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The Association of Clinical Follow-Up Intervals in HIV-Infected Persons with Viral Suppression on Subsequent Viral Suppression

April Buscher, MD, MPH,[1]* Michael Mugavero, MD, MHSc,[2] Andrew O. Westfall, MS,[2] Jeanne Keruly, MS, CRNP,[3] Richard Moore, MD, MHS,[3] Mari-Lynn Drainoni, PhD,[4,5] Meg Sullivan, MD,[5] Tracey E. Wilson, PhD,[6] Allan Rodriguez, MD,[7] Lisa Metsch, PhD,[7]* Lytt Gardner, PhD,[8] Gary Marks, PhD,[8] Faye Malitz, MS,[9] and Thomas P. Giordano, MD, MPH[1]

Abstract

The recommendation for the frequency for routine clinical monitoring of persons with well-controlled HIV infection is based on evidence that relies on observed rather than intended follow-up intervals. We sought to determine if the scheduled follow-up interval is associated with subsequent virologic failure. Participants in this 6-clinic retrospective cohort study had an index clinic visit in 2008 and HIV viral load (VL) ≤400 c/mL. Univariate and multivariate tests evaluated if scheduling the next follow-up appointment at 3, 4, or 6 months predicted VL >400 c/mL at 12 months (VF). Among 2171 participants, 66%, 26%, and 8% were scheduled next follow-up visits at 3, 4, and 6 months, respectively. With missing 12-month VL considered VF, 25%, 25%, and 24% of persons scheduled at 3, 4, and 6 months had VF, respectively ($p = 0.95$). Excluding persons with missing 12-month VL, 7.1%, 5.7%, and 4.5% had VF, respectively ($p = 0.35$). Multivariable models yielded nonsignificant odds of VF by scheduled follow-up interval both when missing 12-month VL were considered VF and when persons with missing 12-month VL were excluded. We conclude that clinicians are able to make safe decisions extending follow-up intervals in persons with viral suppression, at least in the short-term.

Introduction

Persons with HIV infection are living longer with the disease as a result of effective antiretroviral therapy (ART).[1] ART is a life-long treatment that requires repeated laboratory monitoring and HIV primary care clinic visits, and which results in substantial costs for patients and healthcare systems. How often HIV-infected persons with viral suppression need to have clinical follow-up is difficult to study. Treatment failure rates are low, and randomizing persons to defined intervals would be difficult to justify. To attempt to answer this question, Reekie et al.[2] examined virologic failure rates in a cohort of 2240 participants on stable and fully suppressive ART regimens for at least 1 year. After 3, 6, and 12 months, 0.1%, 1.5%, and 4.6% of participants had virologic failure, respectively. The authors concluded that it might be reasonable to extend monitoring to 6 months, given the low failure rate at 3 months.[2] A small study of persons who had been on ART for 15 months and had viral suppression found that virologic failure was not associated with time between viral load tests. In fact, in unadjusted analyses, persons with failure had more monitoring, not less.[3]

[1]Baylor College of Medicine, Thomas Street Health Center, and the Michael E. DeBakey VA Medical Center, Houston, Texas.
[2]University of Alabama at Birmingham (UAB) School of Medicine, UAB Center for AIDS Research, and UAB 1917 Clinic, Birmingham, Alabama.
[3]Johns Hopkins University School of Medicine, Baltimore, Maryland.
[4]Boston University School of Public Health and Center for Health Quality, Outcomes and Economic Research, ENRM Memorial VA Hospital, Boston, Massachusetts.
[5]Boston University School of Medicine, Boston, Massachusetts.
[6]State University of New York Downstate Medical Center, School of Public Health, Brooklyn, New York.
[7]University of Miami School of Medicine, Miami, Florida.
[8]Centers for Disease Control and Prevention, Atlanta, Georgia.
[9]Health Resources and Services Administration, Rockville, Maryland.
*Current affiliations: AB: Durham VA Medical Center, Durham, North Carolina, USA; LM: Columbia University Mailman School of Public Health, New York, New York, USA.

Health care providers likely use objective and subjective criteria to determine when a patient ought to be scheduled to return for a follow-up visit. The current U.S. Department of Health and Human Services treatment guidelines state that in persons on a stable ART regimen, viral load assessments should be repeated every 3–4 months. However, the guidelines do acknowledge that some clinicians may extend the interval to every 6 months for adherent individuals who have maintained suppressed viral loads for more than 2–3 years and who are clinically stable.[4] This is a B-III recommendation (i.e., it is based on expert opinion).

