitor
NVP	Nevirapine, Viramune
PI	Protease inhibitor
RAL	Isentress, MK-0518, Raltegravir, RGV, MK-0518
RTV	Ritonavir, Norvir
SQV	Saquinavir, Fortovase, Invirase, SQV-HGC
T20	Enfuvirtide, Fuzeon
TDF	Tenofovir, Viread
TPV	Tipranavir, Aptivus

CHAPTER 1 INTRODUCTION

1.1 HIV/AIDS

1.1.1 Background on HIV/AIDS

Since 1981 when the first case of the acquired immunodeficiency syndrome (AIDS) was recognized by Centers for Disease Control and Prevention (CDC) in the United States [1], AIDS has caused nearly 30 million deaths as of 2009 [2]. AIDS is now the fourth-biggest killer globally. Up to 2010, approximately 34 million people were living with human immunodeficiency virus infection (HIV)—the cause of AIDS [3, 4]. AIDS is a pandemic—a disease that is actively spreading globally [5].

Genetic research has suggested that HIV originated in west-central Africa during the early twentieth century [6]. The initial stage after the contraction of HIV is called acute HIV, following by a period of clinical latency, it develops to chronic HIV. Without treatment, the clinical latency can last from about three years to over 20 years [7], with an average of about eight years. HIV will eventually progress to AIDS, defined by either a CD4+ T cell count below 200 cells/μL or the occurrence of specific diseases [8]. In 2008, CDC has updated the classification system for HIV into three stages based on CD4 count and clinical symptoms [9]:

Stage 1: CD4 count $\geq$ 500 cells/μL and no AIDS defining conditions

Stage 2: CD4 count 200 to 500 cells/μL and no AIDS defining conditions

Stage 3: CD4 count $\leq$ 200 cells/μL or AIDS defining conditions

Major transmission pathways of HIV include unprotected sexual intercourse, contaminated blood transfusions, and from mother to child through pregnancy, delivery, or breastfeeding [10]. Therefore, a key strategy for the prevention of HIV is to promote safe-sex behaviors and needle-exchange programs.

1.1.2 HIV/AIDS in the United States

1.1.2.1 Persons Living with a Diagnosis of HIV Infection

At the end of 2009, an estimated 1,148,200 persons aged 13 and older were living with HIV infection in the United States, including 207,600 (18.1%) persons whose infections had not been diagnosed [11]. The estimated number of persons living with a diagnosis of HIV infection in the 46 states and 5 U.S. dependent areas with confidential name-based HIV infection reporting was 803,771. In the 46 states only, this included 781,756 adults and adolescents, and 2,945 children aged less than 13 years at the end of the year [11].

1.1.2.2 Persons Living with an AIDS Diagnosis

At the end of 2009, the estimated number of persons living with an AIDS diagnosis in the United States and 6 U.S. dependent areas was 487,968. In the 50 states and the District of Columbia, this included 476,186 adults and adolescents, and 546 children aged less than 13 years at the end of the year [11].

1.1.2.3 HIV Incidence

The estimated incidence of HIV has remained stable overall in recent years, at about 50,000 new HIV infections per year [12]. Within the overall estimates, however, some groups are affected more than others. For instance, MSM continue to bear the greatest burden of HIV infection [12].

1.1.3 Current HIV/AIDS treatments

Currently, there is no cure or effective vaccine for HIV or AIDS [13]. However, modern clinical treatments are available to extend and improve the lives of patients infected with HIV. Azidothymidine (AZT), a reverse transcriptase inhibitor, previously known as a potential

anticancer agent, was the first antiretroviral drug for treating AIDS approved by the U.S. Food and Drug Administration (FDA) in 1987. HIV is a member of retroviruses that possess complex genomes and exhibit cone-shaped capsid core particles [14, 15]. As a characteristic of all retroviruses, HIV's genome is encoded by RNA. The virus replication cycle starts with the binding to CD4 on the cell surface, and then followed by fusion into the cell membrane [16, 17], reverse transcription catalyzed by reverse transcriptase, integration catalyzed by integrase, and viral maturation operated by protease [18, 19]. Therefore, four categories of HIV drugs—targeting at four important stages of viral replication cycle, have been developed. They are entry/fusion inhibitors (EFI), reverse transcriptase inhibitors (NTI, including non-nucleoside reverse transcriptase inhibitor (NNRTI) and nucleoside analogue reverse transcriptase inhibitor (NRTI)), integrase inhibitors (INI), and protease inhibitors (PI). FDA has approved nine NRTIs, including zidovudine (AZT), tenofovir (TDF), lamivudine (3TC), emtricitabine (FTC), abacavir (ABC), zalcitabine (ddC), didanosine (ddI), stavudine (d4T), apricitabine (ATC), and five NNRTIs, including rilpivirine (RPV), etravirine (ETV), delavirdine (DLV), efavirenz (EFV) and nevirapine (NVP) [20]. The PIs are saquinavir (SQV), amprenavir (APV, off-market now), fosamprenavir (FOS-APV), indinavir (IDV), nelfinavir (NFV), ritonavir (RTV), atazanavir (ATV), lopinavir (LPV), darunavir (DRV) and tipranavir (TPV) [20]. EFI and INI are relatively new categories of HIV drugs. There are one fusion inhibitor, enfuvirtide (T-20), one entry inhibitor, maraviroc (MVC) and one INI, raltegravir (RAL) available on the market [20]. In 1996, combination antiretroviral treatment, known as Highly Active Antiretroviral Therapy (HAART), was proposed for its high effectiveness against HIV. Many clinical studies had shown that HAART substantially reduce the death rate and illness caused by AIDS, including [21-24]. HAART are "cocktails" consisting of at least three medications belonging to at least two classes

of antiretroviral agents [25, 26]. Typically two NRTIs form the backbone of the treatment and then enhanced with one more NNRTI or one PI or one INI [25].

Clinical interventions, such as ART, can delay the progression to AIDS and prolong life after HIV infection. ART regimens significantly improves current life qualities and decreases the risk of opportunistic infections and cancer—two major causes of death from HIV/AIDS, which probably are the result of the progressive failure of the immune system [27-30]. For instance, there is a 70% reduced risk of acquiring tuberculosis with treatment [25]. In the developing world treatment also improves physical and mental health [31]. Moreover, timely treatment reduces the risk of transmission, including both sexual partners' transmission and mother-to-child transmission [25]. The United States recommends ART treatment for all HIV-infected people regardless of CD4 count or symptoms [32].

The effectiveness of treatment largely depends on adherence [33]. Therefore, accessibility of medical care, strength of social supports, as well the quality of treatment regimens (complexity and adverse effects), play important roles in controlling HIV [34, 35].

This thesis takes advantages of Medical Monitoring Program (MMP), a unique surveillance program that combined personal interviews and medical records, to study the status of HIV treatment and health conditions of HIV patients receiving medical care in the United States. The information gathered here are nationally representative; therefore, they can be valuable for reviewing the quality of current medical services of HIV/AIDS, strategic prevention planning, and care resource allocation.

1.2 Data Sources

1.2.1 Background of MMP

The data used in this study were obtained from MMP, a unique supplementary surveillance project designed to provide representative, population-based data on clinical status, care, outcomes, and behaviors of HIV-infected persons receiving care in the United States [36]. It is supported by several government agencies and conducted by state and local health departments along with the CDC. The MMP was first piloted in 2004 [37]. It is designed to achieve following objectives [38, 39]:

- describe the clinical and virological status of HIV-infected persons in care;
- describe the prevalence of co-morbidities related to HIV disease;
- describe HIV care and support services received and the quality of such services determine prevalence of ongoing risk behaviors and access to, and use of, prevention services among persons living with HIV;
- identify met and unmet needs for HIV care and prevention services to inform prevention and care planning groups, health care providers, and other stakeholder [39].

1.2.1.1 Sampling Design of MMP

MMP uses three stages sampling design to achieve annual representative samples of adults receiving out-patient care for HIV infection in the U.S. [36]:

First Stage: State Level

All 50 states, the District of Columbia, and Puerto Rico were eligible for inclusion in MMP. A sample was selected proportional to size based on existing HIV/AIDS cases within each area. A total of 16 states and 1 U.S. territory were selected based on the availability of funds. The

selected states included 6 separately funded cities, resulting in 23 participating project areas. The project areas selected are estimated to include 73% of the total HIV/AIDS cases in the U.S. [36].

Second Stage: Health Care Facility Level

Outpatient HIV medical care facilities in the sampled project areas are sampled every two years based on the number of patients seen at the facilities. The annual sample of facilities includes about 25-50 facilities from each project area representing small, medium, and large HIV medical care facilities. Facilities are eligible to participate if they prescribe antiretroviral medications or order CD4 and/or HIV viral load (VL) tests in the context of treating and managing HIV. Healthcare facilities that participate are expected to represent similar healthcare facilities that were not selected to participate [36].

Third Stage: Patient Level

A sample of about 100 to 800 patients from each project area was selected from participating health care facilities in 2009. Patients must be at least 18 years old, diagnosed with HIV, and receiving care during January to April 2009. Patients who are selected are asked to participate in an interview and answer questions about their demographics, behavior pattern and HIV care. Patients who participate are expected to represent patients like them that were not selected to participate [36].

1.2.1.2 Data Collection

A total of 23 project areas were involved in data collection activities for the 2009 MMP data collection cycle: Chicago, Illinois; Delaware; Florida; Georgia; Houston, Texas; Illinois; Indiana; Los Angeles County, California; Michigan; Mississippi; New Jersey; the state of New York; New York City, New York; North Carolina; Oregon; Pennsylvania; Philadelphia, Pennsylvania; Puerto Rico; San Francisco, California; Texas; Virginia; and Washington. Figure 1.1 shows the

selected 16 states and 1 U.S. territory and color-coded weighted percentage of sampled patients in 2009 data collection cycle. Selected HIV patients ≥18 years of age and who received medical care during January–April 2009 at an MMP participating facility, if agreed to participate, were interviewed once during June 2009–April 2010 regarding their behaviors and medical status during the 12 months preceding the interview. In addition, these patients' medical records were abstracted for documentation of medical care for the 12 months preceding the interview. Moreover, data were extracted from the National HIV Surveillance System for every patient who was selected to participate in MMP in order to provide basic descriptive information [39].

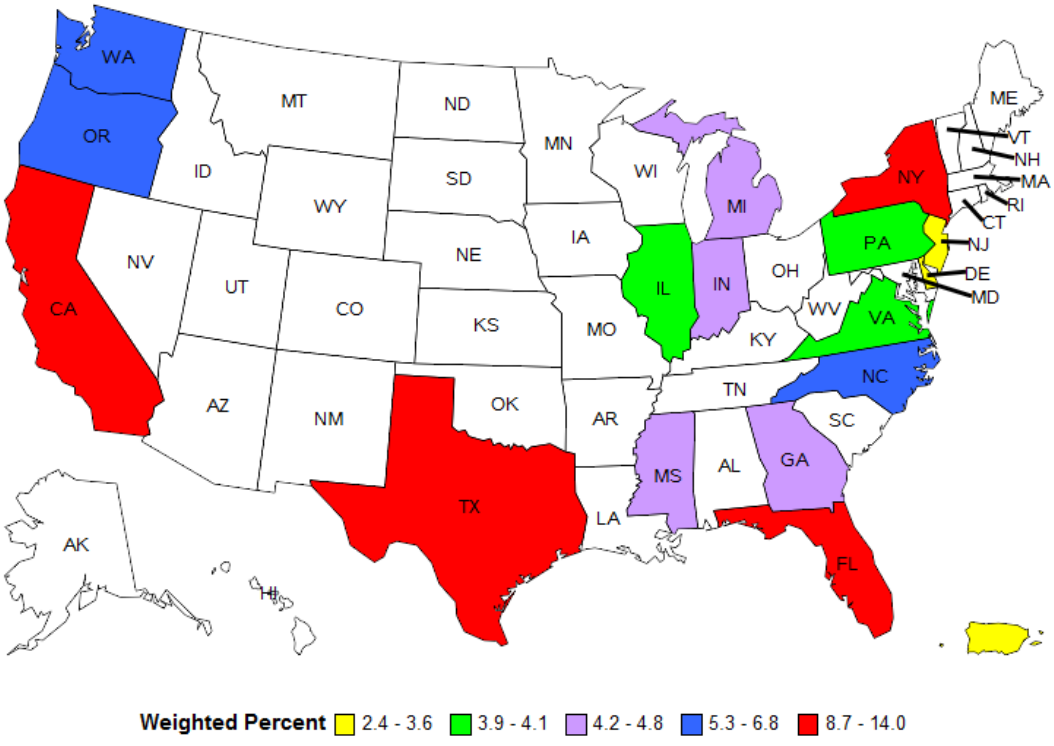


Figure 1.1 Weighted percentage of sampled patients receiving medical care in the United States—Medical Monitoring Project, 2009

Personal Interview: The MMP interview is a face-to-face structured interview with two different questionnaire s: the Standard Questionnaire and Short Questionnaire. The Standard Interview takes about 45 minutes to complete while the Short Questionnaire is an abridged version of the

Standard Questionnaire which takes about 20 minutes. Both questionnaires are available in both English and Spanish. Generally the Standard Questionnaire was preferred for collecting interview data. Under certain circumstances, patients who are too ill, or non-English, non-Spanish speaking patients who need a translator, were administered the Short version [39].

The 2009 Standard Questionnaire consists of 10 modules: Preliminary Information; Demographics; Access to Health Care; HIV Treatment and Adherence; Sexual Behavior; Drug and Alcohol Use; Prevention Activities; Anxiety and Depression; Health Conditions and Preventive Therapy; and Gynecological and Reproductive History. Electronic versions of all questionnaires are provided by CDC, including handheld-assisted personal interview (HAPI) device or computer-assisted personal interview (CAPI) device. HAPI and CAPI interview applications were developed using Questionnaire Development System (QDS) software (NOVA Research Company, Bethesda, Maryland). Paper versions of the questionnaires are provided for use in the event of HAPI/CAPI break down. Local questions may be added by individual project area. These questions are not transmitted to CDC[39].

Medical Record Abstraction (MRA): Medical records are abstracted by project area staff trained to abstract clinical information from medical charts and enter the abstracted information into an electronic application provided by CDC. The electronic medical record abstraction consists of 4 data collection forms: Medical History Form (MHF); Surveillance Period Visit Form (SPVF); Surveillance Period Summary Form (SPSF); and Surveillance Period Inpatient Form (SPIF). The information abstracted reflects patient's clinical condition from the time first diagnosed as HIV positive to the time of interview. Information collection will include the diagnosis of opportunistic illnesses, provision of preventive therapies, prescription of antiretroviral medications, laboratory results, assessment of adverse events due to medications, and health

services utilization. If a patient cannot be located for recruitment, the patient's medical record is abstracted without interview, if allowed under local surveillance authority. To collect complete information on the entire surveillance period, which is the 12 months prior the interview, project staff needs to abstract medical record information from all facilities where a participant has received medical care for HIV infection during the surveillance period.

Minimal Data Set (MDS): Regardless of level of participation, minimum data are collected on all sampled patients. The minimum data set contains basic demographic and clinical data abstracted from the same source for each project area, which is the Enhanced HIV/AIDS Reporting System (eHARS). Minimal Data is important as it is the most complete dataset from MMP sampling. It provides basic descriptive information regarding the population of inference and is critical for assessing potential non-response bias for the data collected through interview and medical record abstraction [39].

1.2.2 Sources of Error in the MMP

Non-coverage Error: The non-coverage error in MMP may come from three sources: (1) sampled HIV patients are those older than eighteen and received medical care during January–April 2009 at an MMP participating facility, therefore those younger patients, or those received care only during May—December 2009, or those received care from non-selected or refused-participation facilities, are not covered; (2) HIV-infected adults who received all of their care solely from emergency departments or inpatient facilities will be excluded from MMP as these facilities are not covered by MMP facility sampling frame; (3) patients in prisons or military bases are excluded from the sampling frame. The first group seems to be the major source of non-coverage error. However, a study focused on "time to first annual HIV care visit" using 2003 data has shown that 88% and 95% HIV patients had their first visit within four and six

months, respectively, therefore, an enrollment period of four-six months should sufficiently reflect the patient population seen in a one-year period, including those attending care infrequently [40]. On the other hand, the sub-population from 2nd and 3rd sources is relatively small comparing to the national disease population of HIV-infected persons.

Sampling Error: Similar to all of other surveys, interview/MRA data in MMP are collected on only a small sample size of the entire disease population. This may lead to sampling error. Strict adherence to sampling rules at each of three sampling stages may reduce some of the sampling error.

Non-response Error: Non-response error is a common problem in all surveillance studies. This is especially critical for MMP because it uses a three-stage sampling strategy; therefore, non-response error may occur at each stage. There are unit non-response and item non-response. Unit non-response can arise at multiple levels of MMP data collection, for instance, when a selected facility refuses to participate, or when a selected patient refuses to participate in the interview or cannot be located, or when the provider denies MMP staff access to the medical records. Item non-response may arise when data are not completely obtained for all questionnaire or medical records items. The advantage of MMP is that data from the minimal data set which contains information on all sampled persons, both respondents and non-respondents can be used to create non-response weights to reduce non-response bias.

Measurement Error: The quality of MMP interview data can be disturbed by the question order, question wording, response-code precision, recall error, length of interview, interviewer technique, coding errors, and simple data entry error. The quality of MMP medical record data is

relying on the accuracy and completeness of medical records, as well as abstractor's technique, coding errors and data entry errors.

1.2.3 Design Variables Related to Data Analysis

Each participant is coded by a 12-digits ID which consists of 4 digits which identifies the project area ID, 4 digits which represents the facility ID, and 4 digits for an assigned patient ID. The design of 2009 MMP data comprised 18 strata and 228 clusters which can be identified by variables:

nat_strat_owt = strata variable in matched interview-MRA dataset

nat_clust_owt = cluster variable in matched interview-MRA dataset

nat_owt = stratum weight variable in matched interview-MRA dataset

The weights had been calculated to adjust for probability of selection and non-response [41].

1.3 Purpose of Study

ART therapy is a key component of clinical care for HIV/AIDS patients. Studies have shown that successful ART can significantly reduce the HIV viral load and delay disease progression [42-45]. Consistently suppressed HIV viral load is associated with reduced mortality and a lower probability of sexual transmission [46, 47]. Therefore, the pattern of ART prescription and adherence are of great interest and has been studied using several large databases [48, 49], such as HIV Insight™ (APACHE), Target Management Services (TMS) and Clinical Partners (CP). Although such databases provide a rich source of information, none of them are nationally representative. In this thesis, we use MMP, a supplementary surveillance program designed to cover all HIV patients receiving medical care in the U.S., to achieve the following goals:

(1) To provide a nationally representative profile of HIV treatments of HIV-infected adults receiving care;

(2) To project a nationally representative picture of clinical and virological status of HIV infected adults in care;

(3) To characterize patterns of antiretroviral use in HIV infected adults receiving care and explore variations in clinical outcomes resulting from different regimens and patient characteristics.

