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Measuring Retention in HIV Care: The Elusive Gold Standard

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Abstract

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Background—Measuring retention in HIV primary care is complex as care includes multiple visits scheduled at varying intervals over time. We evaluated six commonly used retention measures in predicting viral load (VL) suppression and the correlation among measures.

Methods—Clinic-wide patient-level data from six academic HIV clinics were used for 12-months preceding implementation of the CDC/HRSA Retention in Care intervention. Six retention measures were calculated for each patient based upon scheduled primary HIV provider visits: count and dichotomous missed visits, visit adherence, 6-month gap, 4-month visit constancy, and the HRSA HAB retention measure. Spearman correlation coefficients and separate unadjusted logistic regression models compared retention measures to one another and with 12-month VL suppression, respectively. The discriminatory capacity of each measure was assessed with the c-statistic.

Results—Among 10,053 patients, 8,235 (82%) had 12-month VL measures, with 6,304 (77%) achieving suppression (VL<400 c/mL). All six retention measures were significantly associated (P<0.0001) with VL suppression (OR;95%CI, c-statistic): missed visit count (0.73;0.71–0.75,0.67), missed visit dichotomous (3.2;2.8–3.6,0.62), visit adherence (3.9;3.5–4.3,0.69), gap (3.0;2.6–3.3,0.61), visit constancy (2.8;2.5–3.0,0.63), HRSA HAB (3.8;3.3–4.4,0.59). Measures incorporating “no show” visits were highly correlated (Spearman coefficient=0.83–0.85), as were measures based solely upon kept visits (Spearman coefficient=0.72–0.77). Correlation coefficients were lower across these two groups of measures (Range=0.16–0.57).

Conclusions—Six retention measures displayed a wide range of correlation with one another, yet each measure had significant association and modest discrimination for VL suppression. These data suggest there is no clear gold standard, and that selection of a retention measure may be tailored to context.

Keywords

Retention in care; Adherence; Engagement in care; Viral load

Introduction

In recent years, increased attention has focused on expanding HIV adherence beyond antiretroviral medications to include engagement in medical care.[1–3] Following HIV diagnosis, timely linkage and subsequent retention in care is imperative to allow access to antiretroviral therapy (ART), which requires uninterrupted receipt and a high-level of adherence to achieve and sustain plasma viral load (VL) suppression.[4–6] A recent meta-analysis suggests that 69% (95% confidence interval: 66–71%) of newly diagnosed individuals have timely entry into HIV medical care (included studies defined care entry using a range of 3–6 months from HIV diagnosis date), 59% (95% confidence interval: 53–65%) are retained in care (included studies used varying definitions of “retained” and observation periods), and only 28% of persons living with HIV/AIDS in the US, including the undiagnosed, have achieved VL suppression.[7–9] Clearly, sub-optimal linkage and retention in HIV care are formidable barriers to fully realizing the individual and public health benefits of VL suppression afforded by ART.[4–6,10,11] The importance of this issue is highlighted by the emphasis placed on maximizing retention in care are in the US National HIV/AIDS Strategy,[12] and by mounting enthusiasm for antiretroviral treatment as prevention approaches,[13] which have been bolstered by recent research findings.[14]

Despite the recognized clinical and programmatic importance of retention in care, there is no recognized standard measure for retention in care. In contrast to measuring linkage to care, a dichotomous event, measuring retention is more complex as it includes multiple visits, scheduled at varying time intervals, and occurring across time. Indeed, there are many ways

to operationalize retention in care, and studies have used a wide range of approaches.[15] Most published studies have focused their analyses on a single retention measure, demonstrating factors associated with retention and its impact on HIV biomarker and clinical outcomes.[16–19] However, the degree to which different measures of retention are related to outcomes, as well as to one another, among the same sample of HIV-infected patients is largely unexplored.[20] Here we compare six commonly used measures of retention in HIV care to VL suppression and to one another in a large sample inclusive of all clinic patients participating in a multi-site study. Our aim was to evaluate the prognostic value of retention measures in predicting VL suppression as well as the correlation among measures to inform their use in future research and quality improvement initiatives.

