Trajectories of viral suppression in people living with HIV receiving coordinated care: Differences by comorbidities

Michael J. Li, PhD[1,2], **Erica Su, BS**[3], **Wendy H. Garland, MPH**[1,4], **Sona Oksuzyan, PhD**[1,4], **Sung-Jae Lee, PhD**[1,5], **Uyen H. Kao, MPH**[1,2], **Robert E. Weiss, PhD**[1,3], **Steven J. Shoptaw, PhD**[1,2,5]

[1]Center for HIV Identification Prevention and Treatment Services, University of California, Los Angeles

[2]Center for Behavioral and Addiction Medicine, Department of Family Medicine, David Geffen School of Medicine, University of California, Los Angeles

[3]Department of Biostatistics, Fielding School of Public Health, University of California, Los Angeles

[4]Division of HIV and STD Programs, Los Angeles County Department of Public Health

[5]Department of Psychiatry and Biobehavioral Sciences, David Geffen School of Medicine, University of California, Los Angeles

Introduction

To achieve the benefits of antiretroviral therapy (ART), people living with HIV (PLWH) need to be diagnosed in a timely manner, to be engaged in HIV care, and to initiate and adhere to potentially lifelong ART. In Los Angeles County (LAC), California, 51,438 persons were living with a confirmed HIV diagnosis in 2017, and the number of new HIV diagnoses has remained relatively steady from 2,176 in 2012 to 1,949 in 2016[1]. Based on the local HIV care continuum, the percentage of PLWH who were virally suppressed (viral load [VL]<200 copies/mL at last test in the past 12 months) increased from 53% in 2010 to 60% in 2016. Additionally, the percentage of PLWH who were retained in care (2 CD4, VL, or genotyping HIV laboratory tests within the past 12 months) remained relatively stable at around 56% from 2010 to 2016[1]. These data highlight some modestly improved continuum outcomes, but continued efforts to comprehensively address the health and psychosocial needs of PLWH are needed to reach local and national targets.

Corresponding author: Michael J. Li, Ph.D., M.P.H., Department of Family Medicine, 10880 Wilshire Blvd., Ste. 1800, Los Angeles, CA 90024, mjli@mednet.ucla.edu, 310-825-2557.

While cross-sectional assessment can estimate the proportion of PLWH in care or virally suppressed at any single time point, longitudinal data can capture important clinical trajectories following initial engagement in care, such as changes in the proportion of people achieving VS over follow-up periods of months or even years[2]. This is important information for public health professionals given that late linkage to HIV care, late ART initiation, and in turn, delayed VS have been shown to contribute to increased rates of transmission and poorer clinical outcomes[3–7]. Also, a previously suppressed individual can become virally unsuppressed over time due to challenges with treatment adherence, new barriers to prescription access, or competing life needs that interrupt in care[8]. These population-level trajectories are not evident, however, in the typical cross-sectional analysis. Understanding the factors that contribute to these transitions is vital to attain national and local HIV/AIDS strategy benchmarks.

Syndemic structural, behavioral, and psychosocial conditions linked to HIV infection are associated with poorer management of the virus among PLWH along the HIV care continuum[9–11]. From 2010 to 2015, homelessness in PLWH increased from 7.7% to 9% nationally[12], and has been a structural barrier to accessing HIV medical care, obtaining and adhering to ART, and achieving VS[1,13,14]. Multisite estimates in the U.S. indicate that about 13% and 11% of PLWH meet the diagnostic criteria for methamphetamine use disorder and cocaine use disorder, respectively[15]. Use of such stimulants can contribute to unsuppressed VL and coinfections due to disengagement from HIV care, reduced ART adherence, and direct toxic effects on the immune system[10,16–18]. Depression has been identified as the most common mental health issue among PLWH at rates ranging from 30 to 42%, and is associated with reduced ART adherence, poorer quality of life, unsuppressed VL, and more rapid disease progression, all of which result in negative clinical outcomes[19–22]. Adequate management of HIV requires a holistic approach to care that addresses both HIV directly and the comorbid conditions that perpetuate disease progression[12,23,24], and longitudinal evaluation is necessary to quantify how treatment progression is impacted by multiple comorbidities.