Ultimately, this information can be used to evaluate current clinical services and guide policy and funding decisions aimed at improving the quality of care for people living with HIV/AIDS throughout the United States and globally.

CHAPTER 2 METHODS

2.1 Study Population

HIV infected adults with age of ≥18 years old and received care from any MMP-participating facilities were utilized in analysis. Data files for the 2009 data collection cycle were encrypted and transmitted to CDC through a secure data network. Analyses were done on site at MMP data management office, Clinical Outcomes Team, Division of HIV/AIDS Prevention, CDC.

2.1.1 Facility and Participant Response Rates

For 2009 data collection cycle, the median facility participation rate was 77.8%, ranging from 45.2% to 100% in 23 project areas. The median patient participation rate was 61.9 % among eligible patients, varying from 26.4 % to 70.5 % in all project areas. Data were collected at both the facility level and the patient level. Patient level data was collected for interview, MRA and MDS. The raw national response rates for the 2009 cycle were calculated for all datasets: Facility (76.5%), Interview (55.5%), MRA (66.1%) and MDS (87.8%). The combined response rate is calculated by: overall response rate = Project area response rate × Facility response rate × Individual response rate. So the combined national response rates for Interview, MRA and MDS were 42.4%, 50.5% and 67.2%, respectively [50]. Overall, of a total of 9400 persons who were eligible for participation in MMP, 4620 participated, in which 4415 participants completed standard interview and 4217 participants had matched pairs of interview and medical record abstraction. Therefore, to facilitate analysis of self-reported and clinical data, we used the matched interview-MRA data with 4217 samples, representing 421,186 patients in care in the United States.

2.2 Study Variables

As mentioned earlier, MMP collected three kinds of dataset in 2009 data cycle: self-reported interview dataset, medical records abstraction, and minimal dataset. Our study focused on two sections: "HIV Treatment and Adherence" from interview and "Clinical status" from medical records abstractions. Viral load, drug adherence, and side effects are the outcome variables of interest, while ART regimens and general demographic/behavior characteristics are the risk factors.

2.2.1 Characteristics of Participants (Self-reported)

Characteristics of participants were obtained from MMP interviews and were covered in two parts: demographic characteristics and behavioral characteristics. Demographic characteristics included gender, race/ethnicity, age at interview, education level, country or territory of birth, time since HIV diagnosis, availability of health insurance, types of health insurance coverage, poverty level, yearly income and access to care. The behavioral characteristics included alcohol use, smoking, drug use, depression and sexual risk behavior. The detailed categories for each characteristic were listed in Table 3.1 and were computed based on one or more interview questions.

2.2.2 ART Treatment and Adherence to ART (Self-reported)

In the interview process, ART treatment status was asked in two time courses: the history of ART use (asked by question *T1. Have you ever taken any antiretroviral medicines for your HIV?*), and the current status of ART use (asked by question *T5. Are you currently taking any antiretroviral medicines for your HIV?*), each followed by a list of commercially available antiretroviral medications. The mapping of interview variables to commercial available medicines is shown in Table 2.2. For those who did not take ART, the reason for why not using

ART was asked, while for those who are currently taking ART, the adherences to dose, instruction and schedule, reason for missed doses, trouble with side effect, insurance for ARTs, and satisfaction with ARTs were asked. [Questionnaire available at http://www.cdc.gov/hiv/topics/treatment/mmp/data.htm]

Table 2.1 Mapping of interview/MRA variables to commercial available medicines

Drug category	Drug abbreviation	Variable name in Interview	Variable name in SPVF	Variable name in SPIF
Combo (total 5)	AZT/3TC	COMBCUR	combivir1_vf	combivira1_if
			combivir2_vf	combivira2_if
			combivir3_vf	combivira3_if
	ABC/3TC/AZT	TRIZCUR	trizivir1_vf	trizivira1_if
			trizivir2_vf	trizivira2_if
			trizivir3_vf	trizivira3_if
	ABC/3TC	EPZICUR	epzicom1_vf	epzicoma1_if
			epzicom2_vf	epzicoma2_if
			epzicom3_vf	epzicoma3_if
	FTC/TDF	TRUVCUR	truvada1_vf	truvadaa1_if
			truvada2_vf	truvadaa2_if
			truvada3_vf	truvadaa3_if
			truvada4_vf	truvadaa4_if
			truvada5_vf	truvadaa5_if
	FTC/TDF/EFV	ATRIPLA	atripla1_vf	atriplaa1_if
			atripla2_vf	atriplaa2_if
			atripla3_vf	atriplaa3_if
NRTI (Total 8)	3TC	LAMICUR	lamivudine1_vf	lamivudinea1_if
			lamivudine2_vf	lamivudinea2_if
			lamivudine3_vf	lamivudinea3_if
	ddI	DAECCUR	didanosine1_vf	didanosinea1_if
		DIDACUR	didanosine2_vf	didanosinea2_if
			didanosine3_vf	didanosinea3_if
			didanosine4_vf	didanosinea4_if
	FTC	EMTRCUR	emtricitabine1_vf	emtricitabinea1_if
			emtricitabine2_vf	emtricitabinea2_if
			emtricitabine3_vf	emtricitabinea3_if
	TDF	TENOCUR	tenofovir1_vf	tenofovira1_if
			tenofovir2_vf	tenofovira2_if
			tenofovir3_vf	tenofovira3_if
	ddC	ZALCCUR	zalcitabine1_vf	zalcitabinea1_if
			zalcitabine2_vf	zalcitabinea2_if
			zalcitabine3_vf	zalcitabinea3_if
			zalcitabine4_vf	zalcitabinea4_if
	d4T	STAVCUR	stavudine1_vf	stavudinea1_if
			stavudine2_vf	stavudinea2_if
			stavudine3_vf	stavudinea3_if

Drug category	Drug abbreviation	Variable name in Interview	Variable name in SPVF	Variable name in SPIF
	AZT	ZIDOCUR	zidovudine1_vf	zidovudinea1_if
			zidovudine2_vf	zidovudinea2_if
			zidovudine3_vf	zidovudinea3_if
			zidovudine4_vf	zidovudinea4_if
			zidovudine5_vf	zidovudinea5_if
	ABC	ABACACUR	abacavir1_vf	abacavira1_if
			abacavir2_vf	abacavira2_if
			abacavir3_vf	abacavira3_if
NNRTI (Total 4)	DLV	DELACUR	delaviridine1_vf	delavirdinea1_if
			delaviridine2_vf	delavirdinea2_if
			delaviridine3_vf	delavirdinea3_if
	NVP	NEVICUR	nevirapine1_vf	nevirapinea1_if
			nevirapine2_vf	nevirapinea2_if
			nevirapine3_vf	nevirapinea3_if
	EFV	EFAVCUR	efavirenz1_vf	efavirenza1_if
			efavirenz2_vf	efavirenza2_if
			efavirenz3_vf	efavirenza3_if
	ETV	TMC	etravirine081_vf	etravirinea081_if
			etravirine082_vf	etravirinea082_if
			etravirine083_vf	etravirinea083_if
			etravirine084_vf	etravirinea084_if
PI (Total 10)	APV	AMPRCUR	amprenavir1_vf	amprenavira1_if
			amprenavir2_vf	amprenavira2_if
			amprenavir3_vf	amprenavira3_if
	SQV	SACQCUR	saquinavir081_vf	saquinavira1_if
		SAC2CUR	saquinavir082_vf	saquinavira2_if
			saquinavir083_vf	saquinavira3_if
			saquinavir084_vf	saquinavira4_if
			saquinavir085_vf	saquinavira5_if
	LPVr	LOPICUR	LPVRTV1_VF	LPVRTVA1_IF
			LPVRTV2_VF	LPVRTVA2_IF
			LPVRTV3_VF	LPVRTVA3_IF
			LPVRTV4_VF	LPVRTVA4_IF
			LPVRTV5_VF	LPVRTVA5_IF
			LPVRTV6_VF	LPVRTVA6_IF
	IDV	INDICUR	indinavir1_vf	indinavira1_if
			indinavir2_vf	indinavira2_if
			indinavir3_vf	indinavira3_if
	FPV	FUSACUR	fosamprenavir1_vf	fosamprenavira1_if
			fosamprenavir2_vf	fosamprenavira2_if
			fosamprenavir3_vf	fosamprenavira3_if
			fosamprenavir4_vf	fosamprenavira4_if
	ATV	ATAZCUR	atazanavir1_vf	atazanavira1_if
			atazanavir2_vf	atazanavira2_if
			atazanavir3_vf	atazanavira3_if
	RTV	RITOCUR	ritonavir1_vf	ritonavira1_if
			ritonavir2_vf	ritonavira2_if
			ritonavir3_vf	ritonavira3_if
	NFV	NELFCUR	nelfinavir1_vf	nelfinavira1_if

Drug category	Drug abbreviation	Variable name in Interview	Variable name in SPVF	Variable name in SPIF
			nelfinavir2_vf	nelfinavira2_if
			nelfinavir3_vf	nelfinavira3_if
	TPV	TIPRCUR	tipranavir1_vf	tipranavira1_if
			tipranavir2_vf	tipranavira2_if
			tipranavir3_vf	tipranavira3_if
	DRV	PREZCUR	darunavir081_vf	darunavira1_if
			darunavir082_vf	darunavira2_if
			darunavir083_vf	darunavira3_if
			darunavir084_vf	darunavira4_if
EFI (Total 2)	T20	ENFUCUR	enfuvirtide081_vf	enfuvirtidea1_if
			enfuvirtide082_vf	enfuvirtidea2_if
			enfuvirtide083_vf	enfuvirtidea3_if
			enfuvirtide084_vf	enfuvirtidea4_if
	MVC	MARAVIRO	maraviroc1_vf	maraviroca1_if
			maraviroc2_vf	maraviroca2_if
			maraviroc3_vf	maraviroca3_if
			maraviroc4_vf	maraviroca4_if
			maraviroc5_vf	maraviroca5_if
INI (Only 1)	RAL	RALTEGRA	raltegravir1_vf	raltegravira1_if
			raltegravir2_vf	raltegravira2_if
			raltegravir3_vf	raltegravira3_if
			raltegravir4_vf	raltegravira4_if
			raltegravir5_vf	raltegravira5_if

After the status of individual drug was programmed, the participants were further grouped into two categories: took ART *vs.* not took ART. For those who took ART, they were separated into five major categories including preferred-regimens, alternative-regimens, maybe-selected-regimens, not-recommended-regimens, and other-regimens. The details of first four categories were abstracted from the clinical guideline by Department of Health & Human Services (DHHS) [32], as listed in Table 2.2. Other medications that were not on DHHS recommendation list were grouped into other-regimens.

Table 2.2 Initial antiretroviral regimens for antiretroviral therapy in naïve patients [32]

Regimen group	Name	Combination
Preferred Regimens Regimens with optimal and durable efficacy, favorable tolerability and toxicity profile, and ease of use	NNRTI-Based Regimen	1-1.EFV/TDF/FTC* **(AI)**
	PI-Based Regimens	1-2.ATVr + TDF/FTC* **(AI)**
		1-3.DRVr + TDF/FTC* **(AI)**
	INSTI-Based Regimen	1-4.RAL + TDF/FTC* **(AI)**
Alternative Regimens Regimens that are effective and tolerable but have potential	NNRTI-Based Regimens	2-1.EFV + ABC/3TC* **(BI)**
		*RPV/TDF/FTC** ***(BI)***
		*RPV + ABC/3TC** ***(BIII)***

Regimen group	Name	Combination
disadvantages when compared with preferred regimens.	PI-Based Regimens	2-2.ATVr + ABC/3TC* **(BI)**
		2-3.DRVr + ABC/3TC* **(BII)**
		2-4.FPVr + ABC/3TC* or TDF/FTC* **(BI)**
		2-5.LPVr + ABC/3TC* or TDF/FTC* **(BI)**
	INSTI-Based Regimen	*EVG/COBI/TDF/FTC** ***(BI)***
		2-6.RAL + ABC/3TC* **(BIII)**
Regimens that may be selected for some patients but are less satisfactory than preferred or alternative regimens	NNRTI-Based Regimen	3-1.EFV + ZDV/3TC*
		3-2.NVP + (ABC/3TC* or TDF/FTCa or ZDV/3TC*)
		*RPV + ZDV/3TC**
	PI-Based Regimens	3-3.(ATV or ATVr or DRVr or FPVr or LPVr or SQVr) + ZDV/3TC*
		3-4.ATV + ABC/3TC*
		3-5.SQVr + (ABC/3TC* or TDF/FTC*)
	INSTI-Based Regimen	3-6.RAL + ZDV/3TC*
	CCR5 Antagonist-Based Regimens	3-7.MVC + (ABC/3TC or TDF/FTC or ZDV/3TC*)
ARV drugs or components NOT recommending as initial therapy		4-1.ABC/3TC/ZDV (co-formulated) as triple-NRTI combination regimen **(BI)**
		4-2.ABC + 3TC + ZDV + TDF as quadruple-NRTI combination regimen **(BI)**
		DRV (unboosted)
		4-3.DLV **(BIII)**
		4-4.ddI + 3TC (or FTC) **(BIII)**
		4-5.ddI + TDF **(BII)**
		EVG/COBI/TDF/FTC + other ARV drugs
		T20 ***(BIII)***
		ETR ***(BIII)***
		4-6.FPV (unboosted) **(BIII)**
		4-7.IDV (unboosted) **(BIII)**
		4-8.IDVr **(BIII)**
		4-9.NFV **(BI)**
		RTV as sole PI ***(BIII)***
		4-10.SQV (unboosted) **(BI)**
		4-11.d4T + 3TC **(BI)**
		4-12.TPVr **(BI)**

* 3TC may substitute for FTC or vice versa. **r** stands for Ritonavir boosted.
Rating of Recommendations*: A = Strong; B = Moderate; C = Optional*
Rating of Evidence*: I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*
Italicized letters for those combinations which were not covered in MMP.

2.2.3 MRA variables

Information regarding AIDS diagnosis, CD4 count, prescription of ART, and HIV viral load was abstracted from the patient's medical records data. The most recent ART prescription were computed from multiple clinical visit forms (SPVF, covered in *section V. ANTIRETROVIRAL THERAPY (ART), question "Is there documentation of prescription of antiretroviral therapy*

(ART) during this inpatient stay?") and inpatient forms (SPIF, covered *in section VIII. ANTIRETROVIRAL THERAPY (ART), question "Is there documentation of prescription or continuation of antiretroviral therapy (ART) during this visit?"*). The mapping of SFVF and SPIF variables to commercial available medicines is shown in Table 2.1. Patients with ART prescription were further categorized in the same manner for self-reported ART use, as mentioned previously. The most recent and durable viral load was also calculated from the SPVF and SPIF (SFVF *section X. LABORATORY TESTING – FREQUENTLY REPEATED TEST* and SPIV *section VII. INPATIENT LABORATORY TEST RESULTS*). [MRA forms available at http://www.cdc.gov/hiv/topics/treatment/mmp/data.htm]. Virologic suppression was defined as an HIV VL documented in the MRA of undetectable or 200 copies/ml or less.

2.2 Statistical Analysis

Statistical analyses were conducted using SAS (version 9.3) and SAS-Callable SUDDAN (version 11.0.0). Hypothesis testing results with p-values of 0.05 or less were considered to be statistically significant.

The SURVEY procedures in SAS were used to take into accounts survey study design variables, such as strata, cluster, and weights. Frequencies and weighted percentages of selected characteristics were calculated using PROC SURVEYFREQ. Then the modified Rao-Scott chi-square test, a design-adjusted Pearson chi-square test which involves differences between observed and expected frequencies [51-53], was used to test differences between groups.

Prevalence ratio was used in this study to evaluate the relationship between risk factors and outcomes. MMP is a cross-sectional study. Cross-sectional studies are observational studies typically used to assess the prevalence of disease conditions. Prevalence is the proportion of a population found to have a condition (such as a disease) at a time point or during a time period.

Therefore, PR was used in preference to the odds ratio (OR) in this study because PR is more conservative, consistent, and interpretable relative to the OR in cross-sectional design [54, 55].

Two-step analyses were performed to access the association between ART regimens and health outcomes (most recent viral load, durable viral load, drug adherence, and trouble with side effects): first, the crude bivariate associations were studied using Rao-Scott chi-square test; and then, multivariate logistic regression model for complex survey data was constructed to compute the unadjusted and adjusted prevalence ratios (aPRs). The multivariate modeling was done using PROC SURVEYLOGISTIC, which fit linear logistic regression models for discrete response survey data by the method of maximum likelihood. Demographic factors (including gender, race, age at interview, education level, country or territory of birth, time since HIV diagnosis, type of health insurance, and poverty level), and behavioral factors (including binge drinking, injection and non-injection drug use), as well as clinical status (including nadir CD4 count, type of AIDS, and type of ART regimens), are potential confounding variables which were tested for inclusion in each of the multivariate regression models. Collinearity among the independent variables was assessed. Variables with a *p*-value less than 0.1 at univariate analysis were entered in the initial multivariate model. Furthermore, manual backward stepwise model selection was performed, with a *p*-value of 0.05 criterion for retention of variables in the final model. Possible interaction terms were examined one-by-one. Models were compared through the Akaike's information criterion (AIC). Final model was transferred to SUDDAN PROC RLOGIST to report crude PRs and aPRs and statistical inferences. Model adequacy was evaluated using Hosmer and Lemeshow goodness-of-fit test [56]. Variances of the regression parameters and prevalence ratios were computed by the Taylor linearization method, assuming a with replacement (WR) design [57].

CHAPTER 3 RESULTS

3.1 Frequencies and Descriptive Statistics

3.1.1 General Characteristics

As listed in Table 3.1, of 4,217 participants from the 2009 MMP data cycle, 71% were male, 27% were female, and 1% was transgender or intersex. The age groups with the greatest proportion of participants were two older groups, 40-49 years (39%) and 50 years or older (36%). Most participants were non-Hispanic black (41%) or non-Hispanic white (34%). Majority of the patients were born in the United States (87%). There were 23%, 23% and 54% of participants who were diagnosed with HIV infection within 5 years, 4 to 9 year, or more than 10 years, respectively. A total of 8% of participants reported to be homeless at some point during the past 12 months. Among 3,441 (81%) of participants who reported having health insurance coverage in the past 12 months, 2,443 (69%) used some public insurance/program and 971 (30%) had only private health insurance. (Participants could select more than one type of health insurance.) Minor (28%) amount of participants who had insurance coverage had some loss of insurance in the past 12 months before interview. Around half (51%) of the participants had more than high school education. A total of 64% of participants had low yearly family income (0-$19,999) and approximately half (54%) were under poverty level [58]. Among participants that were diagnosed within 5 years, more than 90% of the participants were able to access to care within 3 months after HIV diagnosis.

