Clinical Infectious Diseases

MAJOR ARTICLE

Clinic-Level Factors Associated With Time to Antiretroviral Initiation and Viral Suppression in a Large, Urban Cohort

Anne K. Monroe,[1] Lindsey P. Happ,[1] Nabil Rayeed,[2] Yan Ma,[3] Maria J. Jaurretche,[1] Arpi S. Terzian,[1] Kevin Trac,[1] Michael A. Horberg,[4] Alan E. Greenberg,[1] and Amanda D. Castel[1]; for the District of Columbia (DC) Cohort Executive Committee

[1]Department of Epidemiology, Milken Institute School of Public Health, The George Washington University, Washington, DC, USA, [2]Cerner Corporation, Kansas City, Missouri, USA, [3]Department of Biostatistics, Milken Institute School of Public Health, The George Washington University, Washington, DC, USA, and [4]Mid-Atlantic Permanente Research Institute, Kaiser Permanente Mid-Atlantic States, Rockville, Maryland, USA

Background. Using the results of a site assessment survey performed at clinics throughout Washington, DC, we studied the impact of clinic-level factors on antiretroviral therapy (ART) initiation and viral suppression (VS) among people living with human immunodeficiency virus (HIV; PLWH).

Methods. This was a retrospective analysis from the District of Columbia (DC) Cohort, an observational, clinical cohort of PLWH from 2011–2018. We included data from PLWH not on ART and not virally suppressed at enrollment. Outcomes were ART initiation and VS (HIV RNA < 200 copies/mL). A clinic survey captured information on care delivery (eg, clinical services, adherence services, patient monitoring services) and clinic characteristics (eg, types of providers, availability of evenings/weekends sessions). Multivariate marginal Cox regression models were generated to identify those factors associated with the time to ART initiation and VS.

Results. Multiple clinic-level factors were associated with ART initiation, including retention in care monitoring and medication dispensing reviews (adjusted hazard ratios [aHRs], 1.34 to 1.40; *P* values < .05 for both). Furthermore, multiple factors were associated with VS, including retention in HIV care monitoring, medication dispensing reviews, and the presence of a peer interventionist (aHRs, 1.35 to 1.72; *P* values < .05 for all). In multivariable models evaluating different combinations of clinic-level factors, enhanced adherence services (aHR, 1.37; 95% confidence interval [CI], 1.18–1.58), medication dispensing reviews (aHR, 1.22; 95% CI, 1.10–1.36), and the availability of opioid treatment (aHR, 1.26; 95% CI, 1.01–1.57) were all associated with the time to VS.

Conclusions. The observed association between clinic-level factors and ART initiation/VS suggests that the presence of specific clinic services may facilitate the achievement of HIV treatment goals.

Keywords. HIV; viral suppression; HIV care continuum; antiretroviral therapy.

Individual-level factors, including African-American race, younger ages, and higher CD4 cell counts, have been shown to be associated with prolonged times to antiretroviral therapy (ART) initiation and viral suppression (VS) [1–3]. Less is known about the impact of specific clinic-level programs and services on the time to ART initiation and VS. The International Association of Physicians in Acquired Immunodeficiency Syndrome (AIDS) Care guidelines recommend systematic retention monitoring and routine adherence monitoring to increase retention in care, ART adherence, and VS [4]. However, research comparing human immunodeficiency virus (HIV) outcomes for patients attending clinics with and without supplemental services is limited.

The HIV Research Network (HIVRN) described care structures at 15 HIVRN sites providing care to adults. Most offered multiple on-site services, including case management, clinical pharmacy services, psychiatry, substance abuse, and co-located gynecology services [5]. A separate evaluation of pediatric and adolescent HIV clinics showed that these clinics generally delivered care within a patient-centered home model, striving to deliver care that was comprehensive, patient-centered, coordinated, accessible, high quality, and safe [6]. Structural characteristics have been shown to affect HIV outcomes: physician expertise, clinic volume, and the involvement of a pharmacist in HIV care [7–10]. A large study in South Africa showed that a low doctor-to-patient ratio and the delivery of a combination of interventions to reduce losses to follow-up were associated with better HIV outcomes [11]. Optimizing clinic-level factors may increase the number of individuals starting ART and achieving VS, and evaluating which clinic-level factors best impact HIV

Received 13 August 2019; editorial decision 31 October 2019; accepted 6 November 2019; published online November 8, 2019.

Correspondence: A. K. Monroe, Department of Epidemiology and Biostatistics, Milken Institute School of Public Health, George Washington University, Project Director, DC Cohort, 950 New Hampshire Avenue NW, 5th Floor, Room 507, Washington, DC 20052 (amonroe@gwu.edu).

Clinical Infectious Diseases® 2020;71(7):e151–8

DOI: 10.1093/cid/ciz1098

outcomes can guide the allocation of retention and adherence resources.

The DC (District of Columbia) Cohort, a 15-site HIV observational cohort representing people with HIV (PLWH) in Washington, DC, provides a unique opportunity to assess clinic-level factors at multiple clinics within a single geographic region. The objective of this analysis was to examine the associations between clinic-level factors and times to ART initiation and VS. We hypothesized that participants attending a clinic with services increasing accessibility to and comprehensiveness of care, with retention monitoring, would have faster times to ART initiation and VS.

METHODS

This was a secondary data analysis of longitudinal, observational data from the DC Cohort using data from 2011–2018, described in detail previously [12]. Briefly, electronic medical record (EMR) data were abstracted both manually and through automatic exports from the EMR and include demographic, social, laboratory, diagnosis, encounter, and procedure information. This analysis includes data from 10 of the 15 sites, excluding 3 sites serving pediatric patients and 2 sites that began enrolling patients after 2017.