In March of 2013, the LAC Department of Public Health Division of HIV and STD Programs (DHSP) developed and implemented a clinic-based Medical Care Coordination (MCC) Program to increase retention in care and VS at 35 Ryan White Program (RWP)-funded HIV clinics[25]. Patients at risk for poor health outcomes (e.g., diagnosed with HIV in the past six months, on ART without VS, out of care for more than six months) were offered the MCC Program. Patients enrolled in MCC during its first year of implementation had complex needs that included comorbid depressive, anxiety, bipolar and/or schizophrenia disorders (51%), history of incarceration (38%), drug/alcohol use in the past six months (66%), and homelessness in the past six months (14%). Results from DHSP's first-year evaluation suggested that MCC was an effective program to improve VS after 12 months among PLWH at risk for poor health outcomes[25]. To better understand whether the MCC program improved VS among patients with complex comorbid conditions, we used a longitudinal evaluation design to account for longer follow-up and changes in VS over multiple years of program implementation. We estimate trajectories of VS from 12-months prior to MCC enrollment to 36 months following MCC enrollment, and assess whether these

trajectories differed by stimulant use, housing instability, and depressive symptom severity as reported by patients at MCC enrollment.

Methods

Medical Care Coordination (MCC) Program

Multidisciplinary MCC teams consisting of a registered nurse, a Master's level social worker and a case worker were integrated in the clinical care teams at LAC RWP clinics. Patients were offered MCC services if they: 1) were newly diagnosed with HIV in the past six months; 2) had not seen an HIV medical provider in 7 months or more; 3) were not on ART despite meeting current clinical guidelines for treatment; 4) were on ART but did not have suppressed VL (>200 copies/mL); or 5) were diagnosed with a sexually transmitted infection (STI) in the past six months. These indicators were used for initial identification of individuals who require rapid linkage to care, as delayed linkage to care in newly diagnosed PLWH, disengagement from treatment, and/or co-infection with an STI increase risk of HIV disease progression[26–29] and transmission[30–32]. To identify and characterize the severity of medical and psychosocial needs, MCC teams conducted standardized assessments. These assessments were used to score needs around physical health, mental health, substance use, and socioeconomic factors, which mapped to a decision tree that guided integrated care plans, the type and frequency of brief interventions delivered, and the provision of support service referrals[25,33]. The MCC services include outreach to those recently diagnosed or out-of-care, linkage to HIV care providers, assistance with healthcare navigation including accompaniment to HIV care appointments if needed, ART adherence counseling, risk reduction counseling, and warm hand-off referrals to psychosocial health services such as addiction counseling/treatment, mental health care, and housing services. The MCC assessment and service components are described in greater detail in LAC's evaluation of the first year of MCC implementation[25] and in the most recent LAC MCC guidelines[33].

Program Evaluation

This evaluation reports on a longitudinal, secondary data analysis of de-identified programmatic and surveillance data from LAC DHSP. We estimated changes in VS among 6,408 PLWH in the MCC Program during the 12 months prior to MCC enrollment through 36 months post-enrollment, as functions of PLWH's housing status, stimulant use and depressive symptoms reported at enrollment. The Los Angeles County Department of Public Health Institutional Review Board and the Office of the Human Research Protection Program at the University of California, Los Angeles approved this secondary data analysis for evaluation of the MCC Program.

Data Sources

We analyzed data for all PLWH who enrolled in MCC from January 1, 2013 through September 31, 2017. Socio-demographic, assessment, and service data were entered by MCC teams in HIV Casewatch, the local data reporting system system for RWP- contracted providers. HIV Casewatch data were matched with the LAC HIV surveillance database, the Enhanced HIV/AIDS Reporting System (eHARS), to obtain VL testing data and HIV diagnosis dates reported as of December 2018. VL data were based on laboratory results

reported between 12 months prior to the patient's MCC enrollment date and 36 months post-enrollment. These laboratory results are routinely reported to the eHARS surveillance system as part of mandated reporting requirements (separate from MCC) for all HIV care patients in the LAC jurisdiction.

Measures

HIV Measures.—The outcome is viral suppression (VS) defined as a VL test less than 200 copies/mL. We defined the baseline VS measure as the most recent VS measurement within 12 months prior to MCC enrollment. The time since HIV diagnosis was calculated as the number of years from date of HIV diagnosis to date of MCC enrollment and coded both as a continuous variable and also rescaled in decades for regression analysis.