Only 99 (2%) participants had used injection drugs, while 1,134 (27%) participants had used non-injection drugs in the past 12 months before the interview. There were 720 (16%) binge drinkers and 1,780 (42%) current smokers among 4,217 participants. Majority (74%) of the participants did not report depression. Among 68% participants that were sexually active in the

past 12 months before the interview, approximately half (45%) had unprotected anal or vaginal intercourse, within which 543 (53%) were reported for unprotected intercourse with a partner of negative or unknown HIV status.

Table 3.1 General characteristics of HIV-infected adults receiving medical care in the United States—Medical Monitoring Project, 2009

Characteristic	No. in sample (un-weighted n)	Estimated population size (weighted n)	Weighted %	95% CI of percentage
Total patients	***4217***	***421186***	***100.0***	
Demographic				
Gender				
Male	3013	299808	71.2	(68.0-74.4)
Female	1139	114527	27.2	(24.0-30.4)
Transgender or intersex	65	6852	1.6	(1.1-2.2)
Age at interview				
18-29	316	31081	7.4	(6.2-8.6)
30-39	722	72150	17.1	(15.3-18.9)
40-49	1647	165506	39.3	(37.5-41.1)
50+	1532	152450	36.2	(34.3-38.1)
Race/Ethnicity				
Non-Hispanic Black	1740	174449	41.4	(33.3-49.6)
Hispanic	881	80606	19.1	(14.2-24.1)
Non-Hispanic White	1395	145586	34.6	(28.0-41.1)
Other	199	20339	4.8	(3.8-5.8)
Foreign born (Country of birth other than US or Puerto Rico)				
Born in US or Puerto Rico	3685	365912	86.9	(84.8-89.0)
Country of birth other than US or Puerto Rico	529	55094	13.1	(11.0-15.2)
Length of time since HIV diagnosis				
0-4 years	951	97527	23.2	(21.2-25.2)
5-9 years	978	96988	23.1	(21.5-24.6)
10+ years	2283	226161	53.8	(51.2-56.3)
Homeless at any time in P12M				
No	3827	383292	91.0	(89.8-92.2)
Yes	390	37894	9.0	(7.8-10.2)
Insurance				
Type of health insurance during P12M				
Private only	971	100516	23.9	(19.9-28.0)
Any public	2423	234888	55.9	(52.6-59.3)
No insurance/coverage	768	79234	18.9	(15.1-22.7)
Unknown/unspecified insurance	47	5359	1.3	(0.5-2.0)
Continuous insurance during P12M				
Continuous insurance/coverage	3020	300481	71.6	(67.2-76.0)
Lapsed insurance/coverage	417	39938	9.5	(8.2-10.8)
No insurance/coverage	768	79234	18.9	(15.1-22.7)
Socioeconomic status				
Education attainment				

Characteristic	No. in sample (un-weighted n)	Estimated population size (weighted n)	Weighted %	95% CI of percentage
< High School	985	95077	22.6	(20.0-25.1)
High school diploma or GED	1161	113016	26.8	(24.1-29.6)
> High School	2070	212981	50.6	(45.8-55.4)
Yearly income during P12M				
$0-$19,999	2699	261705	64.4	(59.8-69.0)
$20,000-$39,999	690	71737	17.7	(15.4-19.9)
≥ $40,000	691	72939	17.9	(14.8-21.1)
Poverty Level during P12M				
Above poverty level	2214	228285	54.2	(50.0-58.4)
At or below poverty level	1866	178097	42.3	(38.3-46.3)
Unknown	137	14805	3.5	(2.5-4.5)
Access to care				
Time to enter care since 1st HIV positive test for those diagnosed <=5 years				
≤ 3 mos.	846	86812	90.9	(88.8-93.0)
4-11 mos.	62	5914	6.2	(4.5-7.9)
≥ 12 mos.	28	2754	2.9	(1.8-4.0)
Behaviors				
Any non-injection drug use				
No	3071	306072	72.9	(71.1-74.8)
Yes	1134	113565	27.1	(25.2-28.9)
Any injection drug use				
No	4108	410926	97.9	(97.1-98.8)
Yes	99	8767	2.1	(1.2-2.9)
Binge drinker				
No	3464	349234	83.6	(82.2-84.9)
Yes	720	68551	16.4	(15.1-17.8)
Current smoker				
No	2427	241965	57.6	(54.9-60.3)
Yes	1780	177980	42.4	(39.7-45.1)
Depression				
Depression diagnosis based on an algorithm from [59]				
No depression	3128	309479	74.4	(72.6-76.2)
Other depression	535	54689	13.1	(12.0-14.3)
Major depression	506	51750	12.4	(11.2-13.7)
Sexual behavior				
Sexual activity in P12M				
No, not sexually active in the P12M	1556	159959	38.2	(35.8-40.5)
Sexually active in the P12M	2641	259236	61.8	(59.5-64.2)
Had unprotected sex among sexually active				
No	1254	122078	54.7	(50.1-59.2)
Yes	1032	101220	45.3	(40.8-49.9)
Had unprotected sex with partner of negative or unknown status among those who reported unprotected sex				
No	478	47458	47.4	(42.0-52.9)
Yes	543	52635	52.6	(47.1-58.0)
Sexual transmission risk category				
Any MSM (MSM only+MSMW)	1950	196519	46.7	(42.1-51.4)
MSW only	1029	99285	23.6	(21.0-26.3)
Any WSM (WSM only+WSMW)	1111	111268	26.5	(23.4-29.6)
Other	121	13418	3.2	(2.4-4.0)

3.1.2 Characteristics of Clinical Status

Clinical status data were abstracted from 46,829 care visits (including 46,297 outpatient visits and 532 inpatient visits) by 4,217 patients during the one-year surveillance period (SP) of 2009. Of the 4,217 patients, 2,940 (69.6%) had 3 or more tests for VL or CD4 within the SP. There were 2,897 (67.6%), 976 (23.9%) and 333 (8.5%) of participants in each of the 3 stages of AIDS according to CDC's classification guidelines [9]. Majority (89.1%) of participants were prescribed ART in the past 12 months before interview. A total of 71.6% participants had a suppressed most recent viral load while less, about 57.7% participants had suppressed durable viral load.

Table 3.2 Characteristics of clinical status of HIV-infected adults receiving medical care in the United States—Medical Monitoring Project, 2009

Characteristic	No. in sample (un-weighted n)	Estimated population size (weighted n)	Weighted %	95% CI of percentage
Total patients	***4217***	***421186***	***100.0***	
Clinical status (MRA)				
Status of AIDS				
AIDS (Clinical or immunologic)	2897	284022	67.6	(65.7-69.6)
No AIDS (Clinical or immunologic)	1309	135980	32.4	(30.4-34.3)
Types of AIDS				
AIDS or nadir CD4 0-199	2897	284022	67.6	(65.7-69.6)
No AIDS and nadir CD4 200-500	976	100455	23.9	(21.9-25.9)
No AIDS and nadir CD4 >500	333	35525	8.5	(7.2-9.7)
Prescribed antiretroviral (ART) therapy in P12M				
No	462	45743	10.9	(9.2-12.6)
Yes	3737	373733	89.1	(87.4-90.8)
Geometric mean CD4 count in P12M				
0-199	543	50476	12.4	(11.0-13.9)
200-349	743	74989	18.5	(17.1-19.8)
350-499	1011	100507	24.8	(23.4-26.2)
500+	1770	179851	44.3	(42.5-46.1)
Viral suppression: Most recent viral load				
Most recent viral load > 200 copies/milliliter	1201	119561	28.4	(25.1-31.6)
Most recent viral load undetectable or ≤ 200 copies/milliliter	3016	301626	71.6	(68.4-74.9)
Durable viral suppression: All viral load				
All viral load > 200 copies/milliliter	1780	178191	42.3	(39.4-45.2)
All viral load undetectable or ≤ 200 copies/milliliter	2437	242995	57.7	(54.8-60.6)
3+CD4/Viral Load in the past 12 months				

Characteristic	No. in sample (un-weighted n)	Estimated population size (weighted n)	Weighted %	95% CI of percentage
3 or more CD4/VL tests not documented	1257	127277	30.4	(28.0-32.7)
3 or more CD4/VL tests documented	2940	292038	69.6	(67.3-72.0)

3.1.3 Characteristics of HIV/AIDS Treatments

Of 4,217 participants in 2009 MMP data collection, 3,931 (93.4%) of the participants had a history of taking ART. Among 3,609 participants who reported ever having a CD4 T-lymphocyte test, 2,996 (83%) reported having three or more CD4 T-lymphocyte tests in the 12 months before the interview. Among 780 participants who were diagnosed within 5 years, 438 (56.8%) started antiretroviral medication within 3 months after diagnosis. The main reason for not currently taking ART medications was doctor's advises of delaying treatment. For most of participants who were on ART, 3,040 (71.6%), the expenses of antiretroviral medicines were partially or entirely covered by public programs, such as Medicaid and Medicare. About 12.7% and 4.3% of the ART users paid for ART using by private insurance or out-of-pocket payments.

High ART adherence is essential to achieve viral suppression. In MMP, the ART adherence was measured by dose-adherence (taking a right dose or set of pills of prescribed ARTs), instruction-adherence (following special instructions for prescribed ART medication) and schedule-adherence (following a specific schedule for ART medication) in the past 3 days before interview. The majority, 85.6%, 69.0% and 71.7% of the respondents claimed completely adherence to dose, instruction (if it was needed) and schedule in the past 3 days, respectively. Only 472 (11.5%) of the ART users admitted taking drug holidays, while the main reasons for taking drug holidays were side effects (22.2%) or being tired of taking medications (26.2%). A total of 645 (17.3%) participants who were on ART reported trouble with side effects from ART for half or more than half of the time in the past 30 days. Eighty seven percent of the respondents

fully trust the positive effects of ART. Approximately half (48.2%) of the participants took complementary therapies in the past 12 months.

Table 3.3 Characteristics of ART treatments of HIV-infected adults receiving medical care in the United States—Medical Monitoring Project, 2009

Characteristic	No. in sample (un-weighted n)	Estimated population size (weighted n)	Weighted %	95% CI of percentage
Total patients	***4217***	***421186***	***100.0***	
HIV treatment (self-reported)				
Ever took ART medication				
No	280	27764	6.6	(5.5-7.7)
Yes	3931	392762	93.4	(92.3-94.5)
Currently taking ART medication				
No	576	55525	13.3	(11.9-14.6)
Yes	3617	363195	86.7	(85.4-88.1)
Time between first time ever took ART and first positive test				
Diagnosed more than 5 Years	3118	308595	79.4	(77.7-81.1)
3 months or less	438	45287	11.7	(10.5-12.8)
3 months-12 months	162	16555	4.3	(3.6-4.9)
12 months or more	180	18021	4.7	(3.9-5.4)
Reasons for not currently taking antiretroviral medicines				
Doctor advised to delay treatment	107	10824	50.0	(40.3-59.6)
Due to side effects of medication	34	3429	15.8	(9.8-21.8)
Other	75	7408	34.2	(26.3-42.1)
Type of health insurance paid for ART in P12M				
Not taking ART medication	416	41603	9.9	(8.7-11.1)
Paid by private only	511	53451	12.7	(10.4-15.0)
Paid by any public program	3040	300933	71.6	(68.2-75.0)
Out of pocket	182	18174	4.3	(2.7-5.9)
Unspecified/unknown	45	4699	1.1	(0.8-1.4)
Trust in ART medication producing a positive effect on health				
Not at all sure	111	11537	3.1	(2.3-3.9)
Somewhat sure	347	34799	9.4	(8.0-10.9)
Very sure	1251	123159	33.4	(30.6-36.3)
Extremely sure	1982	198965	54.0	(50.9-57.1)
Taking complementary or alternative therapies in P12M				
No	2164	218152	51.8	(47.1-56.6)
Yes	2050	202592	48.2	(43.4-52.9)
Drug adherence (self-reported)				
Dose adherence in past 3 days				
No, person is not 100% adherent	526	52024	14.4	(12.9-15.9)
Yes, person is 100% adherent	3080	310025	85.6	(84.1-87.1)
Instruction adherence in past 3 days				
No, person is not 100% adherent	781	76030	31.0	(28.6-33.4)
Yes, person is 100% adherent	1690	169313	69.0	(66.6-71.4)
Schedule adherence in past 3 days				
No, person is not 100% adherent	1067	104322	28.3	(25.9-30.7)
Yes, person is 100% adherent	2629	264688	71.7	(69.3-74.1)

Characteristic	No. in sample (un-weighted n)	Estimated population size (weighted n)	Weighted %	95% CI of percentage
Troubled by side effects from ART medication in past 30 days				
Never	2338	233989	63.4	(61.2-65.7)
Rarely	703	70335	19.1	(16.9-21.2)
About half the time	279	27315	7.4	(6.5-8.3)
Most of the time	191	19929	5.4	(4.7-6.1)
Always	175	16678	4.5	(3.5-5.5)
Understanding of developing resistant to HIV medications if not following instruction				
Not at all sure	234	23483	6.4	(5.7-7.2)
Somewhat sure	441	45058	12.4	(10.6-14.1)
Very sure	1253	122789	33.7	(31.0-36.4)
Extremely sure	1722	172755	47.4	(44.2-50.7)
Drug holiday				
No	3318	334923	88.5	(86.8-90.2)
Yes	472	43510	11.5	(9.8-13.2)
Main reason for drug holiday				
Medicine has side effects or makes me feel bad	115	9556	22.2	(18.9-25.5)
Got tired of taking medicines or needed a break	123	11279	26.2	(21.8-30.6)
Was using drugs or alcohol	62	5992	13.9	(9.6-18.2)
Was on vacation	16	1564	3.6	(2.0-5.3)
Felt good	24	1940	4.5	(1.9-7.1)
Other	128	12758	29.6	(22.5-36.7)

3.2 Detail Categories of ART Regimens

Detailed categories of self-reported and most recently doctor-prescribed ART regimens are shown in Figure 3.1. There is a high crude concordance (95.1%) between self-reported ART regimens and prescription. 3,605 (86.2%) participants were prescribed ARTs and were currently taking ARTs, while 369 (8.9%) participants were not currently taking ARTs, neither were they prescribed. The discordance rate is 4.9%, in which 128 (2.9%) were prescribed ART, but did not report taking ART in the interview and 91 (2.0%) reported taking ART, but had no record of being prescribed ART in the MRA.

Table 3.4 presents the detailed individual regimen comparison of self-reported and prescribed ART regimens. Of 3,605 participants who were prescribed and reported taking ART, 2,562 (71.1%) participants reported using the exact same ART regimen as latest prescription. The

major discrepancies were between “preferred-regimens” and “other-regimens”. The overall concordance at individual regimen level is (2,562 [took=prescribed] + 369 [did not take/not prescribed]) /4,217), that is 69.5%. ART prescription records were believed to be more accurate than the self-reports because the interview data could be biased due to recall for two reasons: (1) major HIV antiretroviral medications, HAART, were involved in multiple drugs—a medication “cocktail”, (2) each drug has several different commercial brand name. Therefore, further analyses were based on most recently prescribed regimens abstracted from the medical records. Of 3,737 participants who were prescribed ART, close to half of (1,841 (43.7%)) were prescribed preferred-regimens. The proportions of participants who were prescribed alternative-regimens, maybe-selected-regimens, not-recommended-regimens and other-regimens were 14.3%, 10.4%, 6.7% and 13.6%, respectively. Such frequency trend is in good agreement with the recommendations for antiretroviral regimen by DHHS guidelines [32]. The further compositions of individual regimens and their popularities were presented in Table 3.5. The top three ART regimens with frequency over 300 were (1-1) EFV/TDF/FTC, a combination of NNRTI and NRTI, prescribed to 1,065 (29.3%) of the participants; (1-2) ATVr with TDF/FTC, a combination of NRTI and PI, prescribed to 520 (13.4%) of the participants; and (2-5) LPVr with ABC/3TC or TDF/FTC, also a combination of NRTI and PI, prescribed to 325 (8.8%) of the participants. The second line of ART regimens with frequency around 150 were (3-2) one NNRTI (NVP) and two NRTIs (ABC/3TC or TDF/FTC or ZDV/3TC), prescribed to 154 (4.0%) of the participants; (1-3) one PI (DRVr) with two NRTIs (TDF and FTC), prescribed to 150 (4.0%) of the participants; and (3-3) any one PI (ATV or ATVr or DRVr or FPVr or LPVr or SQVr) with two NRTIs (ZDV and 3TC), prescribed to 148 (3.8%) of the participants.

