Published in final edited form as:

J Acquir Immune Defic Syndr. 2017 September 01; 76(1): 82–89. doi:10.1097/QAI.0000000000001469.

Assessing Antiretroviral Use During Gaps in HIV Primary Care using Multisite Medicaid Claims and Clinical Data

Anne K. Monroe, MD, MSPH¹, John A. Fleishman, PhD², Cindy C. Voss, MA³, Jeanne C. Keruly, CRNP³, Ank E. Nijhawan, MD, MPH, MSCS⁴, Allison L. Agwu, MD, ScM⁵, Judith A. Aberg, MD⁶, Richard M. Rutstein, MD⁷, Richard D. Moore, MD, MHS¹, and Kelly A. Gebo, MD, MPH³ for the HIV Research Network

¹Division of General Internal Medicine, Department of Medicine, Johns Hopkins School of Medicine, Baltimore, MD ²Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality, Rockville, MD ³Division of Infectious Diseases, Department of Medicine, Johns Hopkins School of Medicine, Baltimore, MD ⁴Department of Internal Medicine, University of Texas Southwestern Medical Center, Dallas ⁵Divisions of Adult and Pediatric Infectious Diseases, Department of Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland ⁶Department of Medicine, Division of Infectious Diseases, Icahn School of Medicine at Mount Sinai ⁷Division of General Pediatrics, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania

Abstract

Background—Some individuals who appear poorly retained by clinic visit-based retention measures are using antiretroviral therapy (ART) and maintaining viral suppression. We examined whether individuals with a gap in HIV primary care (≥ 180 days between HIV outpatient clinic visits) obtained ART during that gap after 180 days.

Setting—HIV Research Network (HIVRN) data from four clinical sites and Medicaid Analytic Extract (MAX) eligibility and pharmacy data were combined.

Methods—Factors associated with having both an HIV primary care gap and a new (i.e., non-refill) ART prescription during a gap were evaluated with multinomial logistic regression.

Results—Of 6,892 HIVRN patients, 6,196 (90%) were linked to Medicaid data, and 4,275 had any Medicaid ART prescription. Over half (54%) had occasional gaps in HIV primary care. Women, older people, and those with suppressed viral load (VL) were less likely to have a gap. Among those with occasional gaps (n=2,282), 51% received a new ART prescription in a gap. VL suppression prior to gap was associated with receiving a new ART prescription in a gap (OR =

Corresponding Author: Anne Monroe, MD, 1830 E Monument St Room 8060, Baltimore MD 21287, Fax: 410-955-7733, Phone: 410-614-5458, amonroe4@jhmi.edu.

Conflict of Interest

The authors have no conflicts of interest to report.

Disclaimer:

The views expressed in this article are those of the authors. No official endorsement by the Department of Health and Human Services or the Agency for Healthcare Research and Quality is intended or should be inferred.

1.91, 95% CI 1.57, 2.32), as was number of days in a gap (OR=1.04, 95% CI 1.02, 1.05), and the proportion of months in the gap enrolled in Medicaid.

Conclusions—Medicaid-insured individuals commonly receive ART during gaps in HIV primary care, but almost half do not. Retention measures based on visit frequency data that do not incorporate receipt of ART and/or viral suppression may misclassify individuals who remain suppressed on ART as not retained.

Keywords

HIV; antiretroviral therapy; retention in care; Medicaid

Introduction

The HIV care continuum describes a series of steps from initial diagnosis of HIV to achieving and maintaining HIV viral load (VL) suppression.^{1–4} An important part of the care continuum is retention in care, which is defined by attending HIV primary care visits at regular intervals. This facilitates prescribing antiretroviral therapy (ART), which, when patients adhere, is the most important component of long-term HIV control^{5,6} and decreased HIV transmission to others.⁷ There are multiple measures for retention in care based on HIV clinic visit data.^{8,9} A commonly used measure stipulates that HIV primary care visits occur at least twice per year, separated by 90 days.¹⁰ Suboptimal retention in care has been associated with a variety of suboptimal clinical outcomes, including worse VL suppression, lower CD4 cell counts, and increased mortality.^{11,12}

There is debate regarding the optimal HIV primary care visit frequency for individuals with stable HIV infection.¹³ Current U.S. Department of Health and Human Services guidelines recommend checking an HIV viral load every 6 months in patients who are on stable ART with VL suppression.¹⁴ Some HIV care providers may feel comfortable seeing stable patients for a clinic visit once per year and checking labs at 6-month intervals. Using standard retention measures, these individuals would not appear to be retained in care, even if they are maintaining viral suppression. A recent study from New York State¹⁵ showed that individuals who were retained in HIV care were more likely to have VL suppression than those who were not retained. However, retention had poor specificity (19.6%) for VL suppression, i.e., not being retained did not reliably indicate that individuals were not suppressed. Whites and older people (55 and up) were more likely to be not retained and to have VL suppression, suggesting that non-retention based on visit frequency is more meaningful among vulnerable young and minority populations. A national study showed that about half of individuals who accessed some care, but did not meet the standards for being retained in continuous care, had VL suppression.¹⁶ Prior work from the HIV Research Network (HIVRN) revealed that about 10% of individuals followed in the HIVRN in 2010 did not meet the retention criteria for that year but had a suppressed VL.¹⁷