Assessment measures.—Programmatic data on comorbidities and patient characteristics were obtained by MCC staff at enrollment using a standardized assessment tool developed by LAC DHSP. The comorbidities of interest were stimulant use, housing instability, and depressive symptoms, and were assessed as follows. Patients were asked if they had ever used substances and if so, whether they had any substance use in the past six months. Those reporting any substance use in the past six months were then asked about specific substances used in the past six months (no/yes), including methamphetamine, cocaine, and crack. Patients who reported no history of substance use were included with patients who reported no specific substance use in the past six months. Those who reported methamphetamine, cocaine, and/or crack were categorized as having used stimulants. To assess housing instability, patients were asked, "Have you been homeless in the past six months?" with response options of No or Yes. The PHQ-9 score was used to assess severity of depressive symptoms on a continuous scale ranging from 0 to 24. Responses to individual items ranged from 0 (Not At All) to 3 (Nearly Every Day) for each depressive symptom described (e.g., Feeling down, depressed, or hopeless), and summed to create the final score[34]. This PHQ-9 score was modeled as continuous in longitudinal regression analyses, then in post hoc analyses, fixed at a score of 10 for estimation of marginal probabilities of VS by comorbidity. We specifically fixed the PHQ-9 score at 10 because this has been shown to be the optimal cut-point for likely major depression[35].

Sociodemographic information included age, gender, race/ethnicity, education, income, and birth outside of the U.S. Age at enrollment was coded in years and rescaled in decades for regression analysis. Gender included the categories cisgender male, cisgender female, and transgender. Race/ethnicity included the categories White, Black, Latinx, and other. Education was categorized as less than high school, completion of high school/GED, and more than high school. Income was measured by federal poverty level (FPL) and categorized as cut-offs of at or below FPL, 101–200% FPL, and 201% FPL or greater. Patients reported whether or not they were born outside the U.S. Baseline behavioral measures included self-reported history of incarceration, cannabis use, and injection drug use in the past six months, self-reported experience of interpersonal violence in the past three months, and any STI diagnosis in the past 6 months reported to LAC public health surveillance. These measures were pre-specified for inclusion in the analyses, having been identified in prior research to

be possible barriers to accessing care and ART adherence[36–38], or factors influencing viral replication[29,39].

Statistical Analysis

Cross-tabulations and chi-squared tests or t-tests were used to assess the association between categorical or continuous variables and baseline VS, and are reported in Table 1.

We analyzed VS longitudinally with a generalized linear mixed model (GLMM) fit in Stata 15 using the mixed command[40]. For the GLMM, we selected a logistic random effects model[41] with a random intercept. MCC enrollment was set as the zero time. Because timing of VL tests varied by patient, depending on degree of engagement care and medical provider practices, time was modeled continuously. The time trend was modeled as piecewise linear from 12 months before MCC enrollment to 36 months after enrollment with slope change points at enrollment and six months post-enrollment. Change points were determined by inspecting LOWESS curves (locally weighted scatterplot smoothing) of VS as functions of time. We allowed for a jump in the logit of VS probability at enrollment to account for the likely possibility of rapid change in VS probability at enrollment. Estimates of VS just before and just after the jump at enrollment are denoted *−0 months* and *+0 months*.

Demographic covariates included in the model were age in decades, gender, race, income, education, foreign born. We also adjusted for pre-specified baseline covariates for report of incarceration, cannabis use, injection drug use, and STI diagnosis in the past six months, and experience of interpersonal violence in the past three months. We included time by covariate interactions for three reported comorbid conditions: stimulant use, housing instability, and depressive symptoms (based on continuous PHQ-9 scores).

Using the Stata margins function[42], we then conducted post hoc estimation of marginal probabilities of VS every 6 months from −12 months pre-enrollment to 36 months post-enrollment including separate estimates for just before (−0) and after (+0) enrollment for the entire population and for five archetypes: 1) no comorbidities, 2) high PHQ-9 only, 3) stimulant use only, 4) housing instability only, and 5) all comorbidities. Probabilities of VS are estimated at fixed time points and at fixed values of PHQ-9 score, stimulant use, and housing instability, with other covariates set to their observed values[42] for all subjects in the data set; estimates are then averaged over all subjects and averages and associated standard errors are reported. We defined the *no comorbidities* archetype as having a PHQ-9 score fixed at 0 points, no stimulant use, and no reported housing instability. The *high PHQ-9 only* archetype was fixed at a PHQ-9 score of 10 points[35], as well as no stimulant use and no reported housing instability. The *stimulant use only* archetype used stimulants, had a PHQ-9 score of 0 and did not report housing instability. The *housing instability only* archetype had housing instability, a PHQ-9 score of 0 and no stimulant use. The *all comorbidities* group had a PHQ-9 score fixed at 10 and both stimulant use and housing instability. We then plotted the estimated probabilities of VS for these five comorbidity archetypes as functions of time.