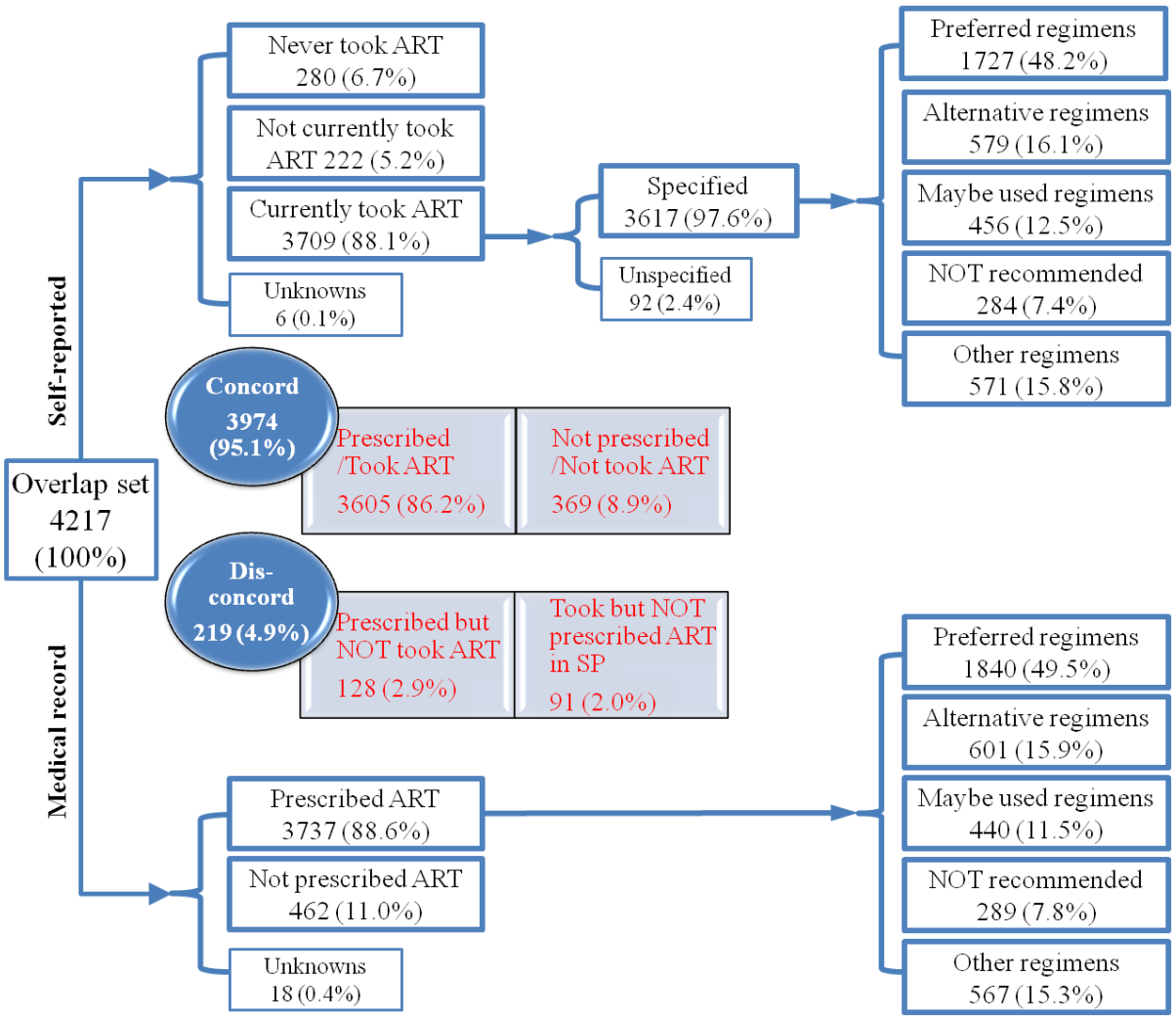


Figure 3.1 Self-reported and most recently prescribed ART regimens of HIV-infected adults receiving medical care in the United States—Medical Monitoring Project, 2009

(Note: Data in category of "unknown" were not included in calculation of concordance)

Table 3.4 Comparison of individual self-reported and prescribed ART regimen of HIV-infected adults in MMP 2009 data

Self-reported current regimen		Prescribed regimen (Gold standard)																														
		Preferred				Alternative regimens						Regimens maybe selected							Regimens NOT recommended										Other regimens				Total
		1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	2-5	2-6	3-1	3-2	3-3	3-4	3-5	3-6	3-7	4-1	4-3	4-4	4-5	4-6	4-7	4-9	4-10	4-11	4-12	5-1	5-2	5-3	5-4	
Preferred regimens (1)	1-1	**956**	6	3	2	3	1	1	1	10	0	0	1	2	2	0	0	0	0	0	0	2	2	0	0	1	0	0	2	1	2	**24***	**1022**
	1-2	6	**371**	1	2	0	3	0	1	2	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**60***	**449**
	1-3	1	1	**100**	6	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	1	0	10	**125**
	1-4	3	1	3	**62**	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	1	9	**85**
Alter-native regimens (2)	2-1	1	0	1	0	**45**	0	0	0	1	1	0	0	1	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	9	**63**
	2-2	0	4	1	0	0	**51**	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	**69**
	2-3	0	0	0	0	0	0	**10**	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	**16**
	2-4	2	1	0	0	0	0	0	**69**	0	0	0	0	0	0	1	0	1	0	0	0	0	7	0	0	0	0	0	1	0	0	1	**83**
	2-5	4	3	3	6	1	0	1	0	**264**	0	1	0	1	1	0	0	0	1	1	0	2	0	1	1	1	1	0	0	1	17	7	**318**
	2-6	0	0	0	0	0	0	1	0	1	**12**	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	**17**
Regimens maybe selected (3)	3-1	4	0	0	0	0	0	0	0	0	0	**59**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	**74**
	3-2	2	3	0	0	0	0	0	2	1	0	0	**140**	1	0	1	0	0	0	0	0	1	0	0	2	0	0	0	3	0	0	13	**169**
	3-3	1	6	0	0	0	3	1	1	1	0	0	1	**106**	2	0	1	1	0	0	2	0	2	0	1	0	0	0	1	0	5	11	**146**
	3-4	0	1	0	0	0	5	0	0	0	0	0	0	0	**28**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	**39**
	3-6	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**6**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**9**
	3-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Regimens NOT recom-mended (4)	4-1	1	1	1	0	0	0	0	0	0	0	1	0	3	0	0	0	0	**35**	0	0	1	0	0	0	0	0	0	0	0	0	2	**45**
	4-3	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	0	0	0	0	0	0	0	0	0	0	0	2	**8**
	4-4	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**10**	1	0	0	0	0	0	0	0	0	0	7	**22**
	4-5	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	**15**	0	0	0	0	0	0	0	0	0	3	**22**
	4-6	4	0	0	0	0	0	0	5	1	0	0	0	0	0	1	0	0	0	0	1	0	**36**	0	0	2	0	0	1	0	0	2	**53**
	4-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**8**	0	0	0	0	0	0	0	0	**9**
	4-9	2	5	0	0	0	1	1	0	1	0	0	1	1	0	0	0	0	2	0	0	1	1	1	**62**	0	0	0	1	0	5	5	**90**
	4-11	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	**11**	0	0	0	0	6	**21**
	4-12	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	**6**	0	1	0	0	**11**
Other regimens (5)	5-1	1	1	5	3	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**37**	0	0	8	**58**
	5-2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	1	**3**
	5-3	2	3	0	1	0	0	0	0	12	0	0	1	1	1	0	0	0	1	0	0	2	0	0	0	4	0	0	1	0	**59**	6	**94**
	5-4	**26***	**67***	18	15	5	8	1	12	8	5	1	5	9	5	6	0	1	1	0	2	6	2	1	3	13	1	0	8	0	2	167	**398**
Unspecified		19	17	2	2	2	5	1	4	5	0	4	1	4	2	1	0	0	0	0	1	2	2	0	0	0	0	0	3	0	0	9	**86**
Total		**1037**	**497**	**140**	**101**	**57**	**77**	**17**	**97**	**312**	**19**	**66**	**151**	**137**	**49**	**10**	**7**	**4**	**41**	**4**	**18**	**36**	**56**	**11**	**69**	**23**	**14**	**7**	**66**	**4**	**93**	**385**	**3605**
% Concord.		*92*	*75*	*71*	*61*	*79*	*66*	*59*	*71*	*85*	*63*	*89*	*93*	*77*	*57*	*0*	*86*	*25*	*85*	*75*	*56*	*42*	*64*	*73*	*90*	*0*	*79*	*86*	*56*	*0*	*63*	---	*71*

**Major discrepancies between self-reported and prescribed ART are shown in red. Agreement between self-reported and prescribed ART regimen are highlighted in yellow.*

Coding of the regimens: the 1st number represents the major regimen group while the 2nd number stands for the order within that group in ART recommendation list (Table 2.2).

Table 3.5 Most recently prescribed ART regimens of HIV-infected adults receiving medical care in the United States—Medical Monitoring Project, 2009

Prescribed Regimen	Regimen detail combination	Freq.	Weighted n	Weighted %	95% CI
	Total	3737	373733	100.0	
Preferred regimens (1)	1-1.EFV/TDF/FTC* **(AI)**	1064	109385	29.3	(26.7-31.8)
	1-2.ATVr + TDF/FTC* **(AI)**	520	50021	13.4	(11.5-15.3)
	1-3.DRVr + TDF/FTC* **(AI)**	150	14993	4.0	(3.1-4.9)
	1-4.RAL + TDF/FTC* **(AI)**	106	10685	2.9	(2.2-3.5)
Alternative regimens (2)	2-1.EFV + ABC/3TC* **(BI)**	59	5885	1.6	(1.2-2.0)
	2-2.ATVr + ABC/3TC* **(BI)**	79	7512	2.0	(1.5-2.5)
	2-3.DRVr + ABC/3TC* **(BII)**	*19*#	*2165*#		
	2-4.FPVr + ABC/3TC* or TDF/FTC* **(BI)**	100	9471	2.5	(1.9-3.2)
	2-5.LPVr + ABC/3TC* or TDF/FTC* **(BI)**	325	32762	8.8	(7.7-9.8)
	2-6.RAL + ABC/3TC* **(BIII)**	19	1781	0.5	(0.3-0.7)
Regimens maybe selected (3)	3-1.EFV + ZDV/3TC*	68	6440	1.7	(1.2-2.3)
	3-2.NVP + (ABC/3TC* or TDF/FTCa or ZDV/3TC*)	154	15119	4.0	(3.1-5.0)
	3-3.(ATV or ATVr or DRVr or FPVr or LPVr or SQVr) + ZDV/3TC*	148	14083	3.8	(2.8-4.8)
	3-4.ATV + ABC/3TC*	49	4973	1.3	(0.9-1.8)
	3-5.SQVr + (ABC/3TC* or TDF/FTC*)	*10*#	*950*#		
	3-6.RAL + ZDV/3TC*	*7*#	*733*#		
	3-7.MVC + (ABC/3TC or TDF/FTC or ZDV/3TC*)	*4*#	*491*#		
Regimens NOT re-commended (4)	4-1.ABC/3TC/ZDV (co-formulated) as triple-NRTI combination regimen (**BI**)	42	4254	1.1	(0.7-1.5)
	4-3.DLV **(BIII)**	*4*#	*354*#		
	4-4.ddI + 3TC (or FTC) **(BIII)**	20	2307	0.6	(0.3-1.0)
	4-5.ddI + TDF **(BII)**	38	3748	1.0	(0.6-1.4)
	4-6.FPV (unboosted) **(BIII)**	58	5917	1.6	(1.1-2.0)
	4-7.IDV (unboosted) **(BIII)**	*11*#	*1079*#	0.3	(0.1-0.5)
	4-8.IDVr **(BIII)**	0			
	4-9.NFV **(BI)**	71	6865	1.8	(1.3-2.3)
	4-10.SQV (unboosted) **(BI)**	23	2545	0.7	(0.3-1.0)
	4-11.d4T + 3TC **(BI)**	*15*#	*1318*#		
	4-12.TPVr **(BI)**	*7*#	*578*#		
Other regimens (5)	5-1.Other ART with ETV	69	7136	1.9	(1.4-2.4)
	5-2.Other ART with TPV	*4*#	*337*#		
	5-3.LPVr alone	93	9293	2.5	(1.9-3.1)
	5-4.Other ART	401	45743	10.8	(9.3-12.4)

* 3TC may substitute for FTC or vice versa. **r** stands for Ritonavir boosted.

Rating of Recommendations: *A = Strong; B = Moderate; C = Optional*

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized t trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Population estimate was not provided because the coefficient of variance exceeded 30%.

Top 3 popular regimens are highlighted in yellow while second line of popularity in cyan.

3.3 Factors Associated with Major ART Regimens Groups

The demographic pattern of ART prescription in HIV-infected adults receiving care was studied using Rao-Scott modified chi-square tests (Table 3.6). Of 3,737 participants who were prescribed ART, prescribed major regimen groups were significantly associated with age groups, history of diagnosis, poverty level, and the type of insurance patients had. Gender, race, status of homeless, education level, and birth country were independent from the major ART regimen groups. Further multivariate logistic regression was applied to compare the probability of prescribing preferred-regimens over all other four groups (Table 3.7). After adjustment, preferred-regimens were more likely to be prescribed to younger (<50 years old), recently diagnosed (< 5 years), and above poverty level patients. Such preference in diagnosis history may be explained by the fact that the long-term HIV patients would reserve effective regimens from earlier prescription while the regimen categorization system used here was developed recently for ART initiation in naïve patients [32]. Compared to those with only private insurance, patients with only Ryan White (RW) coverage were more likely to get preferred-regimens, while those with only Medicare or both Medicare and Medicaid were less likely to be prescribed preferred-regimens.

Table 3.6 Correlation of major ART regimen groups and demographic characters of patients receiving medical care for HIV infection—Medical Monitoring Project, 2009

Characteristic	Sample size n	Preferred regimens (Row%)	Alternative regimens (Row%)	Regimens maybe selected (Row%)	Regimens NOT recom-mended (Row%)	Other regimens (Row%)	Chi-square* p-value
Total patients prescribed ART	***3737***	***49.56***	***15.94***	***11.45***	***7.60***	***15.46***	
Gender							0.1945
Male	2706	50.14	15.80	11.43	6.99	15.65	
Female	971	48.25	16.57	11.85	8.62	14.71	
Transgender or intersex	60	45.13	12.42	5.89	17.59	18.96	
Age at interview							<.0001
18-29 yrs	239	66.27	11.74	8.55	4.65	8.79	
30-39 yrs	615	58.86	15.53	9.40	5.59	10.62	

Characteristic	Sample size n	Preferred regimens (Row%)	Alternative regimens (Row%)	Regimens maybe selected (Row%)	Regimens NOT recom-mended (Row%)	Other regimens (Row%)	Chi-square* p-value
40-49 yrs	1476	50.82	15.76	11.29	6.67	15.47	
>=50 yrs	1407	41.48	16.98	12.98	9.93	18.63	
Race/Ethnicity							0.0761
Non-Hispanic Black	1495	50.64	15.92	11.70	7.33	14.41	
Hispanic	786	51.81	16.10	9.44	9.90	12.75	
Non-Hispanic White	1281	47.83	14.88	12.50	6.78	18.01	
Other	174	44.69	23.71	9.62	5.93	16.05	
Foreign born (Country of birth other than US or Puerto Rico)							0.2884
No, not born in foreign country	3270	49.00	15.76	11.71	7.88	15.66	
Yes, born in foreign country	465	53.42	17.13	9.71	5.60	14.14	
Length of time since HIV diagnosis							<.0001
<5 years	759	66.52	15.28	8.74	2.61	6.85	
5-9 years	885	52.20	15.47	13.21	7.31	11.81	
>=10 years	2091	42.14	16.40	11.67	9.58	20.21	
Homeless at any time in P12M							0.0806
No	3402	49.18	15.63	11.72	7.70	15.76	
Yes	335	53.46	19.18	8.59	6.52	12.25	
Type of health insurance during P12M							<.0001
No insurance	497	57.69	17.14	9.62	5.00	10.55	
Only RW	135	68.66	8.86	10.79	4.49	7.20	
Only private	861	54.47	12.84	11.29	7.73	13.66	
Only Medicaid	790	47.29	15.79	11.33	7.78	17.81	
Only Medicare	270	40.17	19.85	12.78	8.20	19.00	
Only Medicare and Medicaid	450	37.06	17.47	16.75	10.12	18.61	
Multiple public	439	47.40	16.94	9.55	5.73	20.38	
Private and public combo	247	47.17	21.64	8.03	10.75	12.42	
Unknown/unspecified insurance	42	53.51	15.30	7.39	7.68	16.12	
Education attainment							0.1749
<High School	878	47.82	16.66	11.02	8.67	15.83	
High School diploma or equivalent	1034	49.58	16.23	12.14	8.87	13.19	
>High School	1825	50.34	15.46	11.28	6.42	16.51	
Poverty Level during P12M							0.0177
Above poverty level	1982	51.49	15.21	11.49	6.36	15.46	
At or below poverty level	1639	47.15	16.95	11.59	8.94	15.36	

**Rao-Scott modified chi-square test*

Table 3.7 Logistic regression model of factors associated with prescription of preferred-regimens—Medical Monitoring Project, 2009

Characteristic	Unadjusted PR	Adjusted PR
Gender		
Male	Reference	Reference
Female	0.96 (0.88, 1.05)	0.95 (0.88, 1.03)
Transgender or intersex	0.90 (0.61, 1.32)	0.81 (0.55, 1.20)
Age at interview		
18-29 yrs	Reference	Reference
30-39 yrs	0.89 (0.78, 1.01)	0.96 (0.83, 1.11)
40-49 yrs	0.77 (0.69, 0.85)	0.90 (0.79, 1.03)
>=50 yrs	0.62 (0.54, 0.72)	0.78 (0.67, 0.91)

Characteristic	Unadjusted PR	Adjusted PR
Race/Ethnicity		
Hispanic	Reference	Reference
Non-Hispanic Black	0.98 (0.85, 1.12)	1.03 (0.90, 1.18)
Non-Hispanic White	0.92 (0.8, 1.07)	0.94 (0.82, 1.07)
Other	0.86 (0.68, 1.09)	0.85 (0.69, 1.05)
Foreign born (Country of birth other than US or Puerto Rico)		
No, not born in foreign country	1.09 (0.96, 1.24)	Not
Yes, born in foreign country	Reference	significant
Length of time since HIV diagnosis		
<5 years	Reference	Reference
5-9 years	1.58 (1.43, 1.74)	1.43 (1.31, 1.57)
>=10 years	1.24 (1.13, 1.36)	1.16 (1.07, 1.25)
Homeless at any time in P12M		
No	0.92 (0.82, 1.03)	Not
Yes	Reference	significant
Type of health insurance during P12M		
No insurance	1.06 (0.94, 1.19)	1.04 (0.92, 1.18)
Only RW	1.26 (1.10, 1.44)	1.22 (1.04, 1.42)
Only private	Reference	Reference
Only Medicaid	0.87 (0.78, 0.97)	0.92 (0.83, 1.02)
Only Medicare	0.73 (0.61, 0.87)	0.82 (0.68, 0.98)
Only Medicare and Medicaid	0.68 (0.58, 0.79)	0.77 (0.67, 0.89)
Multiple public	0.87 (0.72, 1.05)	0.95 (0.80, 1.12)
Private and public combo	0.87 (0.72, 1.04)	0.96 (0.83, 1.11)
Unknown/unspecified insurance	0.98 (0.72, 1.34)	0.95 (0.72, 1.25)
Education attainment		
<High School	Reference	Not
High School diploma or equivalent	1.04 (0.95, 1.13)	significant
>High School	1.05 (0.97, 1.14)	
Poverty Level during P12M		
Above poverty level	1.09 (1.01, 1.18)	1.09 (1.00, 1.20)
At or below poverty level	Reference	Reference
Types of AIDS (Clinical status from MRA)		
AIDS	Reference	Not
No AIDS	1.22 (1.12, 1.33)	significant
Nadir CD4 count (cells/mm3)		
0-199	Reference	Not
200-349	1.17 (1.07, 1.27)	significant
350-499	1.13 (0.99, 1.28)	
500+	1.10 (0.96, 1.27)	

PR: Prevalence ratio
PRs that were significantly larger than 1 are colored in red while those significantly less than 1 are in blue.