Individuals were included if they enrolled in the cohort by 31 March 2017, were not virologically suppressed at cohort enrollment (ie, had a baseline HIV RNA ≥ 200 copies/mL, per the Department of Health and Human Services [DHHS] definition), and were not on ART at the time of cohort enrollment. Each participant had at least 12 months of follow-up after cohort enrollment and at least 1 additional viral load value after baseline.

An outcome of interest was ART initiation. A participant was considered to have achieved this outcome if there was a record of a prescription for at least 1 ART agent. This outcome was exported from the EMR. The second outcome of interest was VS. VS was defined as having at least 1 follow-up HIV RNA test result of less than 200 copies/ml. All outcomes were assessed as time-to-event outcomes. Demographic covariates included baseline age, sex at birth, race/ethnicity, residence (DC, Maryland, or Virginia), insurance status (baseline), and calendar year of DC Cohort enrollment. HIV-related covariates included HIV transmission risk factor, HIV duration, opportunistic infection history at time of HIV diagnosis, and whether a participant was ART naive at enrollment. Additional clinical covariates, collected through a combination of manual and automated data abstraction, included any history of substance abuse, the presence of chronic hepatitis C (based on International Classification of Disease, Ninth and Tenth Editions [ICD9 and ICD10], diagnosis codes in the medical record or abstracted data), the presence of chronic hepatitis B (based on ICD9 and ICD10 diagnosis codes in the medical record or abstracted data), and the presence of any diagnosed psychiatric disorder (including any type of depression).

A site assessment survey was undertaken at all DC cohort sites in the first quarter of 2017. Site principal investigators received an electronic survey based on questionnaires from the HIVRN [5], the Center for Disease Control and Prevention's Medical Monitoring Project, and the International Epidemiologic Databases to Evaluate AIDS network [13], which were aligned with standard indicators of HIV care outcomes from the Institute of Medicine's 2012 report on monitoring HIV care in the United States [14]. The questionnaire captured information about care delivery (eg, clinical services, adherence services, patient monitoring services) and clinic characteristics (eg, types of providers, availability of sessions on evenings/weekends). The co-location of psychiatry and gynecology at the HIV site has previously been described as the presence of "key" medical services for PLWH [6], so these 2 services were examined separately from the other medical specialties available at the site. Information was collected regarding navigation services (services to help participants obtain HIV-related medical and social services) and the presence of the Red Carpet Entry program [15], a DC Health Department–funded initiative to enhance linkage to HIV care. In this program, newly diagnosed patients or patients out of care can access a new patient appointment in 1–2 days. Table 1 shows the site assessment survey questions and response selections (both shown verbatim).

Descriptive statistics for the study sample, stratified by whether or not patients achieved ART initiation and VS, were generated using a Chi-square test for categorical variables and Wilcoxon rank sum tests for continuous variables. We then performed Cox regression for time-to-event outcomes. We adjusted for individual-level factors in all regression analyses. These individual-level variables were selected either *a priori* (age, race/ethnicity, HIV transmission risk factor, and sex) or because they were associated with VS or ART initiation, with small P values (<.1), based on the descriptive analysis (insurance, year of enrollment, and presence of chronic hepatitis C). Each clinic-level variable was evaluated separately, adjusting for the individual-level factors using marginal Cox regression with a robust sandwich covariance matrix to account for the intra-cluster effect of the clinic site. These results were evaluated by the Empirical Wald test for each outcome separately, and those with a P value less than .05 were included in respective multivariate marginal Cox regression models for each outcome [16, 17]. We assessed goodness of fit for the multiple variable regression models using likelihood ratio testing, and reported the most parsimonious multivariate models. The significance level was set at .05. All analyses were performed in SAS (version 9.3).

Table 1. Clinic-Level Variables with Corresponding Survey Questions and Responses

Variable Name	Survey Questions, Verbatim	Response Selected, Verbatim
Retention in care monitoring	What practices does your site use to link and retain HIV-infected patients in care? Please select all that apply to your clinic.	Systematic monitoring of retention in care (eg, monitoring visit adherence, gaps in care, or visits per interval of time)
Substance abuse counseling offered in clinic	Please indicate below whether your DC Cohort clinic offers these services for HIV-infected patients.	Substance abuse counseling
Opioid treatment offered in clinic	Please indicate below whether your DC Cohort clinic offers these services for HIV-infected patients.	Opioid treatment programs
Case management services offered in clinic	Please indicate below whether your DC Cohort clinic offers these services for HIV-infected patients.	Case management
HIV + peer intervention program	Please indicate below whether your DC Cohort clinic offers these services for HIV-infected patients.	Peer intervention programs
Navigation services available on site	What practices does your site use to link and retain their HIV-infected patients in care? Please select all apply	Patient navigation services (eg, accompanying to Appointments)
	Please indicate below whether your DC Cohort clinic offers these services for HIV-infected patients.	Nurse navigation [has either or both of the above]
Medication dispensing review	Which ART adherence support activities are provided at your DC Cohort HIV clinic? Please select all that apply to your clinic	Routine review of medication pick up
Ryan White funding recipient	Has your clinic ever participated in any of the following DC Department of Health activities?	Ryan White care program
Red Carpet Program (new patient appointment in 1–2 days) participant	Has your clinic ever participated in any of the following DC Department of Health activities?	Red Carpet Entry
MD and PA or NP practicing at site	Types of HIV care providers at site	Attending MD NP PA
Evening hours available	Please check off the days by session (ie, morning versus afternoon versus evening) when the HIV clinic is open.	At least 1 evening clinic each week
Psychiatry and gynecology both available at DC Cohort site	Select medical specialties available at your DC Cohort site:	Site has psychiatry and gynecology in addition to HIV primary care
Greater than 3 additional medical services available at DC Cohort site	Select medical specialties available at your DC Cohort site:	>3 additional medical services (dermatology, colposcopy, hepatology, neurology, ophthalmology, gastroenterology, dental, or oncology)
Urgent care available at clinic	Please indicate below whether your DC Cohort clinic offers these services for HIV-infected patients.	Urgent care
Enhanced adherence support services available at clinic	Which ART adherence support activities are provided at your DC Cohort HIV clinic?	1-on-1 counseling Group counseling Telephone calls/text messages [has at least 1 of the above]
Care for persons of any income or insurance status	What practices does your site use to link and retain HIV-infected patients in care?	Providers offer care to persons with any income level and insurance status

Abbreviations: ART, antiretroviral therapy; DC, District of Columbia; HIV, human immunodeficiency virus; MD, medical doctor; NP, nurse practitioner; PA, physician assistant.