Results

Baseline patient characteristics and bivariate associations with VS

Table 1 reports HIV-related, psychosocial, and behavioral characteristics and demographics of 6,408 MCC patients overall and by viral suppression at time of enrollment. Patients in MCC had a mean age at enrollment of 40.5 years (SD = 11.9). MCC patients were 19% White, 48% Latinx, 28% Black, and 4% other. The majority of MCC patients were cisgender male (84%), while the remainder were cisgender female (13%) and transgender (2%).

At enrollment, on average, people who were virally suppressed were older and had been diagnosed with HIV longer time ago. Cisgender female patients were more likely (47.3%) to be virally suppressed than cisgender male patients (41.9%) and transgender patients (43.2%) (p<.012). Cisgender men who reported being were exposed to HIV through sex with men (MSM) were less likely (40.3%) to be virally suppressed than those who did not (48.3%) (p<.001). Patients who were born outside the U.S. were more likely (44.3%) to be virally suppressed compared to those born in the U.S. (41.7%) (p=.039), and those who were incarcerated in the past six months were more likely (52.8%) to be suppressed than those who were not incarcerated (41.7%) (p<.001). Patients who reported housing instability (40.2%) (p=.023), methamphetamine use (34.8%) (p<.001), cocaine/crack use (34.4%) (p<.001), cannabis use (36.7%) (p<.001), and injection drug use (35.8%) (p=.005) in the past six months, as well as those who had an STI in the past six months (37.9%), were less likely to be virally suppressed than those with no housing instability (43.5%), no meth (44.6%), cocaine (43.3%), or cannabis use (45.0%), and no STIs (43.9%). Patients with a PHQ-9 score 10 were less likely (40.5%) to be virally suppressed at enrollment (p=.025) than those with lower scores (42.8% for scores 1–9 and 46.0% for scores of 0).

Modeling VS trajectories by comorbid conditions

Figure 1 plots the time trends of the estimated VS probabilities for the five comorbidity archetypes—*no comorbidities*, *high PHQ-9 only*, *stimulant use only*, *housing instability only*, and *all comorbidities*. VS probabilities and changes from previous time points are presented in Table 2, and differences in VS probabilities between archetypes are in Table 3. The time trend for the probability of VS was similar across all five comorbidity archetypes (Figure 1) though levels differ significantly. The overall probability of VS declined rapidly over the 12 months prior to MCC enrollment, from 0.64 (95% CI [0.62, 0.65]) to 0.35 (95% CI [0.34, 0.36]) (p<.001). Probability of VS increased substantially (p<.001) to 0.57 (95% CI [0.56, 0.58]) immediately after MCC enrollment (+0 months), then increased again (p<.001) to 0.77 (95% CI [0.76, 0.78] at six months post-enrollment. By six months post-enrollment, those who reported no comorbidities had a significantly greater VS probability than those who reported using stimulants only, housing instability only, high PHQ-9 only, and all three comorbidities. By 36 months post-enrollment, those with a high PHQ-9 increased to a similar VS probability level as those who reported no comorbidities. However, those in any of the other comorbid archetypes continued to have lower probabilities of VS than those with no comorbidities by 36 months post-enrollment, with the lowest VS probability in those with all three comorbidities.

Odds ratios of VS at different levels of each covariate as measured at enrollment are reported in Appendix 1. Those who were Black had 0.68 times (95% CI: 0.57–0.81), p<.001) lower odds of VS than White patients. Each decade since an HIV diagnosis was associated with 0.91 times (95% CI (0.84, 1.00), p =.043) lower odds of VS. Every decade of age (OR=1.44, 95% CI (1.35, 1.53), p<.001), having a higher income (OR=1.62, 95% CI (1.27, 2.05), p<.001), having a higher education (OR=1.59, 95% CI (1.36, 1.87), p<.001), being born outside the U.S. rather than within the U.S. (OR=1.36, 95% CI (1.17, 1.59), p<.001), and having a positive STI diagnosis in the past six months rather than no diagnosis (OR=1.26, 95% CI (1.08, 1.47) were associated with greater odds of VS.