One limitation of previous observational studies is that they are based on when individuals are actually seen, not when they are scheduled to be seen. Retention in HIV care is often poor,[5] no-show rates are high,[6] and unintended gaps in care are frequent.[7] On the other hand, individuals may present earlier for care than scheduled because of drug side effects or inter-current illnesses. Thus, estimates based on actual visits may be biased. For the clinician seeing a patient, the immediately relevant question is, when should I ask the patient to return for his or her next visit? To our knowledge, no study has attempted to answer whether clinicians can safely extend the requested follow-up interval.

We conducted a multi-center study using clinic-wide data on scheduled appointments, regardless of whether the appointment was attended or missed. Using a retrospective cohort design, we sought to estimate virologic failure rates based not on when individuals attended clinic next, but on when they were scheduled to attend the next visit by their provider. This unique dataset therefore would allow us to answer an important question: Do providers in routine care safely extend follow-up intervals for their patients with viral suppression? More directly, we wanted to determine if scheduling a follow-up interval at 4 or 6 months is associated with an increased risk of virologic failure at 1 year, compared to the more standard 3-month follow-up interval.

Methods

Study design, participants, and data collection

We conducted a retrospective cohort study of HIV-infected persons receiving medical care at one of six academically affiliated clinics (Boston University Medical Center clinic, Boston, MA; STAR Health Center at SUNY Downstate Medical Center, Brooklyn, NY; Johns Hopkins University clinic, Baltimore, MD; Jackson Memorial HIV Clinic, affiliated with the University of Miami, Miami, FL; University of Alabama-Birmingham 1917 Clinic, Birmingham, AL; and Thomas Street Health Center, affiliated with Baylor College of Medicine, Houston, TX). All HIV-infected persons receiving care on or after May 1, 2008 through April 30, 2009, were included in the dataset. In each of these sites, the approximate interval to the next scheduled appointment is indicated by the provider as the patient is discharged from the present appointment.

Demographic and HIV-related clinical and laboratory data were abstracted from electronic clinic files. Data on all HIV primary care clinic appointments during the study period and disposition of all appointments (i.e., whether the appointment was attended, missed, or cancelled) were obtained from clinic administrative files.

The parent study for the present analysis tested the effectiveness of a clinic-wide intervention to improve retention in HIV care. In order to have 12 months of follow-up time before the clinic-wide intervention was deployed in mid-2009, participants in the present analysis were required to have completed a HIV primary care clinic visit in May, June, or July 2008. This visit is considered their index clinic visit. Participants in the present analysis were also required to have an HIV viral load ≤ 400 c/mL between 60 days before and 7 days after their index clinic visit. The index CD4 cell count was abstracted from the same window as the HIV viral load.

Data analysis

The main explanatory variable was time from the completed index visit to the next scheduled HIV primary care appointment (regardless of disposition). In order to discard participants whose next visit was likely not a routine follow-up visit (e.g., walk-in or acute care visits), we only included next scheduled follow-up appointments that were within 7 days of the 3, 4, or 6 month anniversary of the index visit. Participants were then categorized as scheduled to return in 3, 4, or 6 months. Secondary explanatory variables included demographic characteristics and whether the next scheduled appointment was attended, cancelled, or missed ("no show"). The outcome was the 12-month viral load, which was the viral load closest to and within 60 days of the 1 year anniversary of the index visit. Univariate chi-square tests evaluated associations of variables with the time to next scheduled appointment and with virologic failure at 12 months. We expected variations in unmeasured participant characteristics and follow-up scheduling practice patterns by clinic. Therefore, in our multivariate analysis we used generalized estimating equations (GEE) with clinic site as a cluster variable and used an exchangeable correlation structure to account for the clustering of patients within sites.[8] In the primary analysis, missing viral loads at 12 months were considered virologic failures (>400 c/mL). In confirmatory analyses, we excluded participants with missing viral loads at 12 months from the analyses. Each site's Institutional Review Board provided study approval. Because the data were analyzed anonymously, a waiver of the need for individual consent was granted.