RESULTS

Of the overall sample (N = 759), 682 participants (89.9%) achieved ART initiation and 628 participants (82.7%) achieved VS. The sample was predominately young (median age 42), male (74%), and Black (82%). The HIV transmission risks included being a man who has sex with men (41.5%), intravenous drug use (7.9%), being a high-risk heterosexual (35.8%), and other/unknown (14.8%).

Examining baseline characteristics by ART initiation status (Table 2), individuals who initiated ART were more likely than those who did not to have an AIDS diagnosis (37.2% vs 14.3%, respectively) and to have a lower CD4 cell count at enrollment (median CD4 396 cells/mm^3 vs 633 cells/mm^3, respectively; P values < .0001 for both). Otherwise, there were no differences between the groups. The differences in AIDS diagnoses and enrollment CD4 cell counts observed with the ART initiation outcome were not present when comparing individuals who did and did not achieve VS (Table 2).

Table 3 shows the proportion of individuals attending clinics with the clinic-level factors included in the site survey (full

Table 2. Demographic and Clinical Characteristics of Study Participants, by Antiretroviral Therapy Initiation Status and Viral Suppression Status

	Total cohort, N = 759	Achieved ART Initiation, n = 682	Did Not Achieve ART Initiation, n = 77		Achieved VS, n = 628	Did Not Achieve VS, n = 131	
		n (%)	n (%)	*P* Value	n (%)	n (%)	*P* Value
Age, median (IQR)	…	41.8 (31.5–51.6)	42.5 (28.1–50.2)	.33	42.0 (32.1–51.6)	41.3 (28.3–51.5)	.34
Sex at birth	…	…	…	.30	…	…	.24
Male	564 (74.3%)	503 (73.8%)	61 (79.2%)		472 (75.2)	92 (70.2)	
Female	195 (25.7%)	179 (26.2%)	16 (20.8%)		156 (24.8)	39 (29.8)	
Race/ethnicity	…	…	…	.37	…	…	.14
NH Black	620 (81.7%)	560 (82.1%)	60 (77.9%)		507 (80.7)	113 (86.3)	
All other races	139 (18.3%)	122 (17.9%)	17 (22.1%)		121 (19.3)	18 (13.7)	
State of residence	…	…	…	.08	…	…	.47
District of Columbia	579 (76.3%)	528 (77.4%)	51 (66.2%)		474 (75.5)	105 (80.2)	
Maryland	140 (18.4%)	118 (17.3%)	22 (28.6%)		118 (18.8)	22 (16.8)	
Virginia	34 (4.5%)	30 (4.4%)	4 (5.2%)		30 (4.8)	4 (3.0)	
Other	6 (.8%)	6 (.9%)	0 (0%)		6 (.9)	0 (0)	
Transmission risk	…	…	…	.23	…	…	.27
MSM	315 (41.5%)	281 (41.2%)	34 (44.2%)		270 (43.0)	45 (34.4)	
IDU	60 (7.9%)	50 (7.3%)	10 (13%)		48 (7.6)	12 (9.1)	
Heterosexual	272 (35.8%)	247 (36.2%)	25 (32.5%)		217 (34.6)	55 (42.0)	
Other/unknown	112 (14.8%)	104 (15.2%)	8 (10.4%)		93 (14.8)	19 (14.5)	
Insurance status, baseline	…	…	…	.06	…	…	.29
Public	458 (60.3%)	419 (61.4%)	39 (50.6%)		375 (59.7)	83 (63.4)	
Private	196 (25.8%)	175 (25.7%)	21 (27.3%)		169 (26.9)	27 (20.6)	
Other/unknown	105 (13.8%)	88 (12.9%)	17 (22.1%)		84 (13.4)	21 (16.0)	
Median HIV duration in years (IQR)	…	5.7 (1.0–12.1)	3.0 (.8–13.4)	.33	5.39 (.82–12.07)	5.73 (1.93–13.47)	.22
AIDS diagnosis at enrollment[a]	265 (34.9%)	254 (37.2%)	11 (14.3%)	<.0001	214 (34.08)	51 (38.9)	.29
CD4 count at enrollment, median (IQR)	…	396 (204–575)	632.5 (459–825)	<.0001	417 (230–595)	469 (196–673)	.11
Substance use, ever (baseline assessment)	279 (36.8%)	248 (36.4%)	31 (40.3%)	.50	229 (36.5)	50 (38.2)	.71
Calendar year of DC Cohort enrollment	…	…	…	.97	…	…	.17
2011	246 (32.4%)	219 (32.1%)	27 (35.1%)		213 (33.9)	33 (25.2)	
2012	169 (22.3%)	151 (22.1%)	18 (23.4%)		143 (22.8)	26 (19.9)	
2013	115 (15.2%)	105 (15.4%)	10 (13%)		87 (13.9)	28 (21.4)	
2014	123 (16.2%)	110 (16.1%)	13 (16.9%)		99 (15.8)	24 (18.3)	
2015	94 (12.4%)	86 (12.6%)	8 (10.4%)		76 (12.1)	18 (13.7)	
2016	12 (1.6%)	11 (1.6%)	1 (1.3%)		10 (1.6)	2 (1.5)	
Chronic hepatitis C	115 (15.2%)	101 (14.8%)	14 (18.2%)	.43	93 (14.8)	22 (16.8)	.56
Chronic hepatitis B	30 (4.0%)	29 (4.3%)	1 (1.3%)	.35	27 (4.3)	3 (2.3)	.28
Mental health/depression, baseline	336 (44.3%)	304 (44.6%)	32 (41.6%)	.61	279 (44.4)	57 (43.5)	.85

Data are from the DC Cohort, 2011–2018. N = 759.