Methods

Study Sample and Procedures

Clinic-wide, patient-level data were used from six academically-affiliated HIV medical clinics participating in a CDC and HRSA sponsored Retention in Care (RIC) intervention study, which has previously been described in detail.[21,22] The six study sites include HIV clinics affiliated with Baylor College of Medicine, Houston, TX; Boston University Medical Center, Boston, MA; Johns Hopkins University, Baltimore, MD, State University of New York, Downstate Medical Center, Brooklyn, NY; University of Alabama at Birmingham, Birmingham, AL; and University of Miami, Miami, FL. The current study used systematically captured, de-identified, socio-demographic, clinical and medical visit patient-level data from a 2-year period preceding implementation of the intervention. The analysis included patients at the six study sites who had: (1) at least one scheduled primary HIV care appointment during the first 6 months (189 days) of a 12-month observation period (1 May 2008 – 30 April 2009) and (2) attended at least 1 primary HIV medical provider visit in the year preceding the observation period (1 May 2007 – 30 April 2008). These criteria were employed to identify established clinic patients in whom retention in care could be measured. The RIC research protocol received Institutional Review Board approval at all study sites.

Measures of Retention in HIV Care

Our principal focus was upon retention in HIV medical care, using six commonly used measures that have been described in detail previously (Table 1).[15] In accordance with prior studies, only scheduled clinic visits with a primary HIV medical provider with medication prescribing privileges (i.e., MDs, CRNPs, PAs) were included in calculating retention measures; we did not include walk-in, urgent care, subspecialty, or supportive services visits. Three of the retention measures incorporate data on missed clinic visits, and include only no-show visits that were not canceled in advance of the scheduled appointment by the patient, provider or clinic.[15,23] Missed visits were recorded as a count and dichotomous measure (zero vs. ≥1 no-show visits), and visit adherence was calculated as a proportion of kept to scheduled appointments (range=0–100%), with kept visits being those attended by the patient and with the denominator excluding canceled visits. An additional three retention measures were calculated based solely upon kept visits. A 4-month constancy measure calculated the number of 4-month intervals in which a patient had at least one kept visit (range=0–3). A 6-month gap measure captured whether a patient had >189 days between sequential kept visits, and the Health and Resources Services Administration HIV/AIDS Bureau (HRSA HAB) measure calculated whether a patient had 2 kept visits separated by >90 days during the 12-month observation period. With the exception of the missed visit count measure, the other five retention measures were formulated such that a higher value indicated better retention in order to align the directionality and facilitate the interpretation of study results.

Outcome Variable

Plasma VL suppression at the end of the 12-month observation period (12-month VL) was the primary outcome of interest. As VL measures were obtained through routine clinical care and not at a specific study visit, a window of ± 120 days around the study end date of 30 Apr 2009 was used. If multiple VL measures were available in this time window, the measure closest to the study end date was used. A value <400 c/mL was considered suppressed.

Statistical Analyses

Descriptive statistics and plots were generated to evaluate distributions of all study variables, and to generate summary statistics including means, standard deviations, frequencies and percentages. Spearman rank correlation was used to evaluate the associations among retention measures. Logistic regression was used to examine the association between each retention measure and 12-month VL suppression. The c-statistic (range=0.5–1.0), an estimate of the area under the receiver operator characteristic (ROC) curve plotting sensitivity by 1-specificity, was used to evaluate the discriminatory capacity of each retention measure in predicting VL suppression. The c-statistic captures the prognostic value of each retention measure to correctly assign patients to the observed 12-month VL state (suppression vs. failure), with 0.5 indicating a measure is no better than chance, and 1.0 indicating perfect discriminatory capacity. In addition, the sensitivity and specificity of each retention measure in predicting 12-month VL suppression were calculated. In primary analyses, patients with missing 12-month VL measures were excluded. Sensitivity analyses were conducted considering those with missing 12-month VL measures to be detectable (>400 c/mL, missing=failure). All statistical analyses were conducted using SAS version 9.3.