Results

There were 7770 participants who completed a visit in May, June, or July 2008. Thirty-one percent of these participants had viral suppression but had scheduled visit intervals that were outside the 3, 4, and 6 month windows (most had an interval that was <3 months); 9% met the visit interval criterion but did not have a viral load of ≤ 400 c/mL at their index visit; and 32% failed to meet both criteria. As a result, 2171 participants (28%) were included in the analysis. Mean (SD) participant age was 47 (10) years (Table 1). Seventy percent of the participants were male and 52% reported their HIV risk factor as heterosexual sex. Similar numbers of participants had private health insurance, Medicare, Medicaid, and no insurance. The median (IQR) CD4 cell count at the index visit was 497 (345, 692) cells/mm^3. Sixty-six percent of participants had a follow-up appointment scheduled at 3 months, 26% at 4 months, and 8% at 6 months. The majority of the participants scheduled at a 6-month follow-up interval came from a single site.

Participants who were scheduled a follow-up appointment in 3 months were more likely to be non-Hispanic black (62%),

Table 1. Characteristics of 2171 Participants with an HIV Viral Load of ≤400 c/mL and a Next Scheduled Clinic Appointment in 3, 4, or 6 Months

Characteristic	N *(%)*
Gender[a]	
Male	1512 (70%)
Female	653 (30%)
Age, mean (SD)	47 years (10)
Race/ethnicity[a]	
Black, non-Hispanic	1220 (58%)
White, non-Hispanic	443 (21%)
Hispanic	457 (22%)
Health insurance[a]	
Private	449 (21%)
Medicare	571 (27%)
Medicaid	558 (26%)
Uninsured	559 (26%)
HIV risk factors[a]	
IDU or MSM + IDU	257 (13%)
MSM	713 (35%)
Heterosexual	1062 (52%)
HIV duration, median (IQR)[a]	9 years (5, 13)
CD4 cell count at index visit, median (IQR)[a]	497 cells/mm^3 (345, 692)
Time to next scheduled clinic appointment	
3 months	1429 (66%)
4 months	574 (26%)
6 months	168 (8%)
Disposition of next scheduled clinic appointment (at 3, 4, or 6 months)	
Kept	1400 (64%)
Cancelled	379 (17%)
Missed	392 (18%)

IDU, intravenous drug use; IQR, interquartile range; MSM, men who have sex with men.

[a]Missing values include 6 missing gender, 51 missing race/ethnicity, 34 missing health insurance, 139 missing HIV risk factor, 47 missing HIV duration, and 60 missing CD4 cell count at index visit.

while participants who were scheduled an appointment at 6 months were more likely to be non-Hispanic white (54%, $p<0.01$, Table 2). Participants scheduled for follow-up at 6 months were more likely to have private insurance (54%) than participants scheduled at 3-month (18%) or 4-month (19%) intervals ($p<0.01$). Participants scheduled a next follow-up visit at 6 months were more likely to be men who have sex with men (MSM; 53%) compared to participants scheduled at 3-month (31%) and 4-month (39%) intervals ($p<0.01$). Longer intervals between the index and next scheduled visit were also associated with higher index CD4 cell counts ($p<0.01$). Seventeen percent of participants cancelled and 18% missed their next appointment following the index visit. Fewer persons scheduled for a 6-month follow-up appointment missed that visit (7%), compared to persons scheduled follow-up at 3 months (19%) and 4 months (20%; $p<0.01$).

Counting missing viral loads as virologic failure, 25% of participants had virologic failure at 12 months. Participants with a scheduled follow-up appointment at 3 months were as likely to have virologic failure at 12 months (25%) as participants with scheduled follow-up at 4 months (25%) or 6 months (24%, $p=0.95$). Male participants were more likely to have virologic failure at 12 months (26%) compared to females (22%, $p=0.03$) (Table 3). Participants with a CD4 count < 200 cells/mm^3 at the index visit were more likely to have virologic failure at 12 months (33%) compared to participants with CD4 cell counts between 200 and 350 cells/mm^3 (26%) and >350 cells/mm^3 (23%; $p=0.02$). Forty-two percent of participants who missed their next follow-up appointment had virologic failure and 29% of persons who cancelled their next follow-up appointment had virologic failure compared to 19% of persons who attended their follow-up appointment ($p<0.01$).