Abbreviations: AIDS, acquired immunodeficiency syndrome; ART, antiretroviral therapy; DC, District of Columbia; HIV, human immunodeficiency virus; IDU, injection drug user; IQR, interquartile range; MSM, men who have sex with men; NH, non-Hispanic; OI, opportunistic infection; VS, viral suppression.

[a]Opportunistic infection at AIDS diagnosis is any AIDS-defining condition that does not include those with CD4 counts <200 cells/mm3 or CD4% <14.

definitions in Table 1), by ART initiation status. Among the notable differences between the groups, a higher proportion of individuals with ART initiation attended a clinic with retention in HIV care monitoring (65.4% vs 50.6% at clinics without retention; $P = .01$). Retention in care monitoring was defined as the systematic monitoring of retention in care (eg, monitoring visit adherence, gaps in care, or visits per interval of time) by the clinic. Additionally, a higher proportion of those with ART initiation attended clinics with medication dispensing reviews (51.2% vs 37.7% at clinics without reviews; $P = .02$). A medication dispensing review means that the clinic was reviewing whether patients picked up medication from the pharmacy as part of ART adherence support activities. Additionally, there was a higher proportion of individuals with ART initiation at

Table 3. Proportion of Individuals in Study Cohort, by Antiretroviral Therapy Initiation Status

	Achieved ART Initiation, n = 682	Did Not Achieve ART Initiation, n = 77	
Proportion Attending Clinic With:	n (%)	n (%)	aHR (95% CI)
Systematic monitoring of retention in care	446 (65.4%)	39 (50.6%)**	1.37 (1.16–1.62)*
Substance abuse counseling offered in clinic	345 (50.6%)	47 (61%)	.83 (.61–1.11)
Opioid treatment offered in clinic	247 (36.2%)	30 (39%)	.98 (.67–1.43)
Case management services offered in clinic	435 (63.8%)	50 (64.9%)	.96 (.67–1.38)
HIV + peer intervention program	578 (84.8%)	65 (84.4%)	1.11 (.74–1.67)
Navigation services available on site	473 (69.4%)	56 (72.7%)	1.01 (.71–1.43)
Medication dispensing review	349 (51.2%)	29 (37.7%)**	1.34(1.07–1.68)*
Ryan White funding recipient	422 (61.9%)	46 (59.7%)	1.02 (.73–1.43)
Red Carpet Program (new patient appointment in 1–2 days) participant	320 (46.9%)	39 (50.6%)	.92 (.67–1.28)
MD and PA or NP practicing at site	518 (76.0%)	67 (87.0%)**	.72 (.55–.96)*
Evening hours available	397 (58.2%)	46 (59.7%)	.91 (.65–1.25)
Psychiatry and gynecology both available at DC Cohort site	516 (75.7%)	49 (63.6%)**	1.40 (1.12–1.75)*
Greater than 3 additional medical services available at DC Cohort site	455 (66.7%)	44 (57.1%)	1.27 (.93–1.74)
Urgent care available at clinic	527 (77.3%)	55 (71.4%)	1.19 (.83–1.69)
Enhanced adherence support services available at clinic	513 (75.2%)	61 (79.2%)	.98 (.69–1.39)
Care for persons of any income or insurance status	465 (68.2%)	47 (61%)	1.14 (.83–1.56)

Data show the numbers of patients attending a clinic with the listed clinic-level factor, and the association of each clinic-level factor with ART initiation. Data are from the DC Cohort, 2011–2018. Each point estimate reported in this table is the aHR for the listed clinic-level variable, included as the only clinic-level variable in a model adjusted for the following individual-level variables: age, race/ethnicity, HIV transmission risk factor, sex, insurance, year of enrollment, and presence of chronic hepatitis C.

Abbreviations: aHR, adjusted hazard ratio; ART, antiretroviral therapy; CI, confidence interval; DC, District of Columbia; HIV, human immunodeficiency virus; MD, medical doctor; NP, nurse practitioner; PA, physician assistant.

*$P < .05$; **$P < .05$, comparing the proportion of individuals with each characteristic achieving/not achieving ART initiation.

sites where there were co-locations of psychiatry and gynecology along with HIV primary care (75.5% vs 63.6% at clinics without co-location; $P < .05$)

Each clinic-level variable was included as the only clinic-level variable in a model with the following individual-level variables: age, race/ethnicity, HIV transmission risk factor, sex, insurance, year of enrollment, and presence of chronic hepatitis C. Retention in HIV care monitoring, medication dispensing reviews, and co-locations of psychiatry and gynecology at the HIV care site were all associated with ART initiation (aHRs, 1.34 to 1.40; P values < .01 for all). Attending a clinic with a medical doctor (MD) and a physician's assistant (PA) or nurse practitioner (NP) practicing at the site (compared with an MD only) was inversely associated with ART initiation (aHR, 0.72; $P = .023$).