3.4 Comparison of ART Regimens

3.4.1 Comparison of Major Regimen Types

We selected four outcome variables: durable viral suppression, most recent viral suppression, dose-adherence, and side effects, to compare the performance of different ART regimens. Viral suppression was selected because it is the most important indicator of response to ART. Viral

load testing serves as a surrogate marker for treatment response and is commonly used in evaluating patients' health condition and clinical progression [32]. On the other hand, high level of drug adherence and minimal side effects are two key components in ensuring viral suppression with ART.

Crude associations of major regimen types with outcome variables were assessed in Table 3.8. Complied with current knowledge, ART was crucial for viral suppression. Among the patients not on ART, only 21.5% achieved durable viral suppression and 26.3% had most-recent viral suppression, respectively. These proportions were about 2 times lower than those of patients on ART: 66.7% and 79.13% achieved durable and most-recent viral suppression, respectively. Moreover, major ART groups were correlated with viral suppression and independent from side effects in past 30 days and drug adherences in past 3 days (measured by dose-adherence, instruction-adherence, and schedule-adherence).

One multivariate regression model was built for each for the outcome variable of interest. Dose-adherence was used as a surrogate for drug adherence model because (1) it was the most complete data among three measurements of adherences, (2) it was highly correlated with the other two adherence variables (Rao-Scott modified chi-square *p*-values of <.0001).

Logistic regression modeling results indicated that the prevalence ratios of viral suppression were similar for those who took preferred-regimens, alternative-regimens, maybe-selected-regimes and not-recommended regimens. The only difference was for those took other-regimens—regimens not on DHHS recommended list. Compared to preferred-regimens, patients on other-regimens were less likely to achieve durable viral suppression (prevalence ratio [PR], 0.86; 95% confidence interval [CI], 0.80-0.93) and most recent viral suppression (PR, 0.88; CI, 0.84-0.93). Other factors independently associated with durable viral suppression were older age

groups (>29 years old); non-Hispanic white, Hispanic and other race/ethnicity; long-term HIV patients (diagnosed ≥10 years ago); not homeless; above poverty level; partial or complete adherent to medication; without major depression; and with nadir CD4 counts of over 500 (Table 3.9). Other factors independently associated with most recent viral suppression were non-Hispanic white and Hispanic race/ethnicity; not homeless; above poverty level; non-binge drinker; partial or complete adherent to medication; without any depression; and with nadir CD4 counts of over 500 (Table 3.9).

Similar analyses for dose-adherence yielded PRs of 0.95 and 0.94 for maybe-selected-regimens group and other-regimens group, respectively (CIs of 0.89-1.00 and 0.90-0.98, respectively). There were no statistically significant differences in dose adherence for patients on preferred-regimens, alternative-regimens, and maybe-selected-regimens. Other factors independently associated with 100% dose adherence were older age group (>39 years old), long-term HIV patients (diagnosed 5-9 years ago), education of high school diploma or equivalent, non-binge drinker, those not on non-injection drug, and not depressed (Table 3.10).

The adjusted prevalence ratio of side effects was 1.34 times as high (CI, 1.04-1.73) for those who were on not-recommended-regimens. All other four major regimen groups were equally likely for developing side effects. On the other hand, side effects were more likely to be observed in participants who was non-Hispanic white and other race/ethnicity, were at or below poverty level, not adherent to ART, and suffered other or major depression (Table 3.10).

3.4.2 Comparison of Top Six Popular Regimens

As presented in Table 3.5, the top six popular ART regimens were (1-1) EFV/TDF/FTC, (1-2) ATVr with TDF/FTC, (2-5) LPVr with ABC/3TC or TDF/FTC, (3-2) NVP with (ABC/3TC or TDF/FTC or ZDV/3TC), (1-3) DRVr with TDF/FTC, and (3-3) any PIs (ATV or ATVr or DRVr

Table 3.8 Crude comparison of major regimens by outcomes of interest—Medical Monitoring Project, 2009

Most recently prescribed regimen			Most recent VL suppressed		Durable VL suppressed		100% Adherence						Had side effect in past 30 days	
							Dose		Instruction		Schedule			
n=3737			n=2904		n=2345		n=2994		n=1642		n=2553		n=617	
	n	Col%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%
Preferred-regimens	1840	43.9	1455	79.4	1134	62.3	1512	85.6	842	69.4	1294	73.7	288	16.2
Alternative-regimens	601	14.1	457	77.8	381	64.2	464	81.0	261	71.0	402	70.5	103	17.2
Maybe-selected-regimens	440	10.2	353	78.4	307	68.0	356	83.7	160	67.3	287	68.5	61	14.8
NOT-recommended-regimens	289	6.9	233	80.1	205	69.5	224	81.1	125	67.6	189	70.5	59	20.2
Other-regimens	567	13.6	406	71.3	318	55.0	438	80.1	254	67.0	381	69.5	106	20.0
p-value* (5 levels)			*0.006*		*0.0002*		*0.05*		*0.74*		*0.22*		*0.23*	
Did NOT prescribe ART	462	10.9	112	26.3	92	21.5								

**Rao-Scott modified chi-square test*

Table 3.9 Logistic regression models of factors associated with viral suppression in patients receiving ART prescription —Medical Monitoring Project, 2009

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square* p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square* p-value	Unadjusted PR	Adjusted PR
Total patients	3737 (62.7)				3737 (77.8)			
Demographic (Self-reported)								
Gender		<.0001				0.002		
Male	2706 (64.8)		Reference	Reference	2706 (79.8)		Reference	Reference
Female	971 (57.7)		0.89 (0.84, 0.95)	1.00 (0.95, 1.05)	971 (73.0)		0.92 (0.87, 0.96)	1.00 (0.96, 1.04)
Transgender or intersex	60 (49.8)		0.77 (0.60, 0.98)	0.90 (0.74, 1.09)	60 (70.8)		0.89 (0.73, 1.09)	0.98 (0.83, 1.15)
Age at interview		<.0001				<.0001		
18-29 yrs	239 (39.3)		Reference	Reference	239 (72.0)		Reference	Reference
30-39 yrs	615 (51.8)		1.32 (1.13, 1.54)	1.23 (1.04, 1.45)	615 (68.8)		0.96 (0.86, 1.06)	0.92 (0.84, 1.01)
40-49 yrs	1476 (63.6)		1.62 (1.37, 1.91)	1.39 (1.16, 1.65)	1476 (77.3)		1.07 (0.97, 1.18)	1.00 (0.92, 1.10)
>=50 yrs	1407 (70.2)		1.79 (1.55, 2.06)	1.51 (1.27, 1.80)	1407 (83.3)		1.16 (1.06, 1.26)	1.07 (0.99, 1.16)

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square* p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square* p-value	Unadjusted PR	Adjusted PR
Race/Ethnicity		<.0001				<.0001		
Hispanic	786 (64.4)		Reference	Reference	786 (79.8)		Reference	Reference
Non-Hispanic Black	1495 (54.9)		0.85 (0.78, 0.93)	0.86 (0.80, 0.92)	1495 (71.4)		0.89 (0.84, 0.96)	0.91 (0.86, 0.97)
Non-Hispanic White	1281 (70.6)		1.10 (1.02, 1.18)	1.03 (0.96, 1.10)	1281 (84.1)		1.05 (1.00, 1.11)	1.01 (0.96, 1.07)
Other	174 (61.1)		0.95 (0.84, 1.07)	0.95 (0.85, 1.07)	174 (76.5)		0.96 (0.88, 1.04)	0.96 (0.88, 1.05)
Foreign born (Country of birth other than US or Puerto Rico)		0.04				0.05		
No, not born in foreign country	3270 (61.9)		Reference	Not	3270 (77.3)		Reference	Not
Yes, born in foreign country	465 (67.7)		1.09 (1.01, 1.19)	significant	465 (81.7)		1.06 (1.00, 1.12)	significant
Length of time since HIV diagnosis		0.0004				0.94		
<5 years	759 (54.0)		Reference	Reference	759 (78.3)		Reference	
5-9 years	885 (66.4)		0.84 (0.75, 0.94)	0.94 (0.84, 1.05)	885 (78.1)		1.01 (0.96, 1.06)	Not
>=10 years	2091 (64.4)		1.03 (0.96, 1.11)	1.09 (1.02, 1.16)	2091 (77.6)		1.01 (0.95, 1.06)	significant
Homeless at any time in P12M		<.0001				<.0001		
No	3402 (64.6)		1.50 (1.29, 1.75)	1.26 (1.11, 1.43)	3402 (79.3)		1.26 (1.13, 1.42)	1.11 (1.02, 1.20)
Yes	335 (43.0)		Reference	Reference	335 (62.7)		Reference	Reference
Education attainment		<.0001				<.0001		
<High School	878 (56.3)		Reference		878 (70.9)		Reference	
High School diploma or equivalent	1034 (60.6)		1.08 (0.98, 1.19)	Not	1034 (75.0)		1.06 (0.98, 1.14)	Not
>High School	1825 (66.7)		1.19 (1.10, 1.28)	significant	1825 (82.5)		1.16 (1.09, 1.24)	significant
Poverty level during P12M		<.0001				<.0001		
Above poverty level	1982 (68.6)		1.24 (1.17, 1.32)	1.10 (1.04, 1.16)	1982 (83.2)		1.18 (1.13, 1.22)	1.08 (1.04, 1.12)
At or below poverty level	1639 (55.1)		Reference	Reference	1639 (70.8)		Reference	Reference
Behavior (Self-reported)								
Injection drug use during P12M		0.37				0.19		
No	3648 (62.8)		1.12 (1.04, 1.21)	Not	3648 (78.0)		1.12 (0.96, 1.32)	Not
Yes	79 (57.4)		Reference	considered	79 (74.6)		Reference	considered
Non-injection drug use during P12M		0.003				0.07		
No	2745 (64.4)		1.09 (0.91, 1.32)	Not	2745 (78.9)		1.06 (1.00, 1.12)	Not
Yes	980 (57.5)		Reference	significant	980 (74.6)		Reference	significant
Binge drinking in P12M		0.01				0.0003		
No	3083 (63.7)		1.11 (1.02, 1.22)	Not	3083 (79.0)		1.11 (1.05, 1.17)	1.04 (1.00, 1.09)
Yes	626 (57.2)		Reference	significant	626 (71.4)		Reference	Reference

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square* p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square* p-value	Unadjusted PR	Adjusted PR
Depression in P12M		<.0001				<.0001		
No depression	2794 (65.8)		Reference	Reference	2794 (80.6)		Reference	Reference
Other depression	475 (56.4)		0.86 (0.77, 0.95)	0.93 (0.85, 1.02)	475 (71.2)		0.88 (0.83, 0.94)	0.94 (0.89, 0.99)
Major depression	426 (49.6)		0.75 (0.66, 0.86)	0.84 (0.74, 0.94)	426 (67.8)		0.84 (0.77, 0.92)	0.91 (0.83, 0.99)
Overall adherence		<.0001				<.0001		
Not adherent	374 (48.5)		Reference	Reference	374 (62.4)		Reference	Reference
Partial adherent	1193 (61.5)		1.27 (1.06, 1.52)	1.17 (1.02, 1.34)	1193 (78.2)		1.25 (1.12, 1.41)	1.18 (1.08, 1.30)
100% adherent	2046 (68.8)		1.42 (1.19, 1.70)	1.27 (1.10, 1.47)	2046 (83.9)		1.35 (1.20, 1.50)	1.25 (1.14, 1.38)
Clinical status and care (from MRA)								
Type of AIDS		0.02				<.0001		
No AIDS	1002 (66.8)		1.09 (1.01, 1.18)	1.03 (0.94, 1.12)	1002 (82.9)		1.09 (1.05, 1.14)	1.03 (0.98, 1.09)
AIDS	2730 (61.2)		Reference	Reference	2730 (76.0)		Reference	Reference
Nadir CD4 count (cells/mm3)		<.0001				<.0001		
0-199	1928 (59.4)		Reference	Reference	1928 (74.6)		Reference	Reference
200-349	1008 (60.7)		1.02 (0.95, 1.10)	1.00 (0.92, 1.09)	1008 (79.1)		1.06 (1.01, 1.11)	1.01 (0.95, 1.07)
350-499	434 (67.1)		1.13 (1.04, 1.23)	1.08 (0.98, 1.19)	434 (81.2)		1.09 (1.02, 1.16)	1.02 (0.95, 1.11)
500+	346 (82.1)		1.38 (1.27, 1.51)	1.35 (1.25, 1.46)	346 (89.2)		1.20 (1.12, 1.28)	1.15 (1.07, 1.23)
Prescribed antiretroviral (ART) therapy in P12M		0.0002				0.0055		
Preferred-regimens	1840 (62.3)		Reference	Reference	1840 (79.4)		Reference	Reference
Alternative-regimens	601 (64.2)		1.03 (0.97, 1.09)	1.00 (0.95, 1.06)	601 (77.8)		0.98 (0.94, 1.02)	0.97 (0.93, 1.01)
Maybe-selected-regimens	440 (68.0)		1.09 (1.01, 1.18)	1.03 (0.95, 1.12)	440 (78.4)		0.99 (0.93, 1.05)	0.97 (0.91, 1.03)
NOT-recommended-regimens	289 (69.5)		1.12 (1.01, 1.24)	1.05 (0.95, 1.16)	289 (80.1)		1.01 (0.94, 1.08)	0.99 (0.92, 1.06)
Other-regimens	567 (55.0)		0.88 (0.80, 0.97)	0.86 (0.80, 0.93)	567 (71.3)		0.90 (0.84, 0.95)	0.88 (0.84, 0.93)

PRs that were significantly larger than 1 are colored in red while those significantly less than 1 are in blue.

**Rao-Scott modified chi-square test*

Table 3.10 Logistic regression models of factors associated with dose-adherence and side effect in patients receiving ART prescription—Medical Monitoring Project, 2009

Characteristic	100% Dose adherence				Troubled by side effects			
	Sample size n (% Dose adherence 100%)	Chi-square* p-value	Unadjusted PR	Adjusted PR	Sample size n (% Had side effect)	Chi-square* p-value	Unadjusted PR	Adjusted PR
Total patients	3613 (83.5)				3583 (17.1)			
Demographic (Self-reported)								
Gender		0.01				0.31		
Male	2636 (84.6)		Reference		2614 (16.4)		Reference	
Female	921 (80.9)		0.96 (0.93, 0.99)	Not	913 (18.9)		1.15 (0.95, 1.38)	Not
Transgender or intersex	56 (74.8)		0.88 (0.77, 1.02)	significant	56 (16.2)		0.99 (0.53, 1.83)	significant
Age at interview		0.02				0.06		
18-29 yrs	221 (78.2)		Reference	Reference	218 (19.4)		Reference	Reference
30-39 yrs	579 (80.5)		1.03 (0.95, 1.12)	1.06 (0.97, 1.16)	572 (20.1)		1.04 (0.71, 1.52)	1.08 (0.72, 1.61)
40-49 yrs	1430 (84.3)		1.08 (1.00, 1.16)	1.13 (1.03, 1.24)	1422 (17.9)		0.93 (0.65, 1.31)	0.92 (0.61, 1.40)
>=50 yrs	1383 (84.7)		1.08 (1.01, 1.16)	1.13 (1.04, 1.23)	1371 (14.6)		0.75 (0.55, 1.02)	0.81 (0.56, 1.15)
Race/Ethnicity		0.02				0.01		
Hispanic	762 (83.6)		Reference	Reference	758 (14.0)		Reference	Reference
Non-Hispanic Black	1437 (80.5)		0.96 (0.92, 1.01)	0.97 (0.92, 1.01)	1425 (15.5)		1.11 (0.90, 1.36)	1.12 (0.92, 1.37)
Non-Hispanic White	1247 (86.9)		1.04 (0.99, 1.10)	1.05 (0.99, 1.11)	1237 (19.9)		1.42 (1.16, 1.74)	1.58 (1.28, 1.94)
Other	166 (81.3)		0.97 (0.88, 1.07)	1.01 (0.93, 1.09)	162 (22.3)		1.60 (1.05, 2.43)	1.52 (1.00, 2.32)
Foreign born (Country of birth other than US or Puerto Rico)		0.91				0.09		
No, not born in foreign country	3157 (83.4)		Reference	Not	3131 (17.6)		Reference	Not
Yes, born in foreign country	454 (83.7)		1.00 (0.95, 1.06)	considered	450 (13.6)		0.77 (0.56, 1.06)	significant
Length of time since HIV diagnosis		0.01				0.37		
<5 years	725 (87.1)		Reference	Reference	717 (15.9)		Reference	
5-9 years	855 (84.1)		1.07 (1.02, 1.11)	1.09 (1.05, 1.14)	849 (15.9)		0.89 (0.73, 1.07)	Not
>=10 years	2031 (81.8)		1.03 (0.98, 1.08)	1.04 (0.99, 1.10)	2015 (18.0)		0.88 (0.69, 1.13)	significant
Homeless at any time in P12M		0.09				0.06		
No	3302 (83.9)		1.07 (0.99, 1.16)	Not	3278 (16.7)		0.77 (0.61, 0.98)	Not
Yes	311 (78.5)		Reference	significant	305 (21.5)		Reference	significant
Education attainment		0.003				0.02		
<High School	838 (78.1)		Reference	Reference	825 (17.1)		Not	Not
High School diploma or equivalent	997 (85.5)		1.10 (1.03, 1.16)	1.07 (1.00, 1.13)	992 (14.1)		considered	significant