The majority of the virologic failures (79%) were due to missing viral loads at 12 months. There were no statistically significant differences between participants who had available 12-month viral loads and participants whose 12-month viral loads were missing on the following characteristics: gender, age, race/ethnicity, HIV risk factor, HIV duration, or CD4 count at the index visit. Not unexpectedly, a higher percentage of participants with missing 12-month viral loads had cancelled (21%) or missed (32%) their follow-up appointment compared to participants who had available 12-month viral loads (17% and 15%, respectively, $p<0.01$).

In analyses in which persons with missing 12-month viral loads were excluded, 6.5% of participants experienced virologic failure at 12 months, including 7.1% of persons with a 3-month follow-up interval, 5.7% of persons with a 4-month interval, and 4.5% of persons with a 6-month interval ($p=0.35$). Among the other variables we studied, virologic failure was statistically significantly predicted by insurance status (3.0%, 6.5%, 7.3%, and 8.5% for persons with private health insurance, Medicaid, Medicare, and no health insurance, respectively [$p=0.01$]), CD4 cell count at index visit (12.0%, 9.2%, and 5.3% for persons with CD4 count < 200 cells/mm^3, between 200 and 350 cells/mm^3, and >350 cells/mm^3, respectively [$p<0.01$]), and disposition of the next scheduled follow-up appointment (5.1%, 7.9%, and 11.6% for persons who kept, cancelled, and missed the appointment, respectively [$p<0.01$]).

Using a multivariate GEE analysis with site as a cluster variable and where missing 12-month viral loads were considered failures, we determined the factors associated with virologic failure at 12 months (Table 4). Compared to participants scheduled follow-up at a 3-month interval, participants scheduled to follow-up at either 4 months (aOR 1.04, 95% CI 0.88–1.24, $p=0.64$), or 6 months (aOR 0.97, 95% CI 0.57–1.65, $p=0.91$) were as likely to have virologic failure at 12 months. Female sex was associated with a lower odds of having virologic failure (aOR 0.79, 95% CI 0.71–0.88, $p<0.01$) as was Hispanic ethnicity (aOR 0.65, 95% CI 0.56–0.76, $p<0.01$, compared to white, non-Hispanic participants). Index CD4 cell count <200 cells/mm^3 was associated with a higher odds of virologic failure (aOR 1.77, 95% CI 1.28–2.44, $p<0.01$, compared to an index CD4 cell count >350 cells/mm^3). Cancelling the next scheduled follow-up appointment (aOR 1.60, 95% CI 1.29–1.98, $p<0.01$), and missing the next scheduled follow-up appointment (aOR 2.92, 95% CI 2.71–3.15, $p<0.01$) predicted virologic failure compared to attending that follow-up appointment.

In the multivariate GEE analysis in which persons with missing 12-month viral loads were excluded, participants with a scheduled follow-up appointment at 4 months were as likely as participants scheduled a 3-month follow-up appointment to have virologic failure at 12 months (aOR 0.88, 95% CI 0.62–1.27, $p=0.50$), as were participants with

Table 2. Characteristics of 2171 Participants with a Study Index HIV Viral Load of ≤400 c/mL, Stratified by Time to Next Scheduled Clinic Appointment

Characteristic	*3 months* N (%)	*4 months* N (%)	*6 months* N (%)	p *Value*
Gender[a]				0.08
Male	973 (68%)	412 (72%)	127 (76%)	
Female	450 (32%)	162 (28%)	41 (24%)	
Age				0.11
<50 years old	854 (60%)	372 (65%)	104 (62%)	
≥50 years old	575 (40%)	202 (35%)	64 (38%)	
Race/ethnicity[a]				<0.01
Black, non-Hispanic	864 (62%)	293 (52%)	63 (40%)	
White, non-Hispanic	234 (17%)	124 (22%)	85 (54%)	
Hispanic	303 (22%)	146 (26%)	8 (5%)	
Health insurance[a]				<0.01
Private	251 (18%)	108 (19%)	90 (54%)	
Medicare	362 (26%)	167 (29%)	42 (25%)	
Medicaid	418 (30%)	126 (22%)	14 (8%)	
Uninsured	369 (26%)	168 (30%)	22 (13%)	
HIV risk factors[a]				<0.01
MSM	420 (31%)	209 (39%)	84 (53%)	
IDU or MSM + IDU	187 (14%)	57 (11%)	13 (8%)	
Heterosexual	731 (55%)	269 (50%)	62 (39%)	
HIV duration[a]				0.13
≤10 years	826 (59%)	327 (58%)	85 (51%)	
>10 years	566 (41%)	239 (42%)	81 (49%)	
CD4 cell count at index visit[a]				<0.01
<200 cells/mm^3	120 (9%)	27 (5%)	6 (4%)	
200–350 cells/mm^3	272 (20%)	93 (17%)	22 (13%)	
>350 cells/mm^3	1000 (72%)	434 (78%)	137 (83%)	
Disposition of next scheduled clinic appointment (at 3, 4, or 6 months)				<0.01
Kept	907 (63%)	370 (64%)	123 (73%)	
Cancelled	255 (18%)	90 (16%)	34 (20%)	
Missed	267 (19%)	114 (20%)	11 (7%)	