Discussion

The present study shows near immediate improvements in rates of VS in PLWH participating in the LAC MCC Program. Findings also show important lower rates of VS for those living with any of three comorbid conditions—stimulant use, housing instability, and depressive symptoms. Across all comorbidity groups, probability of VS significantly increased with the greatest increase occurring from MCC enrollment to six months later, and this probability remained stable or increased up to 36 months post-enrollment. The significant increase in probability of VS at MCC enrollment (i.e., the jump discontinuity) suggests that the most rapid improvement occurred soon after enrollment, followed by a less rapid improvement for the remainder of the six months post-enrollment. Another explanation is that some patients who were previously non-adherent to their ART regimens resumed taking their medications in the timeframe between first being contacted to participate in MCC and their first actual MCC appointment.

The distinct trajectories in people with different morbidities show differential responses to this widely used model to improve relevant HIV outcomes. These results highlight characteristics of people who may require more intensive services. Patients enrolled in MCC who reported all three comorbidities improved as measured by probability of VS over time, but that improvement progressed more slowly compared to those MCC patients with no comorbid conditions. It is worth noting that after three years of enrollment in MCC, patients who reported high depressive symptoms, but no stimulant use or homelessness, had a similar probability of VS as those with none of the comorbid conditions. This suggests that patients with depressive symptoms may face fewer barriers adhering to HIV treatment than those with chronic problems with stimulant use and homelessness.

Generally, these findings are consistent with evaluation of New York City's HIV Care Coordination Program, which demonstrated increased odds of VS over the course of receiving coordinated care, but also showed that baseline housing instability and substance use decreased these odds[9,43]. Our study expands upon prior program evaluations and research by modeling temporal trends showing when and how VS probabilities improved and stabilized, as well as elucidating disparities in VS by comorbid condition. Even with additional resources, these individuals still endure greater challenges to achieving VS than those without these comorbid conditions[43,44], warranting specific attention to available services and local resources to address substance use and homeless. However, increasing VS from 86% nationally—the current rate under the Ryan White HIV/AIDS Program—to the

Ending the HIV Epidemic (EHE) target of 90%[45], will require further expansion of healthcare resources to reduce comorbidities in PLWH.

Ultimately, investing in HIV coordinated care models like MCC may be more cost-effective than the standard of care if such programs are clinically effective and targeted to PLWH with the greatest needs[46]. Therefore, it will be especially important to leverage the EHE initiative towards supporting local health jurisdictions that currently lack the necessary resources for successful implementation of coordinated care programs[45,47]. A key focus of the EHE initiative is to provide additional funding and support for medical case management across Ryan White Clinics and programs like MCC throughout the U.S., and to partner with local healthcare agencies and other institutions in this effort[45,47]. As such, support from the EHE may open opportunities for other local health agencies to implement new programs, collaborate and coordinate care across agencies at the regional level[48], share programmatic data, and implement and evaluate novel, evidence-based intervention components for substance use and homelessness in comprehensive HIV care programs like MCC.

Our findings have some limitations. There is intentional selection in enrollments into MCC; PLWH in LAC who have characteristics associated with successful VS are not enrolled in MCC and thus are not included in our analysis. In fact, conditions associated with worsening probability of VS are what gets PLWH enrolled in MCC, as reflected in the decrease in VS prior to MCC enrollment. Because the MCC Program serves PLWH the greatest challenges managing HIV, our analysis cannot control for an equivalent comparison group who did not partake in MCC. Still, modeling VS over time allowed us to show that there was meaningful change in the probability of VS at and following MCC enrollment[49]. Even more encouraging, after only six months in MCC, the probability of VS surpassed that at 12 months before MCC participation. Thus, we believe these trends were likely the result of improved access to care. Another limitation is that it is not clear what MCC program components and services were the most effective (or the least effective) at supporting patients in achieving VS, particularly because comprehensive care plans were individually tailored to patients' needs assessments. In other words, MCC patients did not all receive the same services. Still, based on our estimated disparities in VS, we infer that those with stimulant use and housing instability require additional support for those challenges despite significant improvement over the 36-month evaluation period.