Characteristic	100% Dose adherence				Troubled by side effects			
	Sample size n (% Dose adherence 100%)	Chi-square* p-value	Unadjusted PR	Adjusted PR	Sample size n (% Had side effect)	Chi-square* p-value	Unadjusted PR	Adjusted PR
>High School	1778 (84.8)		1.09 (1.04, 1.14)	1.04 (0.99, 1.09)	1766 (18.7)			
Poverty level during P12M		0.0002				0.001		
Above poverty level	1939 (85.8)		1.07 (1.03, 1.10)	Not	1927 (15.2)		0.77 (0.66, 0.90)	0.80 (0.69, 0.93)
At or below poverty level	1566 (80.5)		Reference	significant	1549 (19.6)		Reference	Reference
Behavior (Self-reported)								
Injection drug use during P12M		0.12				0.02		
No	3533 (83.8)		1.16 (0.98, 1.38)	Not	3509 (17.2)		1.59 (0.93, 2.73)	Not
Yes	70(72.0)		Reference	significant	67 (10.8)		Reference	significant
Non-injection drug use during P12M		<.0001				0.48		
No	2665 (86.5)		1.15 (1.10, 1.20)	1.12 (1.08, 1.17)	2648 (16.8)		0.94 (0.78, 1.12)	Not
Yes	937 (75.3)		Reference	Reference	927 (17.9)		Reference	significant
Binge drinking in P12M		<.0001				0.61		
No	2986 (85.5)		1.16 (1.10, 1.22)	1.12 (1.07, 1.17)	2965 (17.2)		1.07 (0.83, 1.37)	Not
Yes	599 (73.8)		Reference	Reference	594 (16.1)		Reference	significant
Depression in P12M		0.0006				<.0001		
No depression	2723 (85.5)		Reference	Reference	2711 (12.6)		Reference	Reference
Other depression	454 (73.8)		0.93 (0.88, 0.99)	0.94 (0.89, 0.99)	445 (23.5)		1.88 (1.54, 2.29)	1.79 (1.47, 2.19)
Major depression	396 (76.8)		0.90 (0.84, 0.96)	0.92 (0.86, 0.98)	392 (38.6)		3.08 (2.43, 3.90)	2.89 (2.26, 3.68)
Overall adherence						<.0001		
Not adherent					361 (25.0)		Reference	Reference
Partial adherent					1187(20.6)		0.83 (0.65, 1.05)	0.91 (0.73, 1.14)
100% adherent					2034(13.7)		0.55 (0.43, 0.70)	0.66 (0.51, 0.85)
Clinical status and care (from MRA)								
Type of AIDS		0.21				0.35		
No AIDS	961 (85.0)		1.03 (0.99, 1.07)	Not	952 (16.1)		Not	Not
AIDs	2647 (82.9)		Reference	significant	2626 (17.5)		considered	considered
Nadir CD4 count (cells/mm3)		0.002				0.48		
0-199	1870 (81.1)		Reference		1856 (17.0)			
200-349	968 (85.8)		1.06 (1.01, 1.11)	Not	958 (18.2)		Not	Not
350-499	421 (88.2)		1.09 (1.04, 1.14)	significant	420 (14.7)		considered	considered
500+	333 (84.5)		1.04 (0.98, 1.10)		328 (17.4)			
Prescribed antiretroviral (ART) therapy in P12M		0.05				0.22		

Characteristic	100% Dose adherence				Troubled by side effects			
	Sample size n (% Dose adherence 100%)	Chi-square* p-value	Unadjusted PR	Adjusted PR	Sample size n (% Had side effect)	Chi-square* p-value	Unadjusted PR	Adjusted PR
Preferred-regimens	1779 (85.6)		Reference	Reference	1762 (16.2)		Reference	Reference
Alternative-regimens	581 (81.0)		0.95 (0.89, 1.01)	0.96 (0.90, 1.01)	575 (17.2)		1.06 (0.80, 1.42)	1.09 (0.83, 1.42)
Maybe-selected-regimens	425 (83.7)		0.98 (0.92, 1.04)	0.97 (0.92, 1.03)	422 (14.8)		0.92 (0.66, 1.28)	1.03 (0.74, 1.42)
NOT-recommended-regimens	279 (81.1)		0.95 (0.89, 1.01)	0.95 (0.89, 1.00)	277 (20.2)		1.25 (0.99, 1.58)	1.34 (1.04, 1.73)
Other-regimens	549 (80.1)		0.94 (0.89, 0.98)	0.94 (0.90, 0.98)	547 (20.0)		1.24 (0.99, 1.55)	1.21 (0.97, 1.52)

PRs that were significantly larger than 1 are colored in red while those significantly less than 1 are in blue.
**Rao-Scott modified chi-square test*

or FPVr or LPVr or SQVr) with ZDV/3TC. They were all NRTIs based combinations with addition of either NNRTIs or PIs. They were in high ranks on the ART recommendation list as well (Table 2.2). Therefore, it will be instructive to compare these six regimens by means of associations with viral suppression, and self-reported dose adherence and side effects.

Crude associations of top six popular regimens with outcome variables were assessed in Table 3.11. There was a statistically significant association between regimens and viral suppression (both durable and most recent viral load). Different regimens were also correlated with dose adherence and schedule adherence. However, ART regimens were independent from instruction adherence and side effects.

A multivariate logistic regression model was setup for each of the four outcome variables. Again, dose-adherence was used as a surrogate for drug adherence. Adjusted prevalence ratios of four models were listed in Table 3.12 and Table 3.13. Compared to the most popular regimen—(1-1) EFV/TDF/FTC, patients on regimens [(1-2) ATVr with TDF/FTC, (2-5) LPVr with ABC/3TC or TDF/FTC and (1-3) DRVr with TDF/FTC] were less likely to achieve durable viral suppression. The adjusted prevalence ratios were 0.84 (0.76-0.94), 0.88 (0.81-0.96), and 0.69 (0.56, 0.86) for regimens (1-2), (2-5), and (1-3), respectively. Other two regimens [(3-2) NVP with (ABC/3TC or TDF/FTC or ZDV/3TC) and (3-3) any PI (ATV or ATVr or DRVr or FPVr or LPVr or SQVr) with ZDV/3TC] were parallel to regimen (1-1). On the other hand, for most recent viral load, patients on regimens (1-2), (2-5), (1-3) and (3-3) were less likely to achieve viral suppression. The adjusted prevalence ratios were 0.93 (0.87-1.00), 0.88 (0.82-0.95), 0.88 (0.79, 0.99) and 0.87 (0.77, 0.99) for regimens (1-2), (2-5), (1-3), and (3-3) respectively. Regimens (1-1) and (3-2) had same prevalence on most recent viral suppression. Other factors independently associated with durable viral suppression were older age groups (over 30 years

old), non-Hispanic white race/ethnicity, birth in foreign country, patients diagnosed more than 10 years ago, not homeless at any time, 100% adherent to medication, no or other depression, and patients with nadir CD4 counts of over 500 (Table 3.12). Other factors independently associated with most recent viral suppression were older age group (over 50 years old), diagnosed more than 10 years ago, not homeless at any time, partial or 100% drug adherent, and over 500 nadir CD4 counts (Table 3.12).

Similar analyses for dose-adherence yielded PRs of 0.90, 0.91 and 0.90 for regimens (1-2), (1-3) and (3-3), respectively (CIs of 0.83-0.97, 0.83-0.99 and 0.84-0.98, respectively). There was no statistically significant difference in dose adherence for regimens (1-1), (1-2) and (3-2). Other factors independently associated with 100% dose adherence were age group of 40-49, non-binge drinker, patients not on non-injection drug, and group without major depression (Table 3.13).

The prevalence ratio of side effects was 1.65 times as high (CI, 1.16-2.36) for those who were regimen (1-3) DRVr with TDF/FTC. All other five regimens did not show statistically significant differences in associations with side effects. Besides, side effects were more likely to be observed in participants who was non-Hispanic white race/ethnicity, were at or below poverty level, and suffered from any depression (Table 3.13).

Table 3.11 Crude comparison of top six popular regimens by outcomes of interest—Medical Monitoring Project, 2009

Most recently prescribed regimen			Most recent VL suppressed		Durable VL suppressed		100% Adherence						Had side effect in past 30 days	
							Dose		Instruction		Schedule			
n=2357			n=1865		n=1497		n=1917		n=1027		n=1625		n=367	
	n	Col%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%
1-1.EFV/TDF/FTC* **(AI)**	1060	46.3	899	84.1	737	69.0	908	87.6	484	70.2	812	78.7	160	15.3
1-2.ATV/r + TDF/FTC* **(AI)**	520	21.2	380	74.8	281	55.5	409	83.2	249	68.9	338	69.5	75	14.6
2-5.LPV/r + ABC/3TC* or TDF/FTC* (BI)	325	13.9	237	73.5	199	61.1	246	78.0	119	65.9	204	64.7	59	18.5
3-2.NVP + (ABC/3TC* or TDF/FTCa or ZDV/3TC*)	154	6.4	140	90.4	123	79.1	131	87.6	38	72.9	112	77.1	23	15.1
1-3.DRV/r + TDF/FTC* **(AI)**	150	6.3	103	69.5	65	46.5	112	81.3	74	62.8	79	57.2	33	26.6
3-3.(ATV or ATV/r or DRV/r or FPV/r or LPV/r or SQV/r) + ZDV/3TC*	148	6.0	106	67.6	89	56.9	111	78.7	63	73.1	80	57.4	17	13.8
***p-value*%**			*<.0001*		*<.0001*		*0.002*		*0.46*		*<.0001*		*0.09*	

* 3TC may substitute for FTC or vice versa. **/r** stands for Ritonavir boosted.
Rating of Recommendations: A = Strong; B = Moderate
Rating of Evidence: I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion
%*Rao-Scott modified chi-square test*

Table 3.12 Logistic regression models of factors associated with viral suppression in patients receiving top six popular ART regimen—Medical Monitoring Project, 2009

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square% p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square p-value%	Unadjusted PR	Adjusted PR
Total patients	2361 (63.5)				2361 (79.2)			
Demographic (Self-reported)								
Gender		0.02				0.02		
Male	1719 (65.5)		Reference	Reference	1719 (80.8)		Reference	Reference
Female	610 (58.8)		0.90 (0.82, 0.98)	1.02 (0.95, 1.09)	610 (74.6)		0.92 (0.87, 0.98)	1.02 (0.97, 1.06)
Transgender or intersex	33 (49.7)		0.76 (0.51, 1.12)	0.89 (0.67, 1.20)	33 (76.8)		0.95 (0.78, 1.16)	1.02 (0.89, 1.17)

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square p-value[%]	Unadjusted PR	Adjusted PR
Age at interview		<.0001				<.0001		
18-29 yrs	179 (38.1)		Reference	Reference	179 (75.1)		Reference	Reference
30-39 yrs	432 (54.4)		1.43 (1.18, 1.73)	1.25 (1.02, 1.52)	432 (70.1)		0.93 (0.83, 1.05)	0.91 (0.82, 1.01)
40-49 yrs	939 (65.5)		1.72 (1.44, 2.06)	1.40 (1.15, 1.70)	939 (78.9)		1.05 (0.96, 1.15)	1.01 (0.93, 1.09)
>=50 yrs	812 (71.6)		1.88 (1.60, 2.21)	1.49 (1.24, 1.79)	812 (85.3)		1.14 (1.04, 1.24)	1.08 (1.00, 1.16)
Race/Ethnicity		<.0001				<.0001		
Hispanic	492 (64.2)		Reference	Reference	492 (80.6)		Reference	Reference
Non-Hispanic Black	979 (57.3)		0.89 (0.81, 0.99)	0.93 (0.85, 1.02)	979 (73.9)		0.92 (0.86, 0.98)	0.93 (0.87, 0.99)
Non-Hispanic White	784 (71.6)		1.11 (1.01, 1.23)	1.12 (1.02, 1.22)	784 (85.2)		1.06 (1.00, 1.12)	1.02 (0.96, 1.08)
Other	107 (55.5)		0.86 (0.73, 1.03)	0.94 (0.82, 1.08)	107 (75.0)		0.93 (0.84, 1.03)	0.97 (0.88, 1.06)
Foreign born (Country of birth other than US or Puerto Rico)		0.07				0.19		
No, not born in foreign country	2049 (62.7)		Reference	Reference	2049 (78.6)		Reference	Not
Yes, born in foreign country	313 (69.0)		1.10 (1.00, 1.21)	1.11 (1.02, 1.21)	313 (82.4)		1.05 (0.98, 1.12)	significant
Length of time since HIV diagnosis		<.0001				0.80		
<5 years	590 (54.3)		Reference	Reference	590 (78.9)		Reference	Reference
5-9 years	587 (67.9)		0.82 (0.74, 0.91)	0.89 (0.80, 1.00)	587 (80.3)		1.00 (0.94, 1.06)	1.02 (0.96, 1.08)
>=10 years	1184 (66.3)		1.02 (0.95, 1.10)	1.07 (1.00, 1.14)	1184 (78.8)		1.02 (0.97, 1.07)	1.05 (1.01, 1.09)
Homeless at any time in P12M		<.0001				<.0001		
No	2134 (65.7)		1.57 (1.30, 1.88)	1.26 (1.09, 1.46)	2134 (80.9)		1.31 (1.14, 1.50)	1.15 (1.03, 1.29)
Yes	228 (42.0)		Reference	Reference	228 (61.9)		Reference	Reference
Education attainment		0.04				<.0001		
<High School	548 (60.3)		Reference	Not	548 (73.8)		Reference	Not
High School diploma or equivalent	667 (60.8)		1.01 (0.90, 1.13)	significant	667 (75.1)		1.02 (0.94, 1.10)	significant
>High School	1147 (66.5)		1.10 (1.02, 1.19)		1147 (83.7)		1.13 (1.06, 1.21)	
Poverty level during P12M		<.0001				<.0001		
Above poverty level	1281 (68.3)		1.19 (1.11, 1.28)	Not	1281 (84.1)		1.15 (1.10, 1.21)	1.06 (1.01, 1.12)
At or below poverty level	1013 (57.3)		Reference	significant	1013 (72.8)		Reference	Reference
Behavior (Self-reported)								
Injection drug use during P12M		0.64				0.40		
No	2308 (63.6)		1.06 (0.82, 1.38)	Not	2308 (79.3)		1.10 (0.88, 1.36)	Not
Yes	45 (59.8)		Reference	significant	45 (72.2)		Reference	significant

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square p-value[%]	Unadjusted PR	Adjusted PR
Non-injection drug use during P12M		0.005				0.03		
No	1716 (65.5)		1.13 (1.04, 1.23)	Not significant	1716 (80.4)		1.06 (1.00, 1.13)	Not significant
Yes	637 (58.0)		Reference		637 (75.5)		Reference	
Binge drinking in P12M		0.05				0.007		
No	1922 (64.5)		1.10 (1.00, 1.22)	Not significant	1922 (80.2)		1.09 (1.02, 1.15)	Not significant
Yes	417 (58.6)		Reference		417 (73.9)		Reference	
Depression in P12M		<.0001				0.0005		
No depression	1779 (66.3)		Reference	Reference	1779 (81.3)		Reference	Not significant
Other depression	295 (58.4)		0.88 (0.78, 1.00)	0.95 (0.85, 1.07)	295 (73.3)		0.90 (0.84, 0.97)	
Major depression	258 (50.1)		0.76 (0.65, 0.87)	0.83 (0.73, 0.94)	258 (70.9)		0.87 (0.79, 0.96)	
Overall adherence		<.0001				<.0001		
Not adherent	224 (49.3)		Reference	Reference	224 (62.0)		Reference	Reference
Partial adherent	744 (62.0)		1.26 (1.03, 1.53)	1.13 (0.97, 1.33)	744 (80.7)		1.30 (1.12, 1.51)	1.19 (1.09, 1.30)
100% adherent	1311 (70.0)		1.42 (1.17, 1.72)	1.23 (1.06, 1.44)	1311 (84.8)		1.37 (1.18, 1.58)	1.23 (1.12, 1.35)
Clinical status and care (from MRA)								
Type of AIDS		0.42				0.01		
No AIDs	699 (65.3)		1.04 (0.95, 1.14)	Not significant	699 (83.0)		1.07 (1.01, 1.13)	Not significant
AIDs	1661 (62.8)		Reference		1661 (77.5)		Reference	
Nadir CD4 count (cells/mm3)		<.0001				0.0004		
0-199	1177 (61.6)		Reference	Reference	1177 (76.1)		Reference	Reference
200-349	653 (58.7)		0.95 (0.87, 1.05)	0.94 (0.86, 1.02)	653 (79.5)		1.05 (0.98, 1.12)	1.00 (0.94, 1.07)
350-499	278 (68.3)		1.11 (1.00, 1.23)	1.05 (0.95, 1.16)	278 (84.1)		1.11 (1.02, 1.20)	1.05 (0.97, 1.13)
500+	238 (81.5)		1.32 (1.19, 1.47)	1.29 (1.16, 1.43)	238 (89.2)		1.17 (1.08, 1.28)	1.11 (1.01, 1.22)
Prescribed antiretroviral (ART) therapy in P12M		<.0001				<.0001		
1-1.EFV/TDF/FTC* (AI)	1064 (69.0)		Reference	Reference	1064 (84.1)		Reference	Reference
1-2.ATV/r + TDF/FTC* (AI)	520 (55.5)		0.80 (0.71, 0.91)	0.84 (0.76, 0.94)	520 (74.8)		0.89 (0.83, 0.96)	0.93 (0.87, 1.00)
2-5.LPV/r + ABC/3TC* or TDF/FTC* (BI)	325 (61.1)		0.89 (0.81, 0.97)	0.88 (0.81, 0.96)	325 (73.5)		0.87 (0.81, 0.94)	0.88 (0.82, 0.95)
3-2.NVP + (ABC/3TC* or TDF/FTCa or ZDV/3TC*)	154 (79.1)		1.15 (0.99, 1.32)	0.99 (0.83, 1.19)	154 (90.4)		1.08 (0.99, 1.16)	1.03 (0.94, 1.14)
1-3.DRV/r + TDF/FTC* (AI)	150 (46.5)		0.67 (0.53, 0.85)	0.69 (0.55, 0.86)	150 (69.5)		0.83 (0.73, 0.93)	0.88 (0.79, 0.99)

Characteristic	Durable viral suppression				Most recent viral suppression			
	Sample size n (% Durable VL suppressed)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR	Sample size n (% Recent VL suppressed)	Chi-square p-value[%]	Unadjusted PR	Adjusted PR
3-3.(ATV or ATV/r or DRV/r or FPV/r or LPV/r or SQV/r) + ZDV/3TC*	148 (56.9)		0.82 (0.70, 0.97)	0.89 (0.77, 1.03)	148 (67.6)		0.80 (0.70, 0.93)	0.87 (0.77, 0.99)

[*] *3TC may substitute for FTC or vice versa.*
PRs that were significantly larger than 1 are colored in red while those significantly less than 1 are in blue.
[%]*Rao-Scott modified chi-square test*

Table 3.13 Logistic regression models of factors associated with dose-adherence and side effect receiving top six popular ART regimen—Medical Monitoring Project, 2009

Characteristic	100% Dose adherence				Troubled by side effects			
	Sample size n (% Dose adherence 100%)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR	Sample size n (% Had side effect)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR
Total patients	2279 (84.4)				2259 (16.2)			
Demographic (Self-reported)								
Gender		0.02				0.14		
Male	1676 (85.9)		Reference	Reference	1662 (16.1)		Reference	
Female	572 (80.5)		0.94 (0.89, 0.98)	0.92 (0.88, 0.97)	566 (17.4)		1.08 (0.84, 1.39)	Not
Transgender or intersex	32 (81.7)		0.95 (0.80, 1.13)	0.96 (0.81, 1.14)	32 (4.7)		0.30 (0.08, 1.11)	significant
Age at interview		0.06				0.25		
18-29 yrs	166 (78.4)		Reference	Reference	164 (18.8)		Reference	
30-39 yrs	403 (82.2)		1.05 (0.95, 1.15)	1.05 (0.96, 1.15)	397 (19.2)		1.02 (0.67, 1.57)	
40-49 yrs	912 (85.1)		1.09 (0.99, 1.19)	1.09 (1.00, 1.18)	906 (16.0)		0.86 (0.58, 1.27)	Not
>=50 yrs	799 (86.0)		1.10 (1.00, 1.20)	1.08 (0.99, 1.17)	793 (14.4)		0.77 (0.51, 1.15)	significant
Race/Ethnicity		0.08				0.04		
Hispanic	473 (86.5)		Reference		471 (14.2)		Reference	Reference
Non-Hispanic Black	945 (81.6)		0.94 (0.90, 0.99)		935 (13.9)		0.98 (0.77, 1.24)	0.93 (0.72, 1.19)
Non-Hispanic White	762 (87.1)		1.01 (0.95, 1.07)	Not	757 (19.3)		1.36 (1.05, 1.75)	1.36 (1.06, 1.74)
Other	100 (81.0)		0.94 (0.82, 1.07)	significant	97 (23.1)		1.62 (0.96, 2.75)	1.44 (0.87, 2.39)