For the viral suppression outcome (Table 4), a higher proportion of participants reaching VS attended a hospital-based clinic than those without VS (52.4 vs 42.7%, respectively; $P = .04$; data not shown). Retention in HIV care monitoring, medication dispensing reviews, an HIV + peer intervention program, navigation services (nurse navigation or, more generally, patient navigation services), co-locations of psychiatry and gynecology at the site, enhanced adherence support (group, telephone/text, and/or 1-on-1 counseling), and care for persons of any income or insurance status were all associated with VS (aHRs, 1.35 to 1.72; P values < .05 for all). Again, attending a clinic with an MD and a PA or NP practicing at the site was inversely associated with the outcome (aHR, 0.78; 95% CI, .63–.98).

Last, we generated multivariable models evaluating the association of ART initiation with different combinations of clinic-level factors (results not displayed in a table). Our final model for factors associated with ART initiation revealed that attending a clinic where medication dispensing reviews occurred was associated with the outcome (aHR, 1.29; 95% CI, 1.11–1.49). Attending a clinic with an MD and a PA or NP practicing at the site was inversely associated with the outcome (aHR, 0.79; 95% CI, .67–.93). In multivariable models evaluating the association of different combinations of clinic-level factors with VS, enhanced adherence services (aHR, 1.37; 95% CI, 1.18–1.58), medication dispensing review (aHR, 1.22; 95% CI, 1.10–1.36), and availability of opioid treatment (aHR, 1.26; 95% CI, 1.01–1.570) were all associated with VS outcomes when entered into the same model. Attending a clinic with an MD and a PA or NP was inversely associated with the outcome (aHR, 0.71; 95% CI, .62–.82).

DISCUSSION

In this large, city-wide sample of PLWH, attending a clinic where medication dispensing reviews occurred was associated with ART initiation. Additionally, enhanced adherence services, medication dispensing reviews, and the availability of opioid treatment were all associated with achieving VS. This research provides evidence for the efficacy of certain

Table 4. Proportion of Individuals in Study Cohort, by Viral Suppression Status

	Achieved VS, n = 628	Did Not Achieve VS, n = 131	
Proportion Attending Clinic With:	n (%)	n (%)	aHR (95% CI)
Systematic monitoring of retention in care	408 (65.0)	77 (58.8)	1.44 (1.23–1.69)*
Substance abuse counseling offered in clinic	329 (52.4)	63 (48.1)	1.15 (.80–1.65)
Opioid treatment offered in clinic	243 (38.7)	34 (26.0)**	1.36 (1.04–1.77)*
Case management services offered in clinic	399 (63.5)	86 (65.7)	1.03 (.70–1.51)
HIV + peer intervention program	539 (85.8)	104 (79.4)	1.72 (1.39–2.14)*
Navigation services available on site	450 (71.7)	79 (60.3)**	1.42 (1.04–1.95)*
Medication dispensing review	318 (50.6)	60 (45.8)	1.36 (1.15–1.61)*
Ryan White funding recipient	381 (60.7)	87 (66.4)	1.17 (.93–1.48)
Red Carpet Program (new patient appointment in 1–2 days) participant	285 (45.4)	74 (56.5)**	1.08 (.83–1.42)
MD and PA or NP practicing at site	477 (76.0)	108 (82.4)	.78 (.63–.98)*
Evening hours available	358 (57.0)	85 (64.9)	1.08 (.82–1.41)
Psychiatry and gynecology both available at DC Cohort site	483 (76.9)	82 (62.6)**	1.64 (1.38–1.93)*
Greater than 3 additional medical services available at DC Cohort site	418 (66.6)	81 (61.8)	.95 (.67–1.35)
Urgent care available at clinic	497 (79.1)	85 (64.9)**	1.15 (.91–1.46)
Enhanced adherence support services available at clinic	480 (76.4)	94 (71.8)	1.49 (1.14–1.96)*
Care for persons of any income or insurance status	435 (69.3)	77 (58.8)**	1.35 (1.09–1.68)*

Data show the numbers of patients attending a clinic with the listed clinic-level factor, and the association of each clinic-level factor with ART initiation. Data are from the DC Cohort, 2011–2018. Each point estimate reported in this table is the aHR for the listed clinic-level variable, included as the only clinic-level variable in a model adjusted for the following individual-level variables: age, race/ethnicity, HIV transmission risk factor, sex, insurance, year of enrollment, and presence of chronic hepatitis C.

Abbreviations: aHR, adjusted hazard ratio; ART, antiretroviral therapy; CI, confidence interval; DC, District of Columbia; HIV, human immunodeficiency virus; MD, medical doctor; NP, nurse practitioner; PA, physician assistant; VS, viral suppression.

*$P < .05$; **$P < .05$, comparing proportion of individuals with each characteristic achieving/not achieving ART initiation.

clinic-based services for helping PLWH start and stay on ART to achieve VS.

An important finding from our work was that attending a clinic with opioid treatment services was associated with a faster time to VS. Ongoing substance use (SU) is highly prevalent among PLWH [18] and remains a critical barrier to optimal engagement in the HIV care continuum. Despite improvements in VS overall among PWLH in the United States [19], disparities in engagement at all steps of the continuum persist among individuals with substance use disorders [20, 21]. SU treatment can have a stabilizing effect, improve quality of life [22], and also improve engagement with and retention in HIV care, as well as receipt of and adherence to ART [23]. Multiple evidence-based, medication-assisted therapy options are available for opioid and alcohol dependence and for stimulant (cocaine and amphetamines) dependence; psychosocial interventions are effective [24]. Although effective treatments are available, they are underused in HIV care [25], and inadequate access to SU treatment hinders HIV treatment efforts. Even in settings where HIV care is almost universally available, patients still have difficulty accessing it, and similar challenges exist for obtaining substance use and mental health treatments [26]. Standard HIV care models may not have fully integrated HIV and SU care [27]. Innovations to address the lack of integration have included adding HIV care to methadone clinics [28] or integrating SU care into an HIV clinic by adding an addiction specialist or having a primary care provider treat both HIV and SU [29, 30]. Coordinated approaches may be required to address these needs of the most vulnerable PLWH who are substance users.