[a]Missing data, including 6 missing gender, 51 missing race/ethnicity, 34 missing health insurance, 139 missing HIV risk factor data, 47 missing HIV duration, and 60 missing CD4 cell count at index visit.

IDU, intravenous drug use; MSM, men who have sex with men.

scheduled follow-up at 6 months (aOR 0.85, 95% CI 0.36–1.97, $p=0.70$). The following variables were associated with higher odds of virologic failure: not having private health insurance (Medicaid [aOR 2.72, 95% CI 1.68–4.41, $p<0.01$], Medicare [aOR 2.59, 95% CI 1.54–4.35, $p<0.01$], and having no insurance [aOR 3.82, 95% CI 2.11–6.93, $p<0.01$] compared to private insurance); CD4 cell count at index visit <200 cells/mm^3 (aOR 2.41, 95% CI 1.92–3.03, $p<0.01$) compared to >350 cells/mm^3, and missing the next scheduled follow-up appointment (aOR 2.23, 95% CI 1.61–3.07, $p<0.01$) compared to attending that appointment.

Discussion

In this multisite retrospective cohort study of 2171 HIV-infected persons with viral suppression in routine care, participants who were scheduled a next HIV primary care clinic visit in 4 or 6 months were not at increased risk of virologic failure at 12 months compared to persons with follow-up scheduled at 3 months. Furthermore, missing or cancelling the next follow-up appointment was independently associated with 12-month virologic failure, and, among the factors we could examine, was the strongest predictor of failure. Even when missing 12-month viral loads were excluded from the analyses, missing the follow-up appointment still predicted virologic failure. These observations lead us to conclude that clinicians providing routine care are able to safely extend scheduled next follow-up intervals beyond 3 months in persons with viral suppression, at least in the short-term. Further, retention in care is strongly predictive of viral suppression, regardless of scheduled follow-up interval.

Few data exist to guide clinicians regarding when to schedule follow-up visits for virally suppressed individuals. Our data extend the previous literature by using the intended follow-up interval as the primary explanatory variable, rather then the observed follow-up interval. In prior work, virologic failure rates in a population with at least 1 year of viral suppression were 0.1% at 3 months, 1.5% at 6 months, and 4.6% at 12 months in one large study that did not count missing values as failures.[2] The rate of failure we found at 12 months after removing missing data was 6.5%. We were unable to assess how long participants had been suppressed because the dataset did not archive that data. However, clinicians almost certainly factored that information as well as other objective and subjective data into their recommended follow-up interval. Persons who were scheduled at a 6-month interval

Table 3. HIV Viral Load at 12 Months for 2171 Participants with a Study Index HIV Viral Load of ≤400 c/mL