The present study suggests that MCC improved probability of VS for all groups of patients regardless of the presence of comorbidities, but as VS is not nearly 100%, further improvements in VS are possible. Expanding resources for and tailoring services to meet the needs of PLWH with complex comorbidities are critical to reaching local and national HIV strategy targets, such as increasing the percentage of PLWH with VS to least 90% and increasing retention in HIV medical care to at least 90%[50], and in turn, decreasing HIV transmission in the era of Undetectable Equals Untransmittable[31]. Future longitudinal analyses are needed to evaluate MCC on other outcomes, specifically, the degree to which comorbid stimulant use, housing instability, depressive symptoms, and other psychosocial challenges improved among MCC patients following enrollment. Such investigation would help to identify additional program components needed to better address these comorbid conditions, retention in care and treatment, and in turn, VS.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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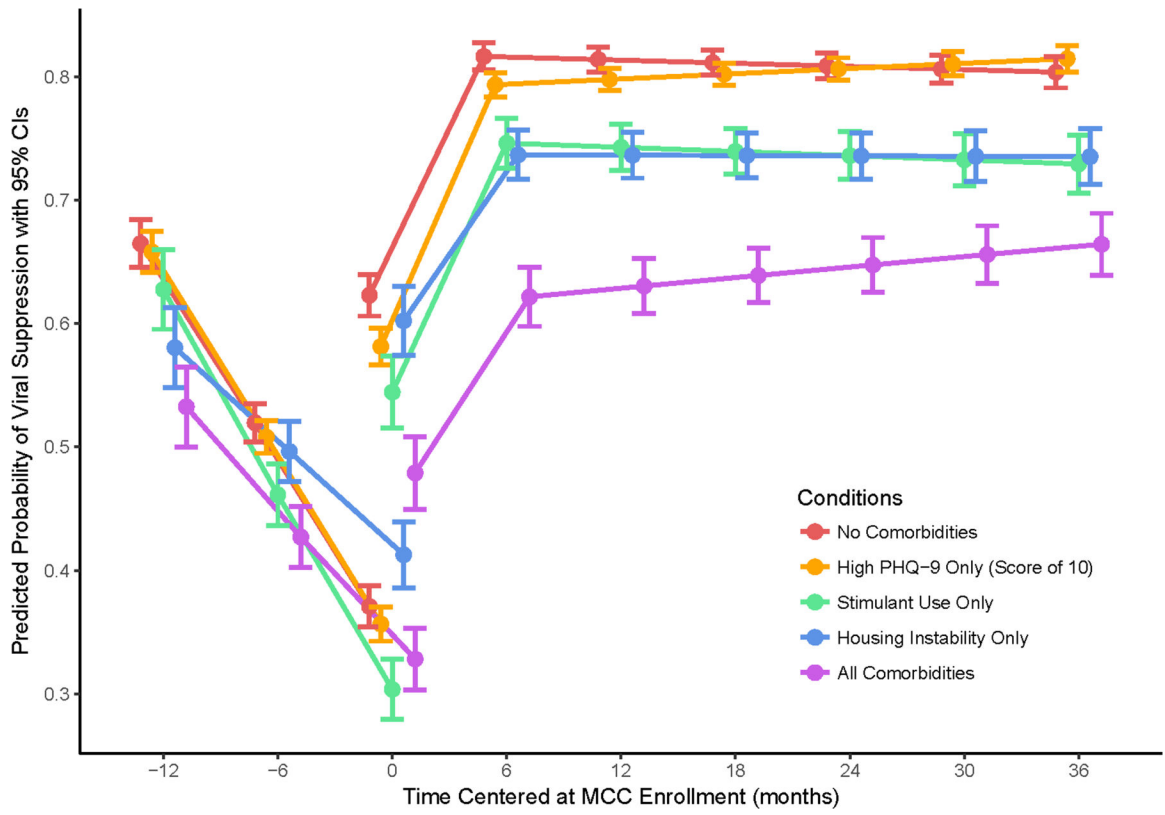
Figure 1.
Probabilities of VS by comorbid condition over time among Medical Care Coordination patients, Los Angeles County, 2013–2018.