Characteristic	100% Dose adherence				Troubled by side effects			
	Sample size n (% Dose adherence 100%)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR	Sample size n (% Had side effect)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR
Foreign born (Country of birth other than US or Puerto Rico)		0.78				0.22		
No, not born in foreign country	1975 (84.4)		Reference	Not	1958 (16.7)		Reference	Not
Yes, born in foreign country	305 (85.0)		1.01 (0.95, 1.06)	considered	302 (13.5)		0.81 (0.56, 1.16)	significant
Length of time since HIV diagnosis		0.44				0.80		
<5 years	569 (86.3)		Reference		564 (16.8)		Reference	
5-9 years	563 (84.1)		1.03 (0.99, 1.08)	Not	559 (15.1)		1.02 (0.78, 1.32)	Not
>=10 years	1147 (83.6)		1.01 (0.95, 1.07)	considered	1136 (16.5)		0.92 (0.66, 1.27)	considered
Homeless at any time in P12M		0.36				0.07		
No	2070 (84.7)		1.04 (0.95, 1.14)	Not	2053 (15.7)		0.73 (0.53, 0.98)	Not
Yes	210 (81.4)		Reference	significant	207 (21.7)		Reference	significant
Education attainment		0.09				0.26		
<High School	521 (80.9)		Reference		513 (16.3)		Reference	
High School diploma or equivalent	647 (86.1)		1.06 (1.01, 1.13)	Not	644 (14.1)		0.87 (0.63, 1.19)	Not
>High School	1112 (85.1)		1.05 (1.00, 1.11)	significant	1103 (17.3)		1.06 (0.84, 1.35)	considered
Poverty level during P12M		0.005				0.07		
Above poverty level	1252 (86.6)		1.07 (1.02, 1.12)	Not	1244 (14.6)		0.80 (0.63, 1.02)	0.80 (0.64, 1.00)
At or below poverty level	965 (81.2)		Reference	significant	953 (18.2)		Reference	Reference
Behavior (Self-reported)								
Injection drug use during P12M		0.14				0.78		
No	2232 (84.9)		1.33 (0.91, 1.96)	Not	2216 (16.3)		1.09 (0.59, 2.02)	Not
Yes	39 (63.7)		Reference	significant	37 (15.0)		Reference	considered
Non-injection drug use during P12M		<.0001				0.31		
No	1664 (87.4)		1.14 (1.08, 1.20)	1.11 (1.06, 1.17)	1652 (15.8)		0.89 (0.72, 1.11)	Not
Yes	608 (76.7)		Reference	Reference	602 (17.7)		Reference	considered
Binge drinking in P12M		<.0001				0.61		
No	1857 (86.6)		1.15 (1.09, 1.21)	1.12 (1.06, 1.17)	1842 (16.4)		1.07 (0.81, 1.43)	Not
Yes	400 (75.1)		Reference	Reference	398 (15.3)		Reference	considered
Depression in P12M		0.001				>.0001		
No depression	1735 (86.3)		Reference	Reference	1727 (12.3)		Reference	Reference
Other depression	278 (81.7)		0.95 (0.89, 1.00)	0.95 (0.90, 1.00)	273 (21.2)		1.73 (1.33, 2.25)	1.68 (1.26, 2.25)
Major depression	238 (76.1)		0.88 (0.81, 0.96)	0.91 (0.85, 0.99)	235 (37.2)		3.03 (2.20, 4.16)	3.00 (2.12, 4.25)

Characteristic	100% Dose adherence				Troubled by side effects			
	Sample size n (% Dose adherence 100%)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR	Sample size n (% Had side effect)	Chi-square[%] p-value	Unadjusted PR	Adjusted PR
Overall adherence						<.0001		
Not adherent					217 (22.2)		Reference	Reference
Partial adherent					739 (20.2)		0.91 (0.67, 1.23)	1.09 (0.81, 1.47)
100% adherent					1303 (13.1)		0.59 (0.44, 0.78)	0.76 (0.56, 1.03)
Clinical status and care (from MRA)								
Type of AIDS		0.61				0.75		
No AIDS	670 (85.3)		1.01 (0.96, 1.07)	Not	663 (15.8)		Not	Not
AIDs	1608 (84.1)		Reference	considered	1595 (16.4)		considered	considered
Nadir CD4 count (cells/mm3)		0.05				0.52		
0-199	1140 (82.3)		Reference		1130 (15.9)			
200-349	629 (85.9)		1.04 (0.98, 1.11)	Not	623 (16.9)		Not	Not
350-499	268 (89.8)		1.09 (1.02, 1.17)	significant	267 (13.8)		considered	considered
500+	227 (86.5)		1.05 (0.98, 1.13)		224 (18.4)			
Prescribed antiretroviral (ART) therapy in P12M		0.002				0.09		
1-1.EFV/TDF/FTC* (AI)	1040 (87.6)		Reference	Reference	1030 (15.3)		Reference	Reference
1-2.ATV/r + TDF/FTC* (AI)	497 (83.2)		0.95 (0.89, 1.01)	0.96 (0.90, 1.02)	492 (14.6)		0.95 (0.74, 1.22)	0.89 (0.69, 1.15)
2-5.LPV/r + ABC/3TC* or TDF/FTC* (BI)	313 (78.0)		0.89 (0.82, 0.97)	0.90 (0.83, 0.97)	312 (18.5)		1.21 (0.87, 1.69)	1.17 (0.86, 1.59)
3-2.NVP + (ABC/3TC* or TDF/FTCa or ZDV/3TC*)	151 (87.6)		1.00 (0.93, 1.08)	0.98 (0.91, 1.05)	150 (15.1)		0.99 (0.53, 1.84)	1.19 (0.66, 2.13)
1-3.DRV/r + TDF/FTC* (AI)	140 (81.3)		0.93 (0.85, 1.01)	0.91 (0.83, 0.99)	139 (26.6)		1.73 (1.21, 2.49)	1.65 (1.16, 2.36)
3-3.(ATV or ATV/r or DRV/r or FPV/r or LPV/r or SQV/r) + ZDV/3TC*	138 (78.7)		0.90 (0.84, 0.96)	0.91 (0.84, 0.98)	139 (26.6)		0.90 (0.57, 1.42)	0.89 (0.57, 1.39)

[*] *3TC may substitute for FTC or vice versa.*

PRs that were significantly larger than 1 are colored in red while those significantly less than 1 are in blue.

[%]*Rao-Scott modified chi-square test*

CHAPTER 4 DISCUSSION

Although many clinical trials and cohort studies have been conducted to compare the efficacy and effectiveness of different ART regimens, this is the first analysis that provides a nationally representative profile of current ART usage and related health outcomes, including viral suppression, adherence and side effects, of HIV-infected adults in care in the United States. MMP is a national surveillance system that uses probability sampling methods. Both interviews and medical record abstractions were collected from 23 project areas (16 states, 1 U.S. territory, and 6 health jurisdictions) in the United States. Large proportion of MMP participants were male (71%) and with age of over 40 (65%). Seventy-seven percent of HIV infected adults in care had been diagnosed for more than 4 years. ART, especially HAART, is the key contributor in extending and improving these patients' lives. The prescription of ART was high among MMP participants (88.6%). Prescribed regimens were further categorized into five major groups based on most recent DHHS HIV treatment guidelines [32]: preferred-regimens, alternative-regimens, maybe-selected-regimens, not-recommended-regimens and other-regimens (Table 2.2). Approximately half of the participants on ART took preferred-regimens. Multivariate analysis suggested that the patients not prescribed preferred-regimens were more likely to be older (>50 years old), with diagnosed with HIV >5 years, at/below poverty level, and insured by Medicare or both Medicare and Medicaid insurances. The disconnection between preferred-regimens and long-term patients can be explained by the fact that patients diagnosed a long time age would continue to use effective regimens from prescribed at a time when more limited ART options were available, while the regimen classification system applied here was based on most recent DHHS Art treatment guidelines for ART initiation in naïve patients [32].

The top six popular regimens were (1-1) EFV/TDF/FTC, (1-2) ATVr with TDF/FTC, (2-5) LPVr with ABC/3TC or TDF/FTC, (3-2) NVP with (ABC/3TC or TDF/FTC or ZDV/3TC), (1-3) DRVr with TDF/FTC, and (3-3) any PI (ATV or ATVr or DRVr or FPVr or LPVr or SQVr) with ZDV/3TC. Each was prescribed to 29.3%, 13.4%, 8.8%, 4.0%, 4.0%, and 3.8% of the MMP participants, respectively. All of them were "cocktail" regimens based on NRTI backbone with addition of NNRTI or PI. (1-1)EFV/TDF/FTC, the most popular and most recommended ART regimen, is simple to use (available in a fixed-dose pill, one pill once daily) and was proved to be the most efficient and safe regimen in a 9-Country 3-Way random clinical trial [60]. Different NRTI backbone were employed in these six regimens: TDF/FTC for regimens (1-1), (1-2), and (1-3); ZDV/3TC for regimen (3-3); either one or ABC/3TC for (2-5) and (3-2). However, experts' panel review had suggested that these recommended regimens (TDF-based or ZDV-based) are comparable in terms of efficacy and safety [61]. On the other hand, regimens containing NVP are more cost-effective than with EFV [61].

There was a high concordance between ART prescription and self-reported ART use. Among MMP participants, 86.2% were prescribed ART and were currently taking ART, while 8.9% participants were not currently taking ART, neither were they prescribed. Only 2.9% patients were prescribed but not taking ART and 2.0% who were currently on ART but were not prescribed ART within the 2009 surveillance period. This finding is consistent with other reports of relatively high correspondence between self-report and medical record abstraction [62, 63].

ART was crucial for viral suppression. Among MMP participants, only 11% were not prescribed ART. However, significantly lower proportion achieved viral suppression in non-ART users than in ART users. Therefore, as recommended in recent treatment guidelines [32], ART should be recommended to every HIV-infected patient to maintain suppressed viral load

and health status. Out-of-care HIV patients are at high risk because they do not have access to ART.

Understanding the relative impact of different regimens may inform efforts and resources to increase appropriate ART medication among HIV-infected patients. Different regimens were compared by means of viral suppression, drug adherence and side effects using multivariate logistic regression. The major ART groups (preferred-regimens, alternative-regimens, maybe-selected-regimens) performed similarly. Minor differences were observed for not-recommended-regimens and other-regimens. Patients on other-regimens (regimens not on the DHHS recommended list) were less likely to achieve viral suppression, or to be dose adherent. Besides, patients on not-recommended-regimens were more likely to have side effects. Comparison of top six regimens revealed small disparities in adjusted prevalence ratios for four outcome variables. Regimen (1-3) was the worst among six top popular regimens. Patients on regimens (1-2), (2-5) and (1-3) were less likely to achieve viral suppression in durable VL and most recent VL while those on (1-3) and (3-3) were less likely to fully adherent to medications. In addition, patients on regimen (1-3) were more prone to side effects compared to regimen (1-1).

The differences in impacts of individual regimen or major regimen groups on the health outcomes were subtle. The adjusted prevalence ratios of regimens for viral suppression, ART adherence, and trouble with side effects were fairly close to 1, although statistically significantly different from 1. Comparable health outcomes from different ART regimens were also reported by Martin and colleagues using a cohort study [64]. Such findings are in concordant with WHO (World Health Organization) experts' panel review comments [61].

Other factors associated with viral suppression were age, race, length of HIV diagnosis, homeless status, depression, drug adherence, and nadir CD4 counts. Patients that were older,

diagnosed with HIV less recently, not homeless, not depressed, highly drug adherent, with high CD4 counts were more likely to achieve viral suppression. Non-Hispanic black patients were less likely to be viral suppressed compared to Hispanic race, while non-Hispanic white were more likely to be suppressed. Similar conclusions have been reported by several other studies [35, 65-68].

Other factors associated with dose-adherence included age, homeless status, poverty level, certain behaviors (such as binge drink, non-injection drug usage), and depression level. Consistent with the published results [35, 68-70], younger, homeless, low poverty level, binge drinker and non-injection drug users were less likely to be adherent to ART medications.

Logistic regression model suggested that self-reported side effects were independently correlated with race, poverty level and depression, as well as ART regimen. Non-Hispanic white patients were more likely to develop side effects. Participants above poverty level and not depressed were less likely to have side effects. There was a statistically significant positive association between depression and side effects. Logistic regression modeling results indicated that the aPRs of side effects almost doubled for those reporting with other depression (PR 1.8, CI 1.5-2.2 for model of major regimen groups; PR 1.7, CI 1.3-2.3 for model of six top regimens), and tripled for those reporting with major depression (PR 2.9, CI 2.3-3.7 for model of major regimen groups; PR 3.0, CI 2.1-4.3 for model of six top regimens). The impact of depression on side effects could be complicated. Several studies had suggested that depression were associated with non-adherence [35, 71, 72], while the latter could induce drug resistance and side effects [69]. On the other hand, drug interactions between anti-depressants and ART medications may also contribute to the development of side effects. Currently a full list of medications for depression in not covered by medical record abstraction in MMP, thus this effect could hardly be

evaluated. Nevertheless, this strong association between depression and side effects emphasizes the need and importance of active screening and treating for depression among HIV-infected patients [61].

Although this thesis has focused on ART prescription/non-prescription, and regimen comparisons within those participants who were prescribed and took ART, it would be instructive to explore the discrepancies between doctors' prescription and patients' medication, and the consequences on viral suppression. MMP participants were categorized into four groups based on ART usage, as shown in Table 4.1, "Prescribed and Took", "Prescribed and NOT took", "NOT prescribed and Took", and "NOT prescribed and NOT took". The crude comparison suggested that two groups of "NOT Took" had significantly lower proportions of viral suppression. The percentage with recent/durable viral suppression were only 18.2%/11.4% and 15.4%/13.1% for "Prescribed and NOT Took" and "NOT prescribed and NOT took" groups, respectively. The survey questions on drug adherence and side effects were skipped for these two groups of participants. Significantly low proportion (23.2%) of patients were diagnosed with AIDS in the "NOT prescribed and NOT Took" group, compared to the other three groups (around 70%). This might be a reason why this group of patients was not exposed to ART. On the other hand, more than half of the participants in the "NOT prescribed and Took" group had suppressed viral load (59.7% and 46.2% for recent and durable viral suppression, respectively); although such proportions were less than those of "Prescribed and Took" group (79.9% and 64.4% for recent and durable viral suppression, respectively). Besides, higher percentage (26.1%) of participants in "NOT prescribed and Took" group was troubled with side effects than that (17.1%) of "Prescribed and Took" group. These findings reinforce the importance of ART and furthermore, the significance of adherence [35, 65-68]. The solid lifelong commitment to

ART is the key in fighting HIV/AIDS [32]. Additionally, routinely follow-up care after ART initiation is necessary to maintain viral suppression and minimize side effects. Unfortunately, multivariate regression analyses for the three minor groups were not appropriate at this point because of the relatively small sample sizes. In the future, such modeling may become possible if multiple years of MMP data can be combined. Further research to characterize and target these three minor groups will help to optimize the use of ART regimens and maximize their benefits for all HIV-infected patient population.

Table 4.1 Crude comparison of prescription *vs.* medication by outcomes of interest—Medical Monitoring Project, 2009

ART Prescription *vs.* Medication			AIDS diagnosis		Most recent VL suppressed		Durable VL suppressed		100% Adherence						Had side effect in past 30 days	
									Dose		Instruction		Schedule			
n=4193			n=2904		n=3013		n=2434		n=3067		n=1684		n=2617		n=639	
	n	Col%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%	n	Row%
Prescribed and Took	3605	86.2	2640	72.0	2877	79.9	2327	64.4	2994	85.6	1642	68.9	2553	71.7	617	17.1
Prescribed and NOT Took	128	2.9	86	68.7	25	18.2	16	11.4	--	--	--	--	--	--	--	--
NOT prescribed and Took	91	2.0	64	71.3	55	59.7	44	46.2	73	86.2	42	72.2	64	70.5	22	26.1
NOT prescribed and NOT took	369	8.9	91	23.2	56	15.4	47	13.1	--	--	--	--	--	--	--	--
p-value*			*<.0001*		*<.0001*		*<.0001*		*0.90*		*0.59*		*0.82*		*0.07*	

**Rao-Scott modified chi-square test*

CHAPTER 5 STUDY LIMITATIONS

Despite the advantages of providing nationally representative estimates, this study is subject to several limitations:

1st, MMP study is limited to HIV-infected adults receiving care therefore it cannot be generalized to all HIV-infected persons in the United States.

2nd, the overall response rate was relatively low (42.4%). Although non response weighting was used, non-response bias can affect the reliability of population estimates.

3rd, MMP is a cross-sectional study, the risk factors and outcomes were measured at the same time, thus finding of any significant association could not be proved as causal.

4th, part of the data of this analysis were obtained from survey; while survey was collected via in-person interviews, certain responses might be subject to recall and social desirability bias, for example, the drug adherence may be over-reported. Moreover, data abstracted from medical records may involve recording errors.