Characteristic	*12-month VL ≤400 c/mL N (%)*	*12-month VL >400 c/mL (or missing) N (%)*	p *Value*
Overall	1632 (75%)	539 (25%)	
Gender			0.03
Male	1116 (74%)	396 (26%)	
Female	511 (78%)	142 (22%)	
Age			0.27
<50 years old	989 (74%)	341 (26%)	
≥50 years old	643 (76%)	198 (24%)	
Race/ethnicity			0.18
Black, non-Hispanic	909 (75%)	311 (25%)	
White, non-Hispanic	328 (74%)	115 (26%)	
Hispanic	359 (79%)	98 (21%)	
Insurance			0.17
Private	352 (78%)	97 (22%)	
Medicare	434 (76%)	137 (24%)	
Medicaid	433 (78%)	125 (22%)	
Uninsured	408 (73%)	151 (27%)	
HIV risk factors			0.66
MSM	539 (76%)	174 (24%)	
IDU or MSM+IDU	185 (72%)	72 (28%)	
Heterosexual	803 (76%)	259 (24%)	
Other/missing	105 (76%)	34 (24%)	
HIV duration			0.59
<10 years	939 (76%)	299 (24%)	
>10 years	663 (75%)	223 (25%)	
CD4 cell count at index visit			0.02
<200 cells/mm^3	103 (67%)	50 (33%)	
200-350 cells/mm^3	285 (74%)	102 (26%)	
>350 cells/mm^3	1209 (77%)	362 (23%)	
Time to next scheduled clinic visit			0.94
3 months	1072 (75%)	357 (25%)	
4 months	432 (75%)	142 (25%)	
6 months	128 (76%)	40 (24%)	
Disposition of next scheduled clinic appointment (at 3, 4, or 6 months)			<0.01
Kept	1136 (81%)	264 (19%)	
Cancelled	268 (71%)	111 (29%)	
Missed	228 (58%)	164 (42%)	

IDU, intravenous drug use; MSM, men who have sex with men.

may have been suppressed longer than persons scheduled at a 3-month interval. Importantly, our data suggest that providers are able to make these decisions safely for their patients, at least in the short-term. The long-term effects of lengthening the intervals between visits are unknown. Efforts to extend the follow-up interval should be balanced against possible negative impacts on the management of comorbidities, early detection of virologic failure, the patient–provider relationship, and retention in care, and so must be done with deliberate clinical judgment.[9–11]

In addition to clinical implications, our study has other implications. Primary care costs (including laboratory but excluding pharmacy costs) in one study were an estimated $3,470 per person per year.[12] Outpatient care costs constitute about 9% of the lifetime medical costs for HIV-infected persons.[13] As more HIV-infected persons live longer, associated outpatient healthcare costs will likely increase. If clinicians safely schedule some patients to be seen less frequently than every 3 months, as our study indicates is possible, cost savings could be realized. In addition, many HIV clinics are overburdened, and lengthening the interval between visits may provide capacity for patients recruited through routing HIV testing and retention in care efforts. This strategy would also benefit resource-constrained settings whose health systems may be over capacity. Finally, less frequent visits would benefit HIV-infected individuals by decreasing their direct costs of care (e.g., co-pays and transportation costs) as well as their opportunity costs (e.g., income lost from time off from work to attend appointments). The cost and capacity savings of extending the follow-up interval will only be realized if providers can extend follow-up intervals without compromising patients' health. Reekie et al. clearly demonstrated that consistency of viral suppression predicted subsequent risk of failure: persons who were suppressed at least 80% of the time before inclusion in their study were less likely to fail than persons suppressed less consistently.[2] Additional studies are needed to offer specific guidance as to when to extend follow-up intervals and for what patients.

Participants in our study who had missed or cancelled their next follow-up appointment had greater odds of virologic

Table 4. Multivariable Generalized Estimating Equations Analysis of Virologic Failure at 12 Months for 2171 Participants with a Study Index HIV Viral Load of ≤400 c/mL