Patients not meeting retention criteria who show suppressed VL may be continuing ART during gaps in care. Our objective is to examine the extent to which patients receive an ART prescription during gap periods. Our analysis expands on prior work by combining demographic and clinical data from the HIVRN with Medicaid pharmacy claims data. With

the combined dataset, we determined the presence of ART prescriptions during gaps and described factors associated with receiving ART during a gap, with the hypothesis that having VL suppression, being white, and being older would be associated with receiving ART during a gap.

Methods

The HIV Research Network (HIVRN) is a consortium of clinics that provide primary and subspecialty care to HIV patients.¹⁸ Each site annually abstracts clinical and demographic data from medical records of patients receiving care for HIV infection. Data are quality-assured and combined across sites after removing personal identifying information. Data for individual patients are linked across calendar years. The study was approved by the Institutional Review Boards at the Johns Hopkins University School of Medicine and at each participating site.

A subset of five HIVRN sites participated. Sites treating adults (age ≥ 18) were located in MA, MD, and NY; pediatric sites (ages 0–25) were in MD and NY. Analyses included only adults. The observation period spanned January 1, 2006 through December 31, 2010.

Patients who had Medicaid insurance recorded in the HIVRN database between 2006–2010 were identified centrally; local sites subsequently linked encrypted HIVRN IDs with patients' social security numbers (SSNs). SSNs were sent to the Centers for Medicare and Medicaid Services (CMS), where they were matched to Medicaid records in the site's state and three adjacent states. 6,892 unique HIVRN IDs were submitted; 6,196 (90%) were matched. The Medicaid Analytic Extract (MAX) files provide enrollment, utilization, and payment data for individual Medicaid beneficiaries on a calendar year basis.^{19,20} MAX data were merged with HIVRN data; identifying information was removed.

Gaps in Care

A gap in care was defined as a period ≥ 180 days without a visit to the HIVRN outpatient HIV clinic with an HIV primary care provider (based on HIVRN visit date data). For decedents, the last gap ended on the date of death. Gaps that began prior to the start of the observation period (January 1, 2006) or that continued after the end of the observation period (December 31, 2010) were included if the number of gap days in the observation period was ≥ 180.

Each patient could have multiple gaps. "Gap 0" refers to a gap among patients who enrolled in the HIVRN prior to January 1, 2006 and entered the observation period in a gap. Patients enrolled in the HIVRN after January 1, 2006 could not have "Gap 0", as their first gap could occur only after their HIVRN enrollment date.

Patients' overall pattern of gaps was classified as: never in a gap, always in a gap, and occasionally in a gap. The first group included patients enrolled in HIVRN after June, 2010 and patients who had only gaps < 179 days. The majority (93.9%) of patients always in a gap had 0–1 HIVRN outpatient visit. The "occasional gaps" group had gaps < 180 days

interspersed with periods with multiple outpatient visits. We calculated the number of months and the percentage of months during each gap the patient was eligible for Medicaid

Variables

Demographic and clinical variables were based on HIVRN data. Age was calculated as of January 1, 2006, categorized as 18–30, 31–40, 41–50, and 51–64 years old. Self-reported race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, and other/unknown. Mutually exclusive categories of self-reported HIV transmission risk behavior reported at time of cohort enrollment were: men who had sex with men (MSM), heterosexual contact (HET), injection drug use (IDU), a combination of HET and IDU (HEI), other (female who has sex with a female, vertical transmission, blood products, other reported by patient (tattoo, e.g.), and unknown. The MSM group included those with both MSM and IDU risk factors. Patients were classified as either enrolling in the HIVRN prior to 2006, or in 2006 or later. Because of small numbers (1% of entire dataset), person-years contributed by transgendered individuals were excluded.

First CD4 level in the observation period was the first reported test after January 1, 2006 and stratified as 200, 201–500, and >500 cells/mm³, or missing. The first VL recorded after January 1, 2006 was classified as either suppressed (<400 copies/ml), not suppressed (>400 copies/ml), or missing. For analyses with the gap as the unit of analysis, we identified the VL test closest in time to the beginning of the gap.

Antiretroviral Therapy (ART) Prescriptions

The following information was available on each Medicaid-purchased medication: date the prescription was written, dates the prescription was filled, National Drug Code (NDC), and identification number for the physician writing the prescription. ART medications were identified by NDCs.

The major outcome variable is whether a new ART prescription was written during a gap. We distinguish “new” prescriptions from previously written prescriptions that had refills purchased. The new ART prescription could be either a previously prescribed medication or a different ART medication if a provider switched the patient’s regimen. A value of zero for the MAX “new refill indicator” variable indicated that a medication purchase was a new ART prescription; this variable had a value >0 if the patient was picking up a refill from a previously written prescription. We assumed that, in most instances, a new ART prescription written during a gap involved contact with a medical provider during that gap (in person or by phone). In contrast, patients could refill an original prescription during a gap without contacting a provider.