Results

Among 10,053 study patients, the mean age was 46 ± 10 years, 65% were male, 64% were black race, 19% were of Hispanic ethnicity and 49% reported heterosexual sex (Table 2). Patients averaged 1.5 ± 1.7 no show visits during the 12-month observation period, with two-thirds of patients having at least one no-show visit. A wide range of visit adherence was observed, with nearly half of patients attending less than 75% of their scheduled clinic appointments. Fifty percent of patients attended visits in all three 4-month intervals (constancy measure), one-third had a 6-month gap, and roughly one-quarter were not retained according to the HRSA HAB measure. Twelve month VL measures were available in 8,235 patients (82%), among whom 6,304 (77%) were suppressed at 12-months (<400 c/mL, Table 2).

When comparing retention measures to one another a wide range of association was observed, with Spearman correlation coefficients ranging from 0.16 to 0.85 (Table 3). In general, measures that incorporate missed visits (missed visit count, missed visit dichotomous measure, and visit adherence) were more highly correlated with each other (0.83–0.85), as were measures based solely on kept visits (4-month constancy, 6-month gap and HRSA HAB measure: 0.72–0.77). Across these two broad categories, the count and dichotomous missed visit measures demonstrated lower correlation (0.16–0.26) with the kept visit group of measures, relative to visit adherence, which had more moderate correlations (0.51–0.57, Table 3).

All six retention measures demonstrated strong and statistically significant (P<0.001) associations with 12-month VL suppression (Table 4a). As anticipated, dichotomous measures (dichotomous missed visit, 6-month gap and HRSA HAB measure) had less

discriminatory capacity for VL suppression as indicated by lower c-statistic values (0.59–62) relative to non-dichotomous measures (missed visit count, visit adherence, 4-month constancy: 0.63–0.69). This is demonstrated graphically as the area under the receiver operator characteristic curve, which is estimated by the c-statistic and plotted as sensitivity by 1-specificity (Figure 1). The performance of retention measures was largely consistent across study sites (data not shown).

Notably, among the dichotomous retention measures the 6-month gap and HRSA HAB measure demonstrated sensitivity for VL suppression of 82% and 91%, respectively, with lower specificity (39% and 27%), whereas the dichotomous missed visit measure displayed specificity of 82%, with lower sensitivity (42%). Thresholds to define retention for other measures were selected to provide a balance of sensitivity and specificity (Table 4), although other cut-points may be applied with an associated tradeoff of sensitivity for specificity and vice versa. Additional analyses using a missing equals failure approach for patients lacking 12-month VL measures (18%) yielded consistent findings with primary analyses, albeit with larger parameter estimates and c-statistic values for retention measures, particularly for kept visit based measures (Table 4b).

Discussion

Our study is the first to evaluate the prognostic value of six commonly used measures in predicting VL suppression as well as the correlation among HIV retention in care measures in the same patient sample. A recent study from the HIV Research Network identified strong correlations (concordance correlation coefficients range=0.67–0.88) among retention measures calculated based upon kept visits only, which was corroborated by our analyses.[20] We extend this work by further examining an additional three measures that incorporate no-show visits, and additionally comparing the prognostic value of the six measures for HIV VL suppression. Overall, considerable variability was observed among these measures in categorizing patients as being retained, ranging from one-third of patients with no missed visits (perfect visit adherence) to over three-quarters of patients meeting the HRSA HAB retention measure. While these varying definitions translated to a broad range of correlations across retention measures (Spearman coefficients range=0.16–0.85), each measure demonstrated a strong and statistically significant ($P<0.001$) relationship with VL suppression. Accordingly, our data suggest there is no clear gold standard to measure retention in care, and that any of the evaluated measures may have a role depending on visit data availability, the questions being addressed, and the principal rationale and goals of measuring “retention.” Moreover, there may be merit to using multiple retention measures, particularly in research settings, and using one measure that incorporates missed visits and another based solely on kept visits.

As anticipated, improved prognostic value for VL suppression was observed for multi-level retention measures compared with dichotomous measures. By allowing more granular categorization of patient retention, the missed visit count measure, visit adherence, and 4-month constancy measures allowed for better discriminatory capacity in predicting VL suppression, as indicated by higher c-statistic values. For example, among the two-thirds of patients categorized as “not retained” by the dichotomous no-show visit measure, a broad range of counts of missed visits and of visit adherence was observed. The enhanced variability captured by these latter two measures translates into improved prognostic capacity for VL suppression, and is perhaps best visualized by the multiple points incorporated into the ROC curves, in contrast to the single point employed for dichotomous measures (Figure 1).