We also found that having medication dispensing reviews was associated with ART initiation and that enhanced adherence services and medication dispensing reviews were both associated with VS. Prior work has shown the crucial role that clinical pharmacists and enhanced pharmacy and medication adherence services can play in improving HIV-related outcomes [8–10]. Ultimately, although the attending clinic is important, taking ART ultimately is what leads to successful HIV treatment.

Interestingly, we did not find that retention in HIV care monitoring was associated with reduced times to ART initiation or VS. Retention monitoring is recommended by the International Association of Physicians in AIDS Care [4] and in the DHHS HIV treatment guidelines [31]. Our survey questioned whether the clinic monitored visit adherence, gaps in care, or visits per interval of time [32]. Poor retention by any of these measures has been associated with worse clinical outcomes in HIV [33]. In the site survey, we did not ask clinics how they monitored retention or what action they took when they found individuals out of care. This likely varied from site to site, depending on available personnel and other resources. We may not have seen an impact of retention monitoring because of differences in the intensity of outreach for people who were determined to be not retained. Certainly, any approach to retention monitoring must use the most current visit and HIV RNA data and must

be monitored for effectiveness. To help sites meet those objectives, DC Cohort site principal investigators and staff have access to the DC Cohort Dashboard. They can view lists of study participants who have not had recent viral load testing or a recent medical visit, in order to try to re-engage them. Another unique aspect of the DC Cohort is that the data from the sites is linked to DC Department of Health HIV surveillance data. Although the surveillance data are not currently available on the Dashboard, they would potentially be helpful to individual sites to determine whether an individual who appears to be lost to care at 1 DC Cohort site is engaged at another site. Surveillance data have been used in this and other jurisdictions to help identify individuals who are out of care, in order to try to re-engage them [34, 35].

Although it did not remain significantly associated with the outcome in multivariable models, attending a clinic with peer intervention services was associated with a faster time to VS in the models that adjusted for all individual-level factors with 1 additional site-level factor. Sites did not report the type or intensity of peer intervention services offered, so it is unclear what the scope of a peer intervention at a given clinical site was or which patients were the focus of the interventionists' efforts. A potential effect of peer intervention programs is stigma reduction [36]. Since stigma has been associated with worse HIV outcomes [37], any efforts that clinics make to reduce stigma, such as having individuals on staff who have HIV, may impact these outcomes. Peer interventionists may have been directly supporting adherence and retention efforts, with their direct experience of living with HIV and the unique ability this gives the peer interventionists to relate to their clients [36]. A systematic review of the efficacy of peer interventions [38] summarized the data available on the efficacy of peer interventions. Very few of these studies had biomarker outcomes. There were insufficient data to support the efficacy of peer interventions, with more rigorous research needed. This is certainly an opportunity for further study within the DC Cohort.

An unexpected finding was the inverse association of attending a clinic with multiple types of HIV providers (MD, PA, NP), compared to MD providers alone, and times to ART initiation and VS. The DC Cohort does not collect provider-level information at the participant level; therefore, although we know the types of providers at each site, it is unclear who was managing each patient and/or how many people were involved in that patient's care. Additionally, this finding may reflect unmeasured characteristics of clinics where only physicians manage care for PLWH versus those clinics where a variety of providers manage HIV care. Prior research does not support there being a difference in HIV outcomes related to the type of provider managing care for PLWH. For example, a prior study among Ryan White clinics in the United States did not show differences in quality outcomes between specialist physicians and physician assistants/NPs caring for PLWH [39]. Research largely done in developing countries and presented in a systematic review showed that HIV management by non-physicians with appropriate HIV training had not led to detrimental HIV outcomes [40].

A limitation is that at each site, we could determine the presence of a service but not whether individual patients were accessing that service. This work would be greatly enhanced by collecting information on which patients were accessing particular services, rather than only capturing whether the service was available at the clinic. This could be accomplished by tablet-based, patient-reported outcomes data collection in the clinic or, potentially, through administrative records. The inclusion of both of these data sources is planned for the DC Cohort. Furthermore, we did not assess specific characteristics of each service. There were likely variations between services provided at the sites. For example, sites may have differed in their approach to retention in care monitoring, such as by using different definitions of retention in HIV care. We tried to capture commonalities between the 15 different sites, so the language of the survey was intentionally somewhat general. The DC Cohort studies in-care populations, so participants were more likely to be virally suppressed than the general population of PLWH. Finally, during the time interval covered by the study, DHHS guidelines for HIV treatment changed, so that ART was recommended for all PLWH starting in 2012. We suspect this may have influenced providers to start ART more rapidly in later years of the study. We adjusted for the calendar year of DC Cohort enrollment to try to account for this change in the guidelines. A strength of our study is that the site assessment survey covered multiple HIV clinics within a small geographic area, reducing variation compared to cohorts with clinics in different cities.

In summary, we found many potential opportunities for services that clinics can implement to improve outcomes for their patients. These approaches must be locally tailored and must have sufficient resources for successful initiation and appropriate long-term maintenance and monitoring.