Statistical Analyses

First, we determined the gap status of each patient. We used multinomial logistic regression to examine clinical and demographic variables associated with always being in a gap and with occasionally being in a gap (both versus no gap). Marginal predicted probabilities for each independent variable were computed.

Second, we focused on only those patients with occasional gaps. Among this group, bivariate analyses examined whether a patient ever had any new ART prescription in any gap. To be counted as being written in a gap, the ART prescription date had to be at least 180 days after the start of a gap. Subsequent multivariate logistic regression analysis used the gap as the unit of analysis. Because each patient could contribute multiple observations, we used generalized estimating equations, with an exchangeable correlation structure.

Third, we assessed the extent to which, in each gap, patients either had a new ART prescription or refilled an existing prescription. Combining new prescriptions and refills provides information on the extent to which patients were accessing any ART during a gap, indicating some level of engagement in care.

Finally, we examined prescribing patterns for patient-provider pairs. Each unique pair of one patient and one prescribing provider served as the unit of analysis. Providers were identified using the prescribing physician ID number in the MAX data. Analyses were limited to patient-provider pairs in which a new ART prescription had been written. We categorized each patient-provider pair as having no new ART prescriptions in a gap, all new ART prescriptions in a gap, or as having a mixture of some prescriptions in a gap and others not in a gap.

Results

Among 6,196 patients in the linked MAX-HIVRN data, we excluded those aged < 18 years on January 1, 2006 (n=279), enrolled in the HIVRN after 2010 (n=131), those with data quality concerns (n=460), who had no record in the MAX prescription medication file (n=242), and 809 who had medication data but no ART prescription. This resulted in 4,275 individuals for analysis (Supplemental Figure 1).

Gap Status

Among these 4,275 individuals, 280 (6.6%) were always in a gap and 2,317 (54.2%) were occasionally in a gap. Table 1 presents a description of the sample and associations with gap status. In a multinomial logistic regression (Table 2), the probability of occasionally being in a gap was lower among patients whose first recorded VL was suppressed (versus not suppressed), who were aged 51–65 (compared to 18–30), who enrolled prior to 2006, who were women, and who had an MSM HIV risk. Supplemental Table A shows average predicted probabilities based on the regression model.

New ART Prescription in a Gap

Patient-Level Analyses—Among 2,317 patients with occasional gaps, 2,282 had a new ART prescription. Over half (51.0%) had a new ART prescription after 180 days in a gap. The median number of new ART prescriptions was 24 (IQR=10–47), including new ART prescriptions written both in care or in a gap; the median number of new ART prescriptions in a gap was 1 (IQR=0–9). Most patients with an occasional gap had one gap (63.1%); 27.3% had two, and 9.6% had three or more (Results not shown).

In unadjusted analyses (Table 3), factors associated with receiving a new ART prescription in any gap included having two or three gaps (vs. one gap), having a longer total time spent in gaps, having more time enrolled in Medicaid, and having suppressed first VL.

Gap-Level Analyses—Subsequent analyses used the individual gap as the unit (N= 2,282 patients and 3,389 gaps). The mean time in a single gap was 540 days (median =361, IQR=227–734). Overall, 62.3% of gaps were covered by Medicaid the entire time, and 6.2% had no Medicaid coverage. ART prescriptions were written in 40.0% of gaps.

A logistic regression of any new ART prescription after 179 days in a particular gap (Table 4) found associations with gap-specific variables, including suppressed VL closest to the gap start date, total time in the gap (in months), and the number of and proportion of months in the gap in which the patient was enrolled in Medicaid.

VL suppression at the measurement closest to the start of a gap was strongly associated with higher odds of receiving a new ART prescription. Hispanic patients were less likely than white patients to receive a new ART prescription. Restricting the analysis to gaps with 100% Medicated coverage only had similar results (results not shown).

Table 5 shows the proportions of patients in each gap who obtained a new ART prescription, refilled an ART prescription, or did neither. The proportion of patients in each gap who received a new ART prescription after 179 days ranged from 25.9% to 45.2%. The proportion with neither a new nor a refill ART prescription ranged from 52.1% to 59.9%. Gap 0 (a gap among patients who enrolled in the HIVRN prior to January 1, 2006 and entered the observation period in a gap) had fewer refills; this gap was atypical (limited to those enrolled prior to the start of the observation period).

Patient-Provider Pairs

There were 11,044 patient-provider pairs that had a new ART prescription at any point, representing 2,264 patients and 2,405 providers. The mean number of providers per patient was 4.9 (median=4, IQR= 2–7). The mean number of patients per provider was 4.6 (median=1, IQR=1–3).