However, dichotomous measures clearly have value, offering advantages including face validity and less complex programming, computational and analytic demands.[15] Moreover, the dichotomous missed visit, 6-month gap and HRSA-HAB measures were all strongly associated with VL suppression, albeit with reduced discriminatory capacity. An interesting study finding was the variability in defining patients as retained across dichotomous retention measures, which translated into robust differences in the sensitivity and specificity of these measures in predicting VL suppression. The dichotomous no-show measure categorized only one-third of the sample as retained, resulting in high specificity (82%) of this measure in relation to VL suppression. In other words, 82% of persons without viral suppression had at least one no show visit during the year. In contrast, the 6-month gap and HRSA HAB measures categorized 68% and 77% of patients as retained, respectively. This translated into high sensitivity of these measures (82% and 91%, respectively) in predicting VL suppression. In other words, 8 or 9 of 10 persons with viral suppression met these standards for retention, respectively. No measure, however, had both high sensitivity and high specificity. These fascinating relationships highlight the potential to use multiple retention measures; one including missed visits and the other based on kept visits only, as they appear to provide complementary information regarding measurement of retention, yet are each significantly associated with VL suppression with large effect sizes. Future studies should evaluate the prognostic value of composite measures of retention integrating two or more of the measures examined here.

Our findings are germane to contemporary clinical and public health issues related to HIV treatment and prevention. In recent years, the importance of retention as a key step on the HIV treatment continuum has received heightened attention.[2,4] Our findings indicate that the operational definition chosen to measure retention can have far-reaching implications in assessing this component, with subsequent downstream implications for estimates of persons on ART and achieving VL suppression. The US National HIV/AIDS Strategy set 80% retention among HRSA Ryan White CARE Act clients as a goal by 2015, with retention measured using the HRSA HAB measure.[12] Among our sample, 77% of patients achieved retention according to this measure, which would have been widely variable, ranging from 33–68%, if other measures had been employed. This observation is of particular importance when comparing retention in care across settings and studies, as the measure employed, as well as the duration of the observation period can have a dramatic impact on interpretation of findings and the inference that may be drawn. It is imperative to ensure consistency of measures when evaluating similarities or differences in retention across settings.

Prior studies have established significant associations between the retention measures under study and HIV biomarker and clinical outcomes.[2,16–19] The current study extends this work by evaluating VL suppression across retention measures among the same study sample, showing strong and statistically significant associations for each measure. The large parameter estimates observed are in accordance with prior studies, and underscore the critical role of retention in care as a key step along the treatment continuum that ultimately leads to VL suppression. However, the retention measures studied demonstrated only modest discriminatory capacity (c-statistic=0.59–0.69) for VL suppression. It is anticipated that including other steps in the treatment continuum, notably ART adherence, to retention measures as an additional independent variable in statistical models would improve overall prognostic value for VL suppression. Notably, a significant association between retention and ART adherence was observed in a previous study that compared visit constancy with pharmacy refills.[16] Future research should examine the discriminatory capacity of models including both measures of retention and ART adherence in relation to HIV biomarker and other clinical outcomes.

Beyond individual health outcomes, considerable improvement in retention in care at the population level is essential to achieving the potential success of ART treatment as prevention initiatives.[4,10,13] There is great need for substantial improvement in retention in care, along with other steps across the treatment continuum, if we are to meaningfully increase the proportion of HIV-infected Americans with suppressed VL levels from current estimates of 19–28%.[4,8,9] The impact of treatment as prevention approaches is predicated upon the collective success of public health, medical and supportive service providers and affected communities in dramatically increasing these estimates.