Notes

Acknowledgments. The authors thank the District of Columbia (DC) Cohort Study Group for data collection, including the investigators and research staff located at the Cerner Corporation (Jeffery Binkley, Rob Taylor, Nabil Rayeed, Cheryl Akridge, Stacey Purinton, Qingjiang Hou, Jeff Naughton, and David Parfitt); Children's National Medical Center Adolescent (Lawrence D'Angelo) and Pediatric (Natella Rahkmanina) clinics; DC Department of Health HIV/AIDS, Hepatitis, STD and TB Administration (HAHSTA) (Michael Kharfen, Senior Deputy Director); Family and Medical Counseling Service (Michael Serlin); Georgetown University (Princy Kumar); The George Washington University Medical Faculty Associates (David Parenti); The George Washington University Department of Epidemiology and Biostatistics (Amanda Castel, Alan Greenberg, Anne Monroe, Lindsey Powers Happ, Maria Jaurretche, Brittany Wilbourn, James Peterson, Matthew Levy, Morgan Byrne, and Yan Ma); Howard University Adult Infectious Disease Clinic (Ronald Wilcox) and Pediatric Clinic (Sohail Rana); Kaiser Permanente Mid-Atlantic (Michael Horberg); La Clinica Del Pueblo (Ricardo Fernandez); MetroHealth (Annick Hebou); National Institutes of Health (Carl Dieffenbach and Henry

Masur); Providence Hospital (Jose Bordon); Unity Health Care (Gebeyehu Teferi); Veterans Affairs Medical Center (Debra Benator); Washington Hospital Center (Maria Elena Ruiz); and Whitman-Walker Health (Deborah Goldstein). They thank Lawrence D'Angelo, Natella Rahkmanina, Michael Kharfen, Michael Serlin, Princy Kumar, David Parenti, Brittany Wilbourn, James Peterson, Matthew Levy, Morgan Byrne, Yan Ma, Ronald Wilcox, Sohail Rana, Ricardo Fernandez, Annick Hebou, Carl Dieffenbach, Henry Masur, Jose Bordon, Gebeyehu Teferi, Debra Benator, Maria Elena Ruiz, Stephen Abbott, Jeffery Binkley, Rob Taylor, Nabil Rayeed, Cheryl Akridge, Stacey Purinton, Qingjiang Hou, Jeff Naughton, and David Parfitt for collaborating on this research.

Financial support. This work was supported by the National Institute of Allergy and Infectious Diseases (grant number UM1 AI069503).

Potential conflicts of interest. The authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