In 27.1% of patient-provider pairs with a new ART prescription, one or more new ART prescriptions were written after 179 days in a gap. Among patient-provider pairs with >1 ART prescription in a gap (n=10,295), 17.0% of the pairs had 100% of ART prescriptions written in a gap. Many more of the pairs (74.6%) had no new ART prescriptions written in a gap (new ART prescriptions only written in care). For only 8.4% of pairs were new ART prescriptions written both in gaps and in care (Results not tabulated). Thus, patients appear to be receiving new ART prescriptions in gaps from different providers than they do during in-care periods.

Discussion

In this analysis using combined Medicaid pharmacy claims and clinical data, we found that suppressed VL, older age, and female sex, but not race, were inversely associated with

having gaps 180 days in HIV primary care. We also found that it was fairly common to receive new ART prescriptions during gaps in HIV primary care, and that suppressed VL (value closest to the gap start) was associated with receiving ART during a gap.

Over one-third (39.3%) of individuals in our dataset did not have any gap in care of at least 180 days. Retention rates using various retention measures in large cohorts have varied, ranging from 66% to 84%.^{4,21,22} Several factors likely explain why our retention appears lower than other large cohorts. The first is that we used up to five years of data combined into one interval, rather than one- or two- year intervals. The longer follow-up time is more likely to identify reduced retention. Additionally, other retention measures have parameters that would allow for a greater than 180 day gap between visits. For example, defining “retained” as 2 visits per year separated by at least 90 days¹⁰ means that patients could have 2 visits that were 275 days apart and be classified as retained. The difference between our proportion of individuals with a 180 day gap (54.2%) and the proportion previously shown with HIVRN data (22–25%)²² likely stems from our use of up to five years of data combined into one interval, which allowed a gap to span across calendar years, compared to the prior study, which used individual calendar year data.

We found that older individuals were less likely to have a gap of > 180 days from HIV primary care. Older age has been associated with improved retention in HIV care.²³ This is likely due to a combination of factors, including older individuals having more comorbidities requiring more frequent contact with the health system, therefore decreasing the likelihood of having a gap in HIV primary care. We also found that women were less likely to have gap from HIV primary care. In the general population, women use health services more frequently than men,^{24, 25} which may reflect differences in seeking symptomatic care or preventive services. Previous work from the HIVRN²⁶ showed similar findings to ours that the likelihood of retention in HIV care was lower for men. And another study with NA-ACCORD data showed less risk of disruption of continuous retention in HIV care among women in the NA-ACCORD.²⁷ So although there are many challenges facing women who present for HIV care, including stigma and competing responsibilities, our findings are congruent with prior work and work from other groups that retention appears improved among women compared to men.

Standard retention measures do not account for people who have not attended HIV primary care visits but continue to fill ART prescriptions. Our finding that individuals who were suppressed were more likely to receive ART in a gap may reflect physicians’ increasing comfort with prescribing ART without a face-to-face clinical encounter. It is possible that our findings reflect physicians’ prescribing ART while monitoring lab results but not scheduling clinic visits with patients whose results were stable; however, we were not able to describe the frequency with which HIV-related lab monitoring occurred. Additionally, as HIV regimens became simpler with less toxicity and fewer side effects in the late 2000s, it is possible that primary care physicians were doing more prescribing of ART with less input from specialist physicians.

We saw potential evidence of this in our analysis focused on patient-provider pairs. Over one sixth of the patient-provider pairs had 100% of all ART prescriptions written in a gap from

the HIVRN primary care site. One possible explanation for this result is that the patient established care with another HIV provider outside the HIVRN. Another potential explanation is that the patient had a primary care provider who wrote prescriptions and that the patient infrequently visited the HIV clinic. Or, if the patient contacted the HIV clinic between visits to request a new prescription, someone other than their primary HIV provider may have written the prescription.

On the opposite side of the coin, at the person level, about half of people who had a gap did not pick up a new ART prescription. At the gap level, up to 60% of gaps did not have an ART prescription (new or refill). Although some people had gaps and continued to receive ART, a substantial proportion had gaps and did not receive ART. This is concerning, because individuals not on ART have worse clinical outcomes and are more likely to transmit HIV to others. The challenge of increasing prescription of ART and subsequent viral suppression is ongoing and may require more flexible care models and/or targeting of resources to those in most need.

The strengths of our study include the use of a unique dataset that included not only clinical data from several high volume high quality HIV clinical care sites, but also Medicaid claims data. This allowed us to capture ART use outside of the clinical site. Limitations include that not all ART use was captured with the Medicaid dataset. Furthermore, our results apply only to individuals with Medicaid. Another limitation is that the HIVRN dataset is not always reliably able to capture whether an individual has established care at another site or has a primary care physician in addition to an HIV specialist. We could not account for prescribing practices that vary by physician and by patient (for example, the number of refills a physician typically writes, which may or may not vary by how adherent a patient is). We could not account for any prescribing that might have occurred when the patient had a gap in Medicaid (e.g., if an alternate payer was used. This analysis could be supplemented by AIDS Drug Assistance Program (ADAP) data to increase available data and determine if prescriptions covered by ADAP occurred during gaps in care from the HIVRN site. We could not account for clinical trial participants who were obtaining their ART without Medicaid claims associated with the ART.