Our study has limitations. By focusing on established clinic patients to allow for a sample with a comparable observation period we cannot comment on retention measures in persons newly establishing HIV medical care, which has been evaluated in other studies.[6,17,24,25] Established patients may be more likely to be adherent to ART regardless of their retention status, and this may place a limit on the discriminatory ability of these measures. We are unable to systematically capture and account for patients who may have transferred their medical care during the one-year observation period, which could impact calculation of retention measures. Similarly, deaths during the 1-year observation period were not systematically captured, which may have resulted in under-reporting of retention, although it is unclear this would introduce systematic bias when making comparisons across retention measures. Moreover, patients who died likely had missing 12-month VL values and were excluded from primary analyses. Our examination of retention measures was for a relatively short period of time. Additional research should evaluate these measures over longer time intervals. While our six sites serve diverse populations across the US, our findings might not translate to other domestic and international treatment settings or to non-academically affiliated clinics. We also note study strengths, including the clinic-wide capture of high quality patient-level visit utilization, socio-demographic and clinical data. In addition, the evaluation of measures incorporating missed clinic visits in addition to those based solely on kept visits is novel, and extends recent work comparing only this latter group of retention measures.[20]

In summary, six commonly used measures of retention in care demonstrated considerable variability in categorizing retention, translating to a wide range of correlations among these measures. In general, stronger associations were observed among measures incorporating missed visits and among those based solely on kept visits, with potentially complementary information provided when using measures from these two groups. Despite the observed heterogeneity across retention measures, each demonstrated strong and statistically significant relations with VL suppression, albeit with variable discriminatory capacity. Taken together, our findings suggest that as for ART adherence, there is no clear gold standard to measure retention in HIV care, and each measure studied may have value and utility according to setting and circumstance.

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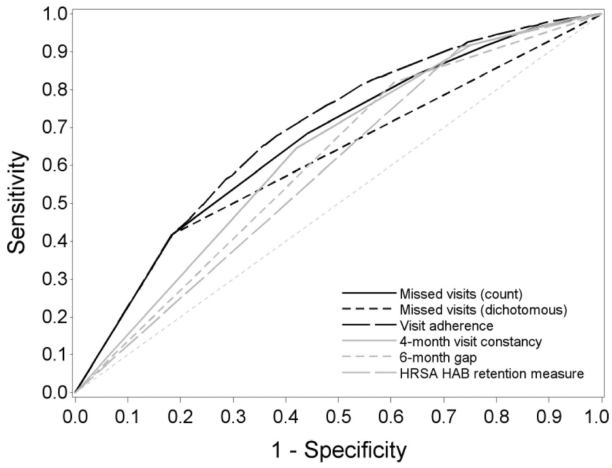
1a) Primary outcome of 12-month viral load suppression (<400 copies/mL) excluding patients with missing values



1b) Sensitivity analyses considering those with missing 12-month viral load measures to be detectable (missing=failure)

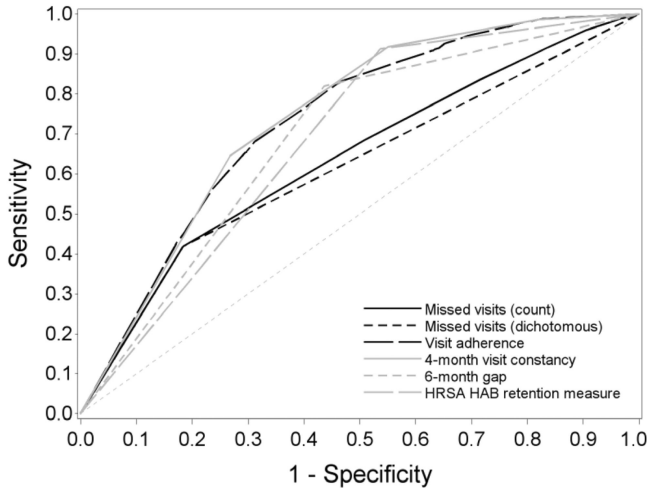


Figure 1.