References

1. Fatukasi TV, Cole SR, Moore RD, Mathews WC, Edwards JK, Eron JJ; CFAR Network of Integrated Clinical Systems Investigators. Risk factors for delayed antiretroviral therapy initiation among HIV-seropositive patients. PLOS One **2017**; 12:e0180843.
2. Hanna DB, Buchacz K, Gebo KA, et al; North American Acquired Immunodeficiency Syndrome (AIDS) Cohort Collaboration on Research and Design (NA-ACCORD) of the International Epidemiologic Databases to Evaluate AIDS. Trends and disparities in antiretroviral therapy initiation and virologic suppression among newly treatment-eligible HIV-infected individuals in North America, 2001-2009. Clin Infect Dis **2013**; 56:1174–82.
3. Castel AD, Kalmin MM, Hart RL, et al. Disparities in achieving and sustaining viral suppression among a large cohort of HIV-infected persons in care—Washington, DC. AIDS Care **2016**; 28:1355–64.
4. International Advisory Panel on Human Immunodeficiency Virus Care Continuum Optimization. IAPAC guidelines for optimizing the HIV care continuum for adults and adolescents. J Int Assoc Provid AIDS Care. **2015**;14 (Suppl 1):S3–S34.
5. Yehia BR, Gebo KA, Hicks PB, et al; Human Immunodeficiency Virus Research Network. Structures of care in the clinics of the HIV Research Network. AIDS Patient Care STDS **2008**; 22:1007–13.
6. Yehia BR, Agwu AL, Schranz A, et al. Conformity of pediatric/adolescent HIV clinics to the patient-centered medical home care model. AIDS Patient Care STDS **2013**; 27:272–9.
7. Engelhard EA, Smit C, Nieuwkerk PT, et al. Structure and quality of outpatient care for people living with an HIV infection. AIDS Care **2016**; 28:1062–72.
8. Horberg MA, Hurley LB, Silverberg MJ, Kinsman CJ, Quesenberry CP. Effect of clinical pharmacists on utilization of and clinical response to antiretroviral therapy. J Acquir Immune Defic Syndr **2007**; 44:531–9.
9. Horberg MA, Hurley LB, Towner WJ, et al. Determination of optimized multidisciplinary care team for maximal antiretroviral therapy adherence. J Acquir Immune Defic Syndr **2012**; 60:183–90.
10. Horberg MA, Hurley LB, Towner WJ, et al. Influence of provider experience on antiretroviral adherence and viral suppression. HIV AIDS (Auckl) **2012**; 4:125–33.
11. Charalambous S, Grant AD, Churchyard GJ, Mukora R, Schneider H, Fielding KL. Clinic-level factors influencing patient outcomes on antiretroviral therapy in primary health clinics in South Africa. AIDS **2016**; 30:1099–109.
12. Greenberg AE, Hays H, Castel AD, et al; District of Columbia (DC) Cohort Executive Committee. Development of a large urban longitudinal HIV clinical cohort using a web-based platform to merge electronically and manually abstracted data from disparate medical record systems: technical challenges and innovative solutions. J Am Med Inform Assoc **2016**; 23:635–43.
13. Duda SN, Farr AM, Lindegren ML, et al; International Epidemiologic Databases to Evaluate Acquired Immunodeficiency Syndrome (IeDEA) Collaboration. Characteristics and comprehensiveness of adult HIV care and treatment programmes in Asia-Pacific, sub-Saharan Africa and the Americas: results of a site assessment conducted by the International Epidemiologic Databases to Evaluate AIDS (IeDEA) Collaboration. J Int AIDS Soc **2014**; 17:19045. doi:10.7448/IAS.17.1.19045
14. Ford M, Spicer C. Monitoring HIV care in the United States: indicators and data systems. Nat Acad Press (US) **2012**; 1:150–2.
15. DC Health. Red carpet entry program. Available at: https://dchealth.dc.gov/service/red-carpet-entry-program. Accessed 23 April 2019.
16. Wei L-J, Lin DY, Weissfeld L. Regression analysis of multivariate incomplete failure time data by modeling marginal distributions. J Am Stat Assoc **1989**;84:1065–73.
17. SAS Institute Inc. SAS/STAT® 9.3 user's guide. Cary, NC: SAS Institute, **2011**.
18. Hartzler B, Dombrowski JC, Crane HM, et al. Prevalence and predictors of substance use disorders among HIV care enrollees in the United States. AIDS Behav **2017**; 21:1138–48.
19. Bradley H, Viall AH, Wortley PM, Dempsey A, Hauck H, Skarbinski J. Ryan White HIV/AIDS program assistance and HIV treatment outcomes. Clin Infect Dis **2016**; 62:90–8.
20. Giordano TP, Visnegarwala F, White AC Jr, et al. Patients referred to an urban HIV clinic frequently fail to establish care: factors predicting failure. AIDS Care **2005**; 17:773–83.
21. Monroe AK, Lau B, Mugavero MJ, et al. Heavy alcohol use is associated with worse retention in HIV care. J Acquir Immune Defic Syndr **2016**; 73:419–25.
22. Altice FL, Bruce RD, Lucas GM, et al; Buprenorphine-HIV Evaluation and Support Collaborative. HIV treatment outcomes among HIV-infected, opioid-dependent patients receiving buprenorphine/naloxone treatment within HIV clinical care settings: results from a multisite study. J Acquir Immune Defic Syndr **2011**; 56(Suppl 1):S22–32.
23. Thompson MA, Mugavero MJ, Amico KR, et al. Guidelines for improving entry into and retention in care and antiretroviral adherence for persons with HIV: evidence-based recommendations from an International Association of Physicians in AIDS Care panel. Ann Intern Med **2012**; 156:817–33.
24. Substance Abuse and Mental Health Services Administration (US) Center for Substance Abuse Treatment. Treatment for stimulant use disorders. Treatment Improvement Protocol (TIP) Series, No. 33. Report No.: (SMA) 09-4209. Rockville (MD): Substance Abuse and Mental Health Services Administration (US); **1999**. Available at: https://www.ncbi.nlm.nih.gov/books/NBK64333/?report=reader. Accessed 2 December 2019.
25. Meyer JP, Althoff AL, Altice FL. Optimizing care for HIV-infected people who use drugs: evidence-based approaches to overcoming healthcare disparities. Clin Infect Dis **2013**; 57:1309–17.
26. Dombrowski JC, Simoni JM, Katz DA, Golden MR. Barriers to HIV care and treatment among participants in a public health HIV care relinkage program. AIDS Patient Care STDS **2015**; 29:279–87.
27. Volkow ND, Montaner J. The urgency of providing comprehensive and integrated treatment for substance abusers with HIV. Health Aff (Millwood) **2011**; 30:1411–9.
28. Batkis MF, Treisman GJ, Angelino AF. Integrated opioid use disorder and HIV treatment: rationale, clinical guidelines for addiction treatment, and review of interactions of antiretroviral agents and opioid agonist therapies. AIDS Patient Care STDS **2010**; 24:15–22.
29. Basu S, Chwastiak LA, Bruce RD. Clinical management of depression and anxiety in HIV-infected adults. AIDS **2005**; 19:2057–67.
30. Sullivan LE, Bruce RD, Haltiwanger D, et al. Initial strategies for integrating buprenorphine into HIV care settings in the United States. Clin Infect Dis **2006**; 43(Suppl 4):S191–6.
31. Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the use of antiretroviral agents in adults and adolescents with HIV. Department of Health and Human Services. Available at: http://www.aidsinfo.nih.gov/ContentFiles/ AdultandAdolescentGL.pdf. Accessed 23 April 2019.
32. Yehia BR, Fleishman JA, Metlay JP, et al; HIV Research Network. Comparing different measures of retention in outpatient HIV care. AIDS **2012**; 26:1131–9.
33. Yehia BR, French B, Fleishman JA, et al; HIV Research Network. 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.
34. Ocampo JMF, Smart JC, Allston A, et al. Improving HIV surveillance data for public health action in Washington, DC: a novel multiorganizational data-sharing method. JMIR Public Health Surveill **2016**; 2:e3.
35. Office of Infectious Disease, Washington State Department of Health. Integrated HIV prevention and care plan - King County Department of Health. Available at: https://www.kingcounty.gov/depts/health/communicable-diseases/hiv-std/patients/~/media/depts/health/communicable-diseases/documents/hivstd/Seattle-TGA-integrated-hiv-prevention-care-plan.ashx Accessed 16 February 2019.
36. Simoni JM, Franks JC, Lehavot K, Yard SS. Peer interventions to promote health: conceptual considerations. Am J Orthopsychiatry **2011**; 81:351–9.
37. Katz IT, Ryu AE, Onuegbu AG, et al. Impact of HIV-related stigma on treatment adherence: systematic review and meta-synthesis. J Int AIDS Soc **2013**; 16:18640. doi:10.7448/IAS.16.3.18640
38. Simoni JM, Nelson KM, Franks JC, Yard SS, Lehavot K. Are peer interventions for HIV efficacious? A systematic review. AIDS Behav **2011**; 15:1589–95.
39. Wilson IB, Landon BE, Hirschhorn LR, et al. Quality of HIV care provided by nurse practitioners, physician assistants, and physicians. Ann Intern Med **2005**; 143:729–36.
40. Kredo T, Adeniyi FB, Bateganya M, Pienaar ED. Task shifting from doctors to non-doctors for initiation and maintenance of antiretroviral therapy. Cochrane Database Syst Rev. **2014**;Cd007331. doi:10.1002/14651858.CD007331.pub3