	Missing = failure N = 2027		*Missing = dropped* N = 1656	
Characteristic	*Odds ratio (95% CI)*	p *Value*	*Odds ratio (95% CI)*	p *Value*
Time to next scheduled clinic appointment				
3 months	Referent		Referent	
4 months	1.04 (0.88–1.24)	0.64	0.88 (0.62,1.27)	0.50
6 months	0.97 (0.57–1.65)	0.91	0.85 (0.36, 1.97)	0.70
Gender				
Male	Referent		Referent	
Female	0.79 (0.71–0.88)	<0.01	0.85 (0.66, 1.11)	0.24
Age (per 10 year increase)	0.92 (0.84–1.01)	0.07	0.90 (0.80, 1.01)	0.08
Race/ethnicity				
White, non-Hispanic	Referent		Referent	
Black, non-Hispanic	1.01 (0.84–1.20)	0.93	1.19 (0.60, 2.35)	0.62
Hispanic	0.65 (0.56–0.76)	<0.01	0.63 (0.36, 1.12)	0.12
Insurance				
Private	Referent		Referent	
Medicare	1.19 (0.92–1.53)	0.19	2.59 (1.54, 4.35)	<0.01
Medicaid	1.20 (0.94–1.52)	0.14	2.72 (1.68, 4.41)	<0.01
Uninsured	1.52 (0.96–2.41)	0.08	3.82 (2.11, 6.93)	<0.01
CD4 cell count at index visit				
>350 cells/mm^3	Referent		Referent	
200–350 cells/mm^3	1.16 (0.91–1.46)	0.23	1.66 (0.99, 2.79)	0.05
<200 cells/mm^3	1.77 (1.28–2.44)	<0.01	2.41 (1.92, 3.03)	<0.01
Disposition of next scheduled clinic appointment (at 3, 4, or 6 months)				
Kept	Referent		Referent	
Cancelled	1.60 (1.29–1.98)	<0.01	1.40 (0.96, 2.05)	0.08
Missed	2.92 (2.71–3.15)	<0.01	2.23 (1.61, 3.07)	<0.01

Site was included as a cluster variable. Missing = failure means missing 12-month viral loads were considered detectable. Missing = dropped means missing persons with missing 12-month viral loads were not included in the analyses. Event modeled = virologic failure.

failure at 12 months. A number of earlier studies have found similar results.[14–17] Notably, our study is among the first to evaluate the impact of cancelled appointments on HIV outcomes. Most prior studies have focused on missed or "no show" visits. Study findings suggest cancelled appointments are similarly associated with virologic failure, albeit with a less strong association than observed for missed appointments. Future research is needed to delineate the impact of cancelled visits on HIV health behaviors and outcomes, but efficacious interventions to improve retention in care are needed.

Persons in our study with a CD4 cell count <200 cells/mm^3 were more likely to have virologic failure at 12 months. CD4 cell count at entry into our cohort may be at least a partial surrogate for duration of viral suppression prior to entering the cohort (a variable that we could not measure). Of course, initiating ART in persons with low CD4 cell counts is associated with poorer treatment outcomes, including less durable viral suppression.[18–21] Low CD4 cell counts are associated with an increased risk of death even after viral suppression, making it imperative that HIV-infected persons receive prompt diagnosis and treatment.[22]

In the analyses that excluded persons with missing 12-month viral loads, participants without private health insurance were more likely to have virologic failure. The same trends were observed when missing viral loads were considered failures (Table 4). Persons without private insurance have well-documented difficulty accessing medical care and obtaining ART consistently[23–25] and as a population have higher viral loads[26] and mortality rates.[27]

Our study has several limitations. It is an observational study that included only six clinics. We had a limited number of participants who were scheduled a 6-month follow-up appointment and most of those persons were concentrated at one of the six sites. Our adjusted analyses relied on GEE with site as a cluster variable, but residual confounding may be present. We do not have data on how long our participants had viral suppression prior to their index visit, or the specifics of their ART regimens. We do note that among the 12,690 persons seen at the clinics during 2008, with a mean (SD) of 3.37 (2.0) VL results per patient, 50.0% had viral suppression at all measurements, 26.5% never had viral suppression during the year, and 23.5% had mixed VL results.

We also do not have information on our participants' adherence to ART, and individuals who miss clinic visits are more likely to have poor adherence to ART.[16] Data on depression and other co-morbidities are also not available. These co-morbid conditions could impact adherence and some of the decisions about when individuals should return for follow-up. Our results may not be generalizable to clinics that are not academically affiliated.

This multicenter retrospective cohort study suggests that clinicians in routine care can safely extend follow-up intervals in persons with viral suppression, at least in the short-term. Increasing the length of time between follow-up visits in the right individuals has the potential to decrease healthcare costs

and relieve overextended clinics operating near or above capacity. Regardless of scheduled visit interval, maximizing appointment adherence remains critical for maintaining viral suppression.

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Author Disclosure Statement

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Address correspondence to:
Thomas P. Giordano, MD, MPH
Michael E. DeBakey VA Medical Center (152)
2002 Holcombe Blvd
Houston, TX 77030

E-mail: tpg@bcm.tmc.edu