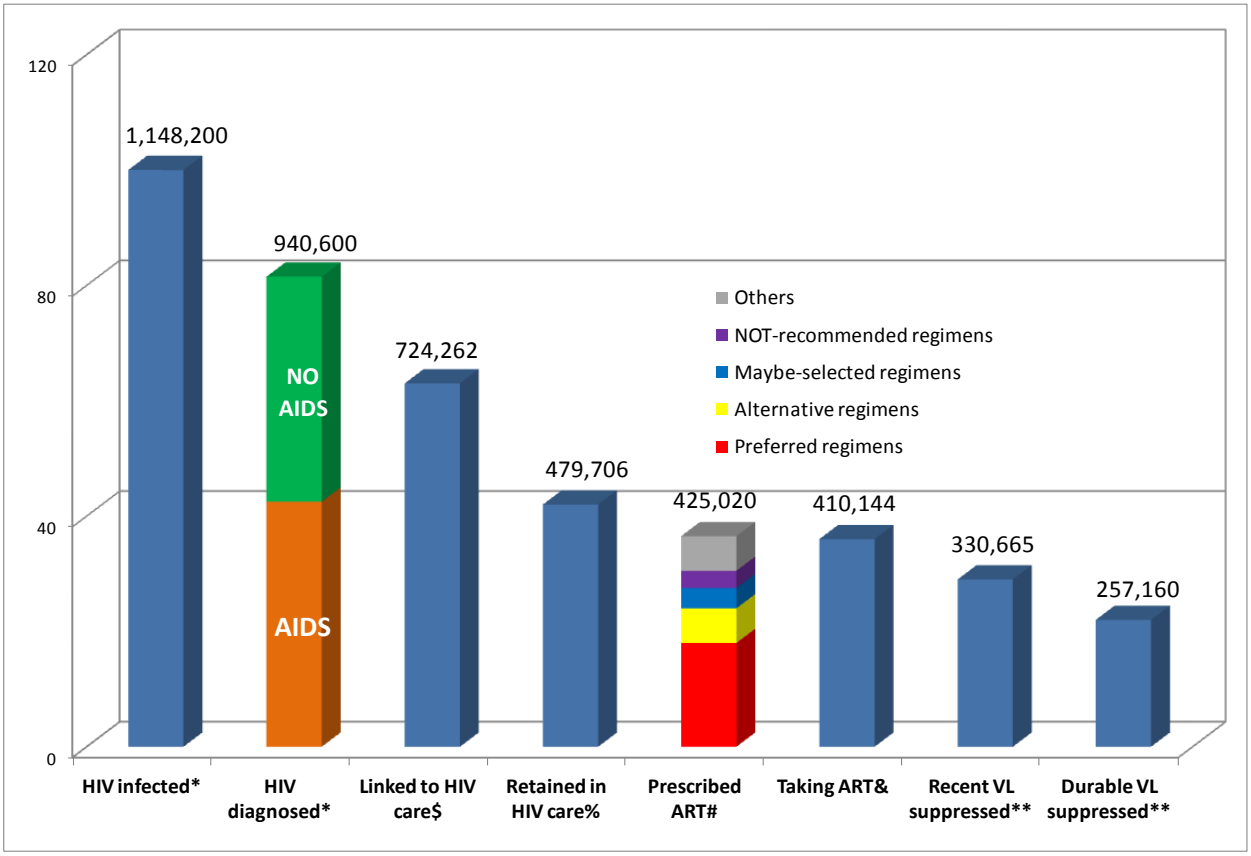
5th, it is difficult to determine the temporal sequence of outcomes and HIV regimens. The viral load, drug adherence, and drug side effect may result from the history of ART treatment and demand modifications in most recent prescription.

Finally, our logistic regression models can consider only a limited number of factors because of the relative small sample size, although MMP collected many more behavior and clinical information. Therefore, interpretation of presence or absence of significant finding might be potential confounded by other factors that the study did not examine. For instance, ART prescription can potentially be affected by patient's health condition and doctor's preferences.

CHAPTER 6 CONCLUSIONS

This thesis provides a nationally representative profile of current ART usage and related health outcomes, including viral suppression, adherence and side effects, of HIV-infected adults receiving care in the United States in 2009. Results showed that a large volume of HIV-infected adults receiving care was prescribed with ART (88.6%). Cocktail regimens based on two NRTIs with addition of NNRTI or PIs were most commonly employed. Approximately half of the participants prescribed ART took preferred-regimens and about 30% were using regimen (1-1) EFV/TDF/FTC. Of MMP participants who were prescribed ART, 96.5% self-reported took ART, 62.7% achieved suppression of durable VL, 77.8% achieved suppression of most recent VL, 83.5% were 100% dose-adherent, and 17.1% complained about side effects. Figure 6.1 presented an overall picture of HIV-infected patients in the United States in 2009. Furthermore, the analyses results suggested that different regimens or regimen groups did not pose large differences in prevalence of viral suppression, adherence and side effects. However, use of ART is a key component in achieving and maintaining suppressed viral load. Therefore, as recommended by the recent treatment guidelines [32], ART should be prescribed to every HIV-infected person regardless of CD4 count or clinical symptoms. Overall, MMP provided comprehensive information about the behaviors, medical care, and health status of the patient samples selected to represent HIV-infected adults receiving medical care in the United States. Results presented in this study could be useful for future strategic planning of HIV care.

Figure 6.1 Number and percentage of HIV-infected persons engaged in selected stages of the continuum of HIV care—United States, 2009



** Numbers of HIV-infected, HIV-diagnosed, AIDs-diagnosed patients were obtained from [11].*
$ Calculated as estimated number of diagnosed × estimated percentage linked to care (77%) [72-74].
% Calculated as estimated number of diagnosed × estimated percentage retained in care (51%) [72-74].
 # Calculated as estimated number of retained in HIV care × percentage prescribed ART in MMP (88.6%).
& Calculated as estimated number of prescribed with ART × percentage took ART in MMP (96.5%).
*** Calculated as estimated number of prescribed with ART × percentage of viral suppression in MMP (62.7% for durable VL and 77.8% for most recent VL).*

REFERENCES

1. Gallo, R.C., *A reflection on HIV/AIDS research after 25 years.* Retrovirology, 2006. **3**: p. 72.
2. UNAIDS, *Global Report Fact Sheet.* 2010.
3. Sepkowitz, K.A., *AIDS--the first 20 years.* N Engl J Med, 2001. **344**(23): p. 1764-72.
4. UNAIDS, *Global Report Fact Sheet.* 2011: p. 1-10.
5. Kallings, L.O., *The first postmodern pandemic: 25 years of HIV/ AIDS.* J Intern Med, 2008. **263**(3): p. 218-43.
6. Sharp, P.M. and B.H. Hahn, *Origins of HIV and the AIDS pandemic.* Cold Spring Harb Perspect Med, 2011. **1**(1): a006841.
7. Evian, C., *Primary HIV/AIDS care: a practical guide for primary health care personnel in a clinical and supportive setting*. 4th ed. 2006, [South Africa]: Jacana: Houghton.
8. *Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases*. 5 ed. 2000: JAMA.
9. Schneider, E.W., S.; Glynn, K.M.; Dominguez, K.; Mitsch, A.; McKenna, M.T., *Revised surveillance case definitions for HIV infection among adults, adolescents, and children aged <18 months and for HIV infection and AIDS among children aged 18 months to <13 years--United States, 2008,* in *MMWR. Recommendations and reports : Morbidity and mortality weekly report.* . 2008, Centers for Disease Control and Prevention, (CDC). p. 1–12.
10. Markowitz, *Environmental and occupational medicine*. 4th ed. ed, ed. N.R. William and B. Steven. 2007, Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins.
11. CDC, *Monitoring selected national HIV prevention and care objectives by using HIV surveillance data-United States and 6 U.S. dependent areas-2010.* HIV Surveillance Supplemental Report, 2012. **17**(No. 3, part A).
12. CDC, *Estimated HIV incidence in the United States, 2007-2010.* HIV Surveillance Supplemental Report 2012. **17**(No. 4).
13. UNAIDS, *The quest for an HIV vaccine*. 2012.
14. Barre-Sinoussi, F., et al., *Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS).* Science, 1983. **220**(4599): p. 868-71.
15. Gallo, R.C., *Kaplan memorial lecture. The family of human lymphotropic retroviruses called HTLV: HTLV-I in adult T-cell leukemia (ATL), HTLV-II in hairy cell leukemias, and HTLV-III in AIDS.* Princess Takamatsu Symp, 1984. **15**: p. 13-38.
16. Doranz, B.J., et al., *A dual-tropic primary HIV-1 isolate that uses fusin and the beta-chemokine receptors CKR-5, CKR-3, and CKR-2b as fusion cofactors.* Cell, 1996. **85**(7): p. 1149-58.
17. Moore, J.P., A. Trkola, and T. Dragic, *Co-receptors for HIV-1 entry.* Curr Opin Immunol, 1997. **9**(4): p. 551-62.
18. Freed, E.O., *HIV-1 replication.* Somat Cell Mol Genet, 2001. **26**(1-6): p. 13-33.
19. Turner, B.G. and M.F. Summers, *Structural biology of HIV.* J Mol Biol, 1999. **285**(1): p. 1-32.
20. FDA. *Antiretroviral drugs used in the treatment of HIV infection*. 2013 [cited 2013 03/07]; Available from: http://www.fda.gov/ForConsumers/byAudience/ForPatientAdvocates/HIVandAIDSActivities/ucm118915.htm.

21. Palella, F.J., et al., *Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection.* New England Journal of Medicine, 1998. **338**(13): p. 853-860.
22. Sterne, J.A.C., et al., *Long-term effectiveness of potent antiretroviral therapy in preventing AIDS and death: a prospective cohort study.* Lancet, 2005. **366**(9483): p. 378-384.
23. Coetzee, D., et al., *Outcomes after two years of providing antiretroviral treatment in Khayelitsha, South Africa.* Aids, 2004. **18**(6): p. 887-895.
24. Mocroft, A., et al., *Decline in the AIDS and death rates in the EuroSIDA study: an observational study.* Lancet, 2003. **362**(9377): p. 22-29.
25. WHO, *Antiretroviral therapy for HIV infection in adults and adolescents: recommendations for a public health approach*. World Health Organization Study Group, Editor. 2010. p. 19–20.
26. Department of Health Human Services. Panel on Clinical Practices for Treatment of HIV Infection. Henry, J. Kaiser Family Foundation Panel on Clinical Practices for Treatment of HIV Infection. *Guidelines for the use of antiretroviral agents in HIV-infected adults and adolescents, January 28, 2000 by the Panel on Clinical Practices for Treatment of HIV Infection.* HIV Clin Trials, 2000. **1**(1): p. 60-110.
27. Sterne, J.A., et al., *Timing of initiation of antiretroviral therapy in AIDS-free HIV-1-infected patients: a collaborative analysis of 18 HIV cohort studies.* Lancet, 2009. **373**(9672): p. 1352-63.
28. Cheung, M.C., L. Pantanowitz, and B.J. Dezube, *AIDS-related malignancies: emerging challenges in the era of highly active antiretroviral therapy.* Oncologist, 2005. **10**(6): p. 412-26.
29. Smith, C., *Concepts in immunology and immunotherapeutics*. 4th ed, ed. B. T. 2008, Bethesda, MD: American Society of Health-System Pharmacists.
30. Montessori, V., et al., *Adverse effects of antiretroviral therapy for HIV infection.* CMAJ, 2004. **170**(2): p. 229-38.
31. Beard, J., F. Feeley, and S. Rosen, *Economic and quality of life outcomes of antiretroviral therapy for HIV/AIDS in developing countries: a systematic literature review.* AIDS Care, 2009. **21**(11): p. 1343-56.
32. *Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents*, DHHS, 2013: Department of Health and Human Services.
33. Nachega, J.B., et al., *HIV treatment adherence, drug resistance, virologic failure: evolving concepts.* Infect Disord Drug Targets, 2011. **11**(2): p. 167-74.
34. Vogel, M., et al., *The treatment of patients with HIV.* Dtsch Arztebl Int, 2010. **107**(28-29): p. 507-15.
35. Beer, L., et al., *Use of and Adherence to Antiretroviral Therapy in a Large U.S. Sample of HIV-infected Adults in Care, 2007-2008.* Open AIDS J, 2012. **6**: p. 213-23.
36. Frankel, M.R., et al., *A probability sample for monitoring the HIV-infected population in care in the U.S. and in selected states.* Open AIDS J, 2012. **6**: p. 67-76.
37. Ford, M.A., C.M. Spicer, and Institute of Medicine (U.S.). Committee to Review Data Systems for Monitoring HIV Care., *Monitoring HIV care in the United States : indicators and data systems*. 2012, Washington, D.C.: National Academies Press. xxii, 329 p.

38. *Medical Monitoring Project (MMP)*. 2013 [cited 2013 03/07]; Available from: http://www.cdc.gov/hiv/topics/treatment/mmp/index.htm.
39. *Medical Monitoring Project 2009 Protocol* Clinical Outcome Team. 2009, Centers for Disease Control and Prevention
40. Sullivan, P.S., et al., *Time to first annual HIV care visit and associated factors for patients in care for HIV infection in 10 US cities.* AIDS Care, 2011. **23**(10): p. 1314-20.
41. ICF, *Weighting Methods for the Medical Monitoring Project (MMP), Unpublished manuscript*.
42. Phillips, A.N., et al., *HIV viral load response to antiretroviral therapy according to the baseline CD4 cell count and viral load.* JAMA, 2001. **286**(20): p. 2560-7.
43. Hogg, R.S., et al., *Rates of disease progression by baseline CD4 cell count and viral load after initiating triple-drug therapy.* JAMA, 2001. **286**(20): p. 2568-77.
44. Lee, N., et al., *Rates of disease progression among human immunodeficiency virus-infected persons initiating multiple-drug rescue therapy.* J Infect Dis, 2003. **188**(1): p. 137-41.
45. Antiretroviral Therapy Cohort, C., *Rates of disease progression according to initial highly active antiretroviral therapy regimen: a collaborative analysis of 12 prospective cohort studies.* J Infect Dis, 2006. **194**(5): p. 612-22.
46. Attia, S., et al., *Sexual transmission of HIV according to viral load and antiretroviral therapy: systematic review and meta-analysis.* AIDS, 2009. **23**(11): p. 1397-404.
47. Bunnell, R., et al., *Changes in sexual behavior and risk of HIV transmission after antiretroviral therapy and prevention interventions in rural Uganda.* AIDS, 2006. **20**(1): p. 85-92.
48. Ghani, A.C., C.A. Donnelly, and R.M. Anderson, *Patterns of antiretroviral use in the United States of America: analysis of three observational databases.* HIV Med, 2003. **4**(1): p. 24-32.
49. Golub, E.T., et al., *Patterns, predictors, and consequences of initial regimen type among HIV-infected women receiving highly active antiretroviral therapy.* Clin Infect Dis, 2008. **46**(2): p. 305-12.
50. ICF, *2009 MMP Response Rate Summary Report, Unpublished manuscript*.
51. Rao, J.N.K., and Scott, A.J. , *The analysis of categorical data from complex sample surveys: chi-squared tests for goodness-of-fit and independence in two-way tables.* Journal of the American Statistical Association, 1981. **76**: p. 221-230.
52. Rao, J.N.K., and Scott, A.J. , *On chi-squared tests for multi-way tables with cell proportions estimated from survey data.* Annals of Statistics, 1984. **12**: p. 46-60.
53. Rao, J.N.K., and Scott, A.J. , *On simple adjustments to chi-squared tests with survey data.* Annals of Statistics, 1987. **15**: p. 385-397.
54. Thompson, M.L., J.E. Myers, and D. Kriebel, *Prevalence odds ratio or prevalence ratio in the analysis of cross sectional data: what is to be done?* Occup Environ Med, 1998. **55**(4): p. 272-7.
55. Lee, J., *Odds ratio or relative risk for cross-sectional data?* Int J Epidemiol, 1994. **23**(1): p. 201-3.
56. Hosmer, D.W. and S. Lemeshow, *Applied logistic regression*. 2nd ed. Wiley series in probability and statistics Texts and references section. 2000, New York: Wiley. xii, 375 p.
57. *SAS/STAT® 9.2 User's Guide*. 2008, Cary, NC: SAS Institute Inc.

58. *The 2009 HHS poverty guidelines*, U.S. Department of Health and Human Services, Washington, D.C.
59. Kroenke, K., et al., *The PHQ-8 as a measure of current depression in the general population.* J Affect Disord, 2009. **114**(1-3): p. 163-73.
60. Campbell, T.B., et al., *Efficacy and safety of three antiretroviral regimens for initial treatment of HIV-1: a randomized clinical trial in diverse multinational settings.* PLoS Med, 2012. **9**(8): p. e1001290.
61. Bottonari, K.A., et al., *A longitudinal investigation of the impact of life stress on HIV treatment adherence.* J Behav Med, 2010. **33**(6): p. 486-95.
62. Wood, E., et al., *Validity of self-reported antiretroviral therapy use among injection drug users.* Jaids-Journal of Acquired Immune Deficiency Syndromes, 2006. **41**(4): p. 530-531.
63. Kalichman, S.C., D. Rompa, and M. Cage, *Reliability and validity of self-reported CD4 lymphocyte count and viral load test results in people living with HIV/AIDS.* International Journal of Std & Aids, 2000. **11**(9): p. 579-585.
64. Martin, M., et al., *Relationship between Adherence Level, Type of the Antiretroviral Regimen, and Plasma HIV Type 1 RNA Viral Load: A Prospective Cohort Study.* Aids Research and Human Retroviruses, 2008. **24**(10): p. 1263-1268.
65. Willis, S., et al. *Factors associated with achieving viral suppression among newly diagnosed HIV/AIDS cases in the Washington, D.C.* in *International AIDS Conference*. 2012. Washington DC.
66. Muthulingam, D., et al., *Disparities in Engagement in Care and Viral Suppression among Persons with HIV.* J Acquir Immune Defic Syndr, 2013.
67. Adeyemi, O.M., et al., *Racial/Ethnic Disparities in Engagement in Care and Viral Suppression in a Large Urban HIV Clinic.* Clin Infect Dis, 2013.
68. Conway, B., *The role of adherence to antiretroviral therapy in the management of HIV infection.* J Acquir Immune Defic Syndr, 2007. **45 Suppl 1**: p. S14-8.
69. Protopopescu, C., et al., *Factors associated with non-adherence to long-term highly active antiretroviral therapy: a 10 year follow-up analysis with correction for the bias induced by missing data.* J Antimicrob Chemother, 2009. **64**(3): p. 599-606.
70. Watt, M.H., et al., *Factors associated with self-reported adherence to antiretroviral therapy in a Tanzanian setting.* AIDS Care, 2010. **22**(3): p. 381-9.
71. DiIorio, C., et al., *Adherence to Antiretroviral Medication Regimens: A Test of a Psychosocial Model.* Aids and Behavior, 2009. **13**(1): p. 10-22.
72. Ammassari, A., et al., *Depressive symptoms, neurocognitive impairment, and adherence to highly active antiretroviral therapy among HIV-infected persons.* Psychosomatics, 2004. **45**(5): p. 394-402.
73. Marks, G., et al., *Entry and retention in medical care among HIV-diagnosed persons: a meta-analysis.* AIDS, 2010. **24**(17): p. 2665-78.
74. Torian, L.V. and E.W. Wiewel, *Continuity of HIV-related medical care, New York City, 2005-2009: Do patients who initiate care stay in care?* AIDS Patient Care STDS, 2011. **25**(2): p. 79-88.