It is imperative to improve retention in care to increase prescription of ART to achieve viral suppression in more people living with HIV. We suggest fine-tuning retention measures so that those in greatest need of increased outreach to improve retention can be identified. Furthermore, more refined measures of retention that include ART use better reflect flexibility in current federal and state clinical practice guidelines with regards to the frequency of clinic visits and viral load measurement.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Sources of Funding:

Supported by the Agency for Healthcare Research and Quality (HHS290201100007C), the Health Resources and Services Administration (HHSH250201200008C), the National Institutes of Health (U01 DA036945, P30 AI094189), and the Clinical Investigation and Biostatistics Core of the UC San Diego Center for AIDS Research (AI036214). Dr. Monroe is supported by K23 MH 105284. Dr. Nijhawan is supported by K23 AI 112477.

Participating Sites

Alameda County Medical Center, Oakland, California (Howard Edelstein, M.D.)
 Children's Hospital of Philadelphia, Philadelphia, Pennsylvania (Richard Rutstein, M.D.)
 Drexel University, Philadelphia, Pennsylvania (Jeffrey Jacobson, M.D., Sara Allen, C.R.N.P.)
 Fenway Health, Boston, Massachusetts (Stephen Boswell, M.D.)
 Johns Hopkins University, Baltimore, Maryland (Kelly Gebo, M.D., Richard Moore, M.D., Allison Agwu M.D.)
 Montefiore Medical Group, Bronx, New York (Robert Beil, M.D.)
 Montefiore Medical Center, Bronx, New York (Uriel Felsen, M.D.)
 Oregon Health and Science University, Portland, Oregon (P. Todd Korthuis, M.D.)
 Parkland Health and Hospital System, Dallas, Texas (Ank Nijhawan, M.D., Muhammad Akbar, M.D.)
 St. Jude's Children's Research Hospital and University of Tennessee, Memphis, Tennessee (Aditya Gaur, M.D.)
 St. Luke's Roosevelt Hospital Center, New York, New York (Judith Aberg, M.D., Antonio Urbina, M.D.)
 Tampa General Health Care, Tampa, Florida (Charurut Somboonwit, M.D.)
 Trillium Health, Rochester, New York (William Valenti, M.D.)
 University of California, San Diego, California (W. Christopher Mathews, M.D.)

Sponsoring Agencies

Agency for Healthcare Research and Quality, Rockville, Maryland (Fred Hellinger, Ph.D., John Fleishman, Ph.D., Irene Fraser, Ph.D.)
 Health Resources and Services Administration, Rockville, Maryland (Robert Mills, Ph.D., Faye Malitz, M.S.)

Data Coordinating Center

Johns Hopkins University (Richard Moore, M.D., Jeanne Keruly, C.R.N.P., Kelly Gebo, M.D., Cindy Voss, M.A., Nikki Balding, M.S., Rebeca Diaz-Reyes)

References

1. Mugavero MJ, Amico KR, Horn T, et al. The state of engagement in HIV care in the United States: from cascade to continuum to control. *Clin Infect Dis*. 2013; 57:1164–1171. [PubMed: 23797289]
2. Hall HL, Gray KM, Tang T, et al. Retention in care of adults and adolescents living with HIV in 13 US areas. *J Acquir Immune Defic Syndr*. 2012; 60:77–82. [PubMed: 22267016]
3. Gardner EM, McLees MP, Steiner JF, et al. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. *Clin Infect Dis*. 2011; 52:793–800. [PubMed: 21367734]
4. CDC. Vital Signs: HIV Prevention Through Care and Treatment — United States. 2011; 47:1618–1623.
5. Sterne JAC, Hernán MA, Ledergerber B, et al. Long-term effectiveness of potent antiretroviral therapy in preventing AIDS and death: a prospective cohort study. *Lancet*. 2005; 366:378–384. [PubMed: 16054937]
6. Hogg RS, Yip B, Chan KJ, et al. Rates of disease progression by baseline CD4 cell count and viral load after initiating triple-drug therapy. *JAMA*. 2001; 286:2568–2577. [PubMed: 11722271]
7. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011; 365:493–505. [PubMed: 21767103]