Receiver operator characteristic (ROC) curves plotting the sensitivity vs. 1-specificity of six commonly used retention in care measures for HIV viral load suppression (<400 c/mL) among 10,053 HIV-infected patients receiving medical care at six academically-affiliated HIV clinics during the year preceding implementation of the CDC/HRSA Retention in Care intervention, 2008–09. ROC curves are displayed for the primary outcome of 12-month viral load suppression excluding patients with missing values (1a), and for sensitivity analyses considering those with missing 12-month viral load measures to be detectable at >400 c/mL (1b). The area under the ROC curve is represented by the c-statistic, which captures the prognostic value of each retention measure to correctly assign patients to the observed 12-month VL state (suppression vs. failure), with 0.5 indicating a measure is no better than chance, and 1.0 indicating perfect discriminatory capacity.

Table 1

Measures of retention in care calculated over a 12-month observation period among 10,053 HIV-infected patients receiving medical care at six academically-affiliated HIV clinics during the year preceding implementation of the CDC/HRSA Retention in Care intervention, 2008–09.

Retention Measure	Description
Missed visits (count)	Number of “no show” visits accrued (count measure, observed range=1–14)
Missed visits (dichotomous)	Measure of any “no show” visits (dichotomous measure, `no' = retained)
Visit adherence	Proportion of kept visits / scheduled visits (kept + “no-show” visits) (continuous measure, range=0.0–1.0)
4-month visit constancy	Number of 4-month intervals with at least 1 kept visit (categorical measure, range=0–3)
6-month gap	≥ 189 days elapsed between sequential kept visits (dichotomous measure, `no' = retained)
HRSA HAB measure	2 kept visits separated by ≥ 90 days (dichotomous measure, `yes' = retained)

In accordance with prior studies, only scheduled clinic visits with a primary HIV medical provider were included in calculating retention measures. “No-show” visits are defined as visits not canceled in advance of the scheduled appointment by the patient, provider or clinic.

Table 2

Characteristics of 10,053 HIV-infected patients receiving medical care at six academically-affiliated HIV clinics during the year preceding implementation of the CDC/HRSA Retention in Care intervention, 2008–09.

Characteristic (N=10053)	Mean ± SD or Frequency (%)
Age (years)	46.0 ± 10.0
Gender	
Male	6549 (65.1%)
Female	3465 (34.5%)
Transgender	39 (0.4%)
Race	
Black	6435 (64.0%)
White	3004 (29.9%)
Other/Unknown	614 (6.1%)
Ethnicity	
Hispanic	1880 (18.7%)
Non-Hispanic	8066 (80.2%)
Missing/Unknown	107 (1.1%)
Risk transmission group	
MSM	2837 (28.2%)
MSM + IDU	230 (2.3%)
IDU	1318 (13.1%)
Heterosexual	4947 (49.2%)
Other/Missing/Unknown	721 (7.2%)
Site	
Baylor College of Medicine	2904 (28.9%)
Boston University Medical Center	1053 (10.5%)
Johns Hopkins University	1883 (18.7%)
SUNY Downstate Medical Center	922 (9.2%)
University of Alabama at Birmingham	1307 (13.0%)
University of Miami	1984 (19.7%)
Baseline plasma HIV RNA (log_{10} c/mL)	2.59 ± 1.17
Baseline CD4+ T lymphocyte count (cells/μL)	456 ± 296
“No show” visits (range=0–14)	1.5 ±1.7
Zero	3327 (33.1%)
One	2895 (28.8%)
Two	1730 (17.2%)
≥ Three	2101 (20.9%)
Visit adherence	0.69 ± 0.30

Characteristic (N=10053)	Mean ± SD or Frequency (%)
0–24%	837 (8.4%)
25–50%	1103 (11.1%)
50–74%	2835 (28.4%)
75–99%	1951 (19.6%)
100%	3244 (32.5%)
4-month visit constancy (intervals with ≥ 1 kept visit)	
Zero	760 (7.6%)
One	1448 (14.4%)
Two	2768 (27.5%)
Three	5077 (50.5%)
6-month gap (≥ 189 days between sequential kept visits)	
No (Retained)	6805 (67.7%)
Yes (Not retained)	3248 (32.3%)
HRSA HAB measure (2 kept visits >90 days apart)	
Retained	7761 (77.2%)
Not retained	2292 (22.8%)
12-month plasma HIV RNA	
≤ 400 copies/mL	6304 (62.7%)
> 400 copies/mL	1931 (19.2%)
Missing	1818 (18.1%)

Baseline plasma HIV RNA and CD4+ T lymphocyte count measurements were the values on the date nearest 1 May 2008 date within a window of ± 120 days. 12-month plasma HIV RNA measurements were the values on the date nearest 30 Apr 2009 within a window of ± 120 days.