8. Yehia BR, Fleishman JA, Metlay JP, et al. Comparing different measures of retention in outpatient HIV care. *AIDS*. 2012; 26:1131–1139. [PubMed: 22382143]
9. Mugavero MJ, Westfall AO, Zinski A, et al. Measuring retention in HIV care: The elusive gold standard. *J Acquir Immune Defic Syndr*. 2012; 61:574–580. [PubMed: 23011397]
10. Institute of Medicine of the National Academies. Monitoring HIV care in the United States: indicators and data systems. National Academy of Sciences; 2012.
11. Mugavero MJ, Westfall AO, Cole SR, et al. Beyond core indicators of retention in HIV care: missed clinic visits are independently associated with all-cause mortality. *Clin Infect Dis*. 2014; 59:1471–1479. [PubMed: 25091306]
12. Berg M, Safren S, Mimiaga M, et al. Nonadherence to medical appointments is associated with increased plasma HIV RNA and decreased CD4 cell counts in a community-based HIV primary care clinic. *AIDS Care*. 2005; 17:902–907. [PubMed: 16120506]
13. Buscher A, Mugavero M, Westfall AO, et al. The association of clinical follow-up intervals in HIV-infected persons with viral suppression on subsequent viral suppression. *AIDS Patient Care STDs*. 2013; 27:459–466. [PubMed: 23886048]
14. Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents. Department of Health and Human Services; Dec 29. 2016 Available at <http://aidsinfo.nih.gov/contentfiles/lvguidelines/AdultandAdolescentGL.pdf>
15. Feller DJ, Agins BD. The Dissociation Between Viral Load Suppression and Retention in Care. *AIDS Patient Care STDs*. 2016; 30:103–105. [PubMed: 26751777]
16. Doshi RK, Milberg J, Isenberg D, et al. High rates of retention and viral suppression in United States HIV safety net system: HIV care continuum in the Ryan White HIV/AIDS Program, 2011. *Clin Infect Dis*. 2014; 60:117–25. [PubMed: 25225233]
17. Yehia BR, Stephens-Shields AJ, Fleishman JA, et al. The HIV Care Continuum: Changes over time in retention in care and viral suppression. *PLOS ONE*. 2015; 10:e0129376. [PubMed: 26086089]
18. Yehia BR, Gebo KA, Hicks PB, et al. Structures of care in the clinics of the HIV Research Network. *AIDS Patient Care STDs*. 2008; 22:1007–1013. [PubMed: 19072107]
19. Centers for Medicare and Medicaid Services. [Accessed February 9, 2016] Medicaid Analytic Extract (MAX) General Information. Available at <https://www.cms.gov/research-statistics-data-and-systems/computer-data-and-systems/medicaiddatasourcegeninfo/maxgeneralinformation.htm>
20. Buccaneer. [Accessed February 9, 2016] Chronic Condition Data Warehouse: Medicaid Analytic Extract Files (MAX) Users Guide. <https://www.ccwdata.org/web/guest/user-documentation>
21. Rebeiro P, Althoff KN, Buchacz K, et al. Retention among North American HIV-infected persons in clinical care, 2000–2008. *J Acquir Immune Defic Syndr*. 2013; 62:356–362. [PubMed: 23242158]
22. Yehia BR, French B, Fleishman JA, et al. Retention in care is more strongly associated with viral suppression in HIV-infected patients with lower versus higher CD4 counts. *J Acquir Immune Defic Syndr*. 2014; 65:333–9. [PubMed: 24129370]
23. Doshi RK, Milberg J, Isenberg D, et al. High rates of retention and viral suppression in United States HIV safety net system: HIV care continuum in the Ryan White HIV/AIDS Program, 2011. 2015; 60:117–25.
24. Bertakis KD, Azari R, Helms LJ, Callahan EJ, Robbins JA. Gender differences in the utilization of health care services. *J Fam Pract*. 2000; 49:147–52. [PubMed: 10718692]
25. Brett KM, Burt CW. Utilization of ambulatory medical care by women: United States, 1997–98. *Vital Health Stat*. 2001; 13(149):1–46.
26. Yehia BR, Fleishman JA, Metlay JP, et al. Comparing different measures of retention in outpatient HIV care. *AIDS*. 2012; 26:1131–9. [PubMed: 22382143]
27. Rebeiro PF, Abraham AG, Horberg MA, et al. Sex, Race, and HIV Risk Disparities in Discontinuity of HIV Care After Antiretroviral Therapy Initiation in the United States and Canada. *AIDS Patient Care STDs*. 2017; 31:129–44. [PubMed: 28282246]

Table 1

Sample Description, by Gap Status (n=4,275 patients)

Variable				
	Total	Always in Gap	Never in Gap	Sometimes in Gap
	N (%)	%	%	%
Location of HIVRN Site				
MA	418 (9.8)	4.8	35.4	59.8
MD	1,229 (28.8)	9.4	30.5	60.1
NY	2,628 (61.5)	5.5	44.0	50.5
Gender				
Female	1,399 (32.7)	8.7	39.7	54.8
Male	2,876 (67.3)	5.5	38.2	53.0
Race/Ethnicity				
White	751 (17.8)	5.7	39.8	54.5
Black	2,500 (58.5)	7.7	37.0	55.4
Hispanic	959 (22.4)	4.2	44.8	51.0
Other/Missing	65 (1.5)	7.7	38.5	53.9
HIV Transmission Category				
MSM/MSI	1,264 (29.6)	3.8	46.0	50.2
IDU	724 (16.9)	8.3	35.2	56.5
HET	1,627 (38.1)	6.7	39.6	53.7
HEI	481 (11.3)	8.3	29.5	62.2
Other	83 (1.9)	0.0	38.6	61.5
Unknown	96 (2.3)	23.9	24.0	52.1
Age on 1/1/2006				
18–30	530 (12.4)	5.1	40.9	54.0
31–40	1,169 (27.4)	9.1	35.1	55.9
41–50	1,850 (43.3)	6.4	38.1	55.5
51–64	726 (17.0)	4.0	47.5	48.5
Enroll in HIVRN before 2006				
No	2,420 (56.6)	6.9	31.7	61.4
Yes	1,855 (43.4)	6.2	49.1	44.8
First CD4 (after 1/1/2006) Level				
200	1,272 (29.8)	5.5	36.6	57.9
201–500	1,761 (41.2)	4.2	40.0	55.9
501	1,098 (25.7)	3.0	44.4	52.6
Missing	144 (3.4)	72.2	14.6	13.9
First Viral Load (after 1/1/06) Suppressed				
No	2,211 (51.7)	4.8	36.1	59.0
Yes	1,861 (43.5)	2.9	45.6	51.5

Variable				
	Total	Always in Gap	Never in Gap	Sometimes in Gap
	N (%)	%	%	%
Missing	203 (4.8)	58.6	15.2	26.1
Total	4,275	280	1,678	2,317
		(6.6%)	(39.3%)	(54.2%)

Demographic characteristics based on HIVRN data. IDU: Injection drug use; MSM: men who have sex with men; HET: heterosexual; HEI: both IDU and HET.

Table 2

Multinomial Logit Regression of Gap Status (n=4,275 patients)

Variable	Relative Risk Ratio (95% CI)	
	Always in Gap vs. Never in Gap	Occasionally in Gap vs. Never in Gap
Location of HIVRN Site		
MA	1.66 (0.83, 3.34)	1.71 (1.30, 2.24)
MD	1.68 (1.16, 2.42)	1.31 (1.11, 1.56)
NY (reference)	-	-
Gender		
Female	0.88 (0.62, 1.26)	0.74 (0.63, 0.87)
Male (reference)	-	-
Race/Ethnicity		
White (reference)	-	-
Black	1.29 (0.79, 2.13)	1.05 (0.85, 1.30)
Hispanic	0.72 (0.40, 1.32)	0.90 (0.71, 1.14)
Other/Missing	1.40 (0.41, 4.77)	1.07 (0.61, 1.86)
HIV Transmission Category		
MSM/MSI (reference)	-	-
IDU	3.91 (2.24, 6.82)	1.98 (1.57, 2.49)
HET	2.61 (1.57, 4.32)	1.66 (1.36, 2.03)
HEI	3.44 (1.82, 6.49)	2.15 (1.64, 2.83)
Other	<i>a</i>	1.72 (1.05, 2.82)
Unknown	8.21 (3.49, 19.27)	3.02 (1.77, 5.15)
Age on 1/1/2006		
18–30 (reference)	-	-
31–40	1.54 (0.90, 2.61)	1.04 (0.82, 1.30)
41–50	0.72 (0.42, 1.23)	0.82 (0.66, 1.03)
51–64	0.36 (0.18, 0.70)	0.52 (0.40, 0.68)
Enroll in HIVRN before 2006		
No (reference)	-	-
Yes	0.48 (0.35, 0.66)	0.42 (0.36, 0.48)
First CD4 (after 1/1/2006) Level, in cells/mm³		
200 (reference)	-	-
201–500	0.88 (0.61, 1.27)	0.95 (0.81, 1.12)
>501	0.65 (0.40, 1.05)	0.87 (0.72, 1.05)
Missing	2.94 (1.20, 7.21)	0.27 (0.12, 0.65)
First Viral Load (after 1/1/06) Suppressed (< 400 copies/mL)		
No (reference)	-	-
Yes	0.53 (0.36, 0.77)	0.64 (0.55, 0.74)

Variable	Relative Risk Ratio (95% CI)	
	Always in Gap vs. Never in Gap	Occasionally in Gap vs. Never in Gap
Missing	13.24 (6.08, 28.81)	1.99 (1.05, 3.76)

^aNo observations

Table 3

Unadjusted Associations of Clinical and Demographic Variables with Receipt of Any New ART Prescription in a Gap, among Patients with Occasional Gaps (N=2,282)

Variable	Total N (%)	Proportion with New ART Prescription in Gap
Location of HIVRN Site		
MA	237 (10.4)	39.7
MD	722 (31.6)	45.0
NY	1,323 (58.0)	56.2
Gender		
Female	734 (32.2)	52.7
Male	1,548 (67.8)	50.1
Race/Ethnicity		
White	394 (17.3)	45.7
Black	1,369 (60.0)	51.1
Hispanic	485 (21.3)	54.6
HIV Transmission Category		
MSM/MSI	617 (27.0)	45.9
IDU	405 (17.8)	51.6
HET	863 (37.8)	52.6
HEI	298 (13.1)	54.4
Age on 1/1/2006		
18–30	282 (12.4)	47.2
31–40	642 (28.1)	50.8
41–50	1,009 (44.2)	52.0
51–64	349 (15.3)	51.3
Enroll in HIVRN before 2006		
No	1,457 (63.9)	50.7
Yes	825 (36.1)	51.4
First CD4 (after 1/1/2006) Level		
200	729 (32.0)	50.0
201–500	973 (42.6)	51.4
>501	561 (24.6)	51.0
First Viral Load (after 1/1/06) Suppressed ‡		
No	1,290 (56.5)	49.1
Yes	939 (41.2)	52.8
Total Number of Gaps		
1	1,439 (63.1)	49.2
2	624 (27.3)	53.4
3	177 (7.8)	57.6
4	39 (1.7)	48.7