Table 3

Spearman rank correlation matrix for measures of retention in care among 10,053 HIV-infected patients receiving medical care at six academically-affiliated HIV clinics during the year preceding implementation of the CDC/HRSA Retention in Care intervention, 2008–09

	Missed visits (count)	Missed visits (dichotomous)	Visit adherence	4-month visit constancy	6-month gap	HRSA HAB measure
Missed visits (count, range=1–14)	1					
Missed visits (dichotomous)	0.84	1				
Visit adherence (continuous, range=0.0–1.0)	0.85	0.83	1			
4-month visit constancy (categorical, range=0–3)	0.21	0.26	0.57	1		
6-month gap (dichotomous)	0.20	0.25	0.51	0.76	1	
HRSA HAB measure (dichotomous)	0.16	0.22	0.53	0.77	0.72	1

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Table 4a

Associations of measures of retention in care with plasma viral load suppression (<400 c/mL) among 10,053 HIV-infected patients receiving medical care at six academically-affiliated HIV clinics during the year preceding implementation of the CDC/HRSA Retention in Care intervention, 2008–09. Patients with missing 12-month viral load values excluded in primary analyses.

	Odds Ratio[a]	95%CI	C-statistic	Sensitivity[b]	Specificity[b]
Missed visits (count)	0.73	0.71–0.75	0.67	68.4%	55.9%
Missed visits (dichotomous)	3.16	2.79–3.59	0.62	41.9%	81.5%
Visit adherence (continuous)	3.87	3.49–4.29	0.69	68.1%	61.4%
4-month visit constancy	2.77	2.52–3.05	0.63	64.6%	57.9%
6-month gap	2.96	2.65–3.31	0.61	82.0%	39.4%
HRSA HAB measure	3.81	3.33–4.35	0.59	91.2%	26.8%

[a]Odds ratios presented per additional missed visit (count), per 0.5 (50%) increase for visit adherence and 4-month visit constancy, and “retained” vs. “not retained” for dichotomous retention measures: missed visits (dichotomous), 6-month gap, and HRSA HAB measure

[b]Sensitivity and specificity for dichotomous cut-points for “retained” of: ≤ 1 missed visit (count), ≥ 70% visit adherence, and attended visits in all 3 intervals for 4-month constancy measures, and per “retained” for dichotomous retention measures: zero missed visits (dichotomous), 6-month gap, and HRSA HAB measure

Table 4b

Sensitivity analyses: Patient with missing 12-month viral load values considered detectable (missing=failure).

	Odds Ratio[a]	95%CI	C-statistic	Sensitivity[b]	Specificity[b]
Missed visits (count)	0.77	0.75–0.79	0.64	68.4%	49.1%
Missed visits (dichotomous)	3.20	2.91–3.53	0.62	41.9%	81.7%
Visit adherence (continuous)	5.13	4.72–5.58	0.73	68.1%	68.8%
4-month visit constancy	5.35	4.94–5.79	0.74	64.6%	73.2%
6-month gap	5.88	5.37–6.44	0.69	82.0%	56.4%
HRSA HAB measure	9.02	8.10–10.06	0.69	91.2%	46.4%

[a]Odds ratios presented per additional missed visit (count), per 0.5 (50%) increase for visit adherence and 4-month visit constancy, and “retained” vs. “not retained” for dichotomous retention measures: missed visits (dichotomous), 6-month gap, and HRSA HAB measure

[b]Sensitivity and specificity for dichotomous cut-points for “retained” of: ≤ 1 missed visit (count), ≥ 70% visit adherence, and attended visits in all 3 intervals for 4-month constancy measures, and per “retained” for dichotomous retention measures: zero missed visits (dichotomous), 6-month gap, and HRSA HAB measure