Variable	Total N (%)	Proportion with New ART Prescription in Gap
5	3 (0.1)	33.3
Total Time in A Gap (days) ^{‡ a,b}		
180 – 227	849 (25.0)	11.1
228 – 361	850 (25.0)	29.3
362 – 734	843 (25.0)	53.1
735 – 1814	847 (25.0)	66.6
Proportions of Months in Gap Enrolled in Medicaid ^{‡ a}		
0	210 (6.2)	0.5
0.01 – 0.33	366 (10.8)	15.6
0.34 – 0.67	330 (9.7)	36.4
0.67 – 0.99	372 (11.0)	55.9
1.0	2,111 (62.3)	45.9

Note: Analysis excluded 35 patients with an occasional gap who never received a new ART prescription (i.e., only refills)

^aBased on 3,389 gaps, not patients;

^bQuartiles

Table 4

Logistic Regression of Any New ART Prescription during a Gap (N=3,389 gaps)

Variable	Odds Ratio (95% CI)
Location of HIVRN Site	
MA (vs. NY)	0.70 (0.47, 1.05)
MD (vs. NY)	0.47 (0.37, 0.60)
Gender	
Female (vs. Male)	0.81 (0.64, 1.02)
Race/Ethnicity	
White (reference)	-
Black	0.76 (0.56, 1.03)
Hispanic	0.68 (0.48, 0.96)
Other/Missing	0.60 (0.26, 1.37)
HIV Transmission Category	
MSM/MSI (reference)	-
IDU	1.25 (0.89, 1.75)
HET	1.31 (0.98, 1.77)
HEI	1.39 (0.96, 2.02)
Other	2.16 (1.11, 4.21)
Unknown	1.15 (0.77, 2.40)
Age on 1/1/2006	
18–30 (reference)	-
31–40	1.22 (0.89, 1.68)
41–50	1.21 (0.89, 1.66)
51–64	1.14 (0.77, 1.68)
Enroll in HIVRN before 2006	
Yes (vs. No)	1.38 (1.10, 1.73)
Suppressed Viral Load (Closest in Time to Gap Start)	
Yes (vs. No)	1.91 (1.57, 2.32)
Missing (vs. No)	1.81 (0.72, 4.51)
Total Number of Gaps	
1 (reference)	-
2	0.81 (0.64, 1.03)
3	0.94 (0.66, 1.33)
4	0.68 (0.36, 1.29)
5	0.47 (0.05, 4.93)
Gap Number^a	
0	1.01 (0.77, 1.32)
1 (reference)	-

Variable	Odds Ratio (95% CI)
2	1.01 (0.80, 1.32)
3	1.15 (0.75, 1.76)
4	0.83 (0.30, 2.30)
5 ^a	-
Time in Gap (months)	1.04 (1.02, 1.05)
Proportions of Gap Months Enrolled in Medicaid	
0	0.03 (0.01, 0.26)
0.01 – 0.33	0.38 (0.23, 0.63)
0.34 – 0.67	0.63 (0.45, 0.88)
0.68 – 0.99	0.74 (0.55, 0.99)
1.0 (reference)	-
Months in Gap Enrolled in Medicaid (quartiles)	
0 – 6 (reference)	-
7 – 8	2.43 (1.66, 3.57)
9 – 16	7.63 (5.23, 11.14)
17 – 59	21.87 (13.32, 35.91)

Analysis used generalized estimating equations with an exchangeable correlation structure. N = 3,389 gaps for 2,282 individual patients. Bolded figures are statistically significant, p<0.05;

^aOnly 2 observations with 5 gaps, neither of whom received ART in gap 5.

Table 5

Receipt of Any ART during a Gap, among Patients with an Occasional Gap (N=2,317).

Gap Number	Proportion with A New ART Prescription	Proportion with an ART Refill, but No new Prescription	Proportion with Neither	N of Persons with Gap
0	45.2	2.7	52.1	451
1	41.3	4.9	53.8	2,155
2	31.1	8.9	59.9	649
3	31.9	8.4	59.6	166
4	25.9	14.8	59.3	27

Note: Samples in each row are not mutually exclusive; some patients have multiple gaps. Analysis included 35 patients with an occasional gap who never received a new ART prescription (i.e., only refills). Only 2 individuals had Gap 5. Gap 0 restricted to patients who enrolled prior to 1/1/2006. Number of patients with gap 1 is less than 2,282 because some patients had only gap 0.