Table 1.

Viral suppression at enrollment by patient characteristics among HIV-positive persons in the Medical Care Coordination Program (n=6,408), Los Angeles County, 2013–2018.

	Viral Suppression					
	All patients		<200 c/mL		200 c/mL	
	n = 6,408		n = 2,734		n = 3,674	
	M	SD	M	SD	M	SD	p
Age (years) at MCC enrollment	40.5	11.9	43.2	12.0	38.6	11.4	< .001
Time (years) since HIV diagnosis	8.3	7.9	10.0	7.9	7.0	7.7	< .001
PHQ-9 score	7.1	6.2	6.7	6.1	7.3	6.4	< .001
	n	column %	n	row %	n	row %	p
Gender							.012
Cisgender male	5,406	84.4	2,266	41.9	3,140	58.1	
Cisgender female	854	13.3	404	47.3	450	52.7	
Transgender [†]	148	2.3	64	43.2	84	56.8	
Men who have sex with men (MSM) [††]							< .001
No	1,088	20.1	525	48.3	563	51.7	
Yes	4,318	79.9	1,741	40.3	2,577	59.7	
Race/Ethnicity							.609
White	1,238	19.3	545	44.0	693	56.0	
Latino/a	3,104	48.4	1,300	41.9	1,804	58.1	
Black	1,807	28.2	778	43.1	1,029	56.9	
Other	259	4.0	111	42.9	148	57.1	
Education							.222
Less than high school	1,866	29.1	779	41.7	1,087	58.3	
High school/GED	2,107	32.9	931	44.2	1,176	55.8	
Some college or higher	2,435	38.0	1,024	42.1	1,411	57.9	
Income							.098
Federal poverty level (FPL)	4,911	76.6	2,064	42.0	2,847	58.0	
101–200% FPL	1,056	16.5	482	45.6	574	54.4	
> 201% FPL	441	6.9	188	42.6	253	57.4	
Born outside of U.S.							.039
No	4,051	63.2	1,689	41.7	2,362	58.3	
Yes	2,357	36.8	1,045	44.3	1,312	55.7	
Housing instability (past 6 months)							.023
No	4,879	76.1	2,120	43.5	2,759	56.5	
Yes	1,529	23.9	614	40.2	915	59.8	
Methamphetamine use (past 6 months)							< .001
No	5,158	80.5	2,299	44.6	2,859	55.4	
Yes	1,250	19.5	435	34.8	815	65.2	
Cocaine/crack use (past 6 months)							< .001
No	5,929	92.5	2,569	43.3	3,360	56.7	

Yes	479	7.5	165	34.4	314	65.6	
Cannabis use (past 6 months)							< .001
No	4,605	71.9	2,072	45.0	2,533	55.0	
Yes	1,803	28.1	662	36.7	1,141	63.3	
Injection drug use (IDU) (past 6 months)							.005
No	6,017	93.9	2,594	43.1	3,423	56.9	
Yes	391	6.1	140	35.8	251	64.2	
Experienced violence (past 3 months)							.509
No	4,647	72.5	1,971	42.4	2,676	57.6	
Yes	1,761	27.5	763	43.3	998	56.7	
Incarcerated (past 6 months)							< .001
No	5,832	91.0	2,430	41.7	3,402	58.3	
Yes	576	9.0	304	52.8	272	47.2	
Sexually transmitted infection (STI) (past 6 months)							< .001
No	5,103	79.6	2,239	43.9	2,864	56.1	
Yes	1,305	20.4	495	37.9	810	62.1	

[†]Includes 146 persons who identify as transgender women and 2 as transgender men

[††]For cisgender men only

Table 2.

Changes in estimated probability of VS over time, by comorbidity archetype with 95% CI

Archetype	Time, mo[*]	Probability	95% CI	Change from previous time	95% CI	p
Overall trend	−12	0.635	0.622, 0.647			
	−0	0.351	0.341, 0.361	−0.284	−0.298, −0.269	<.001
	+0	0.572	0.561, 0.583	0.221	0.211, 0.232	<.001
	6	0.768	0.761, 0.776	0.196	0.186, 0.206	<.001
	36	0.783	0.775, 0.791	0.015	0.007, 0.023	<.001
No comorbidities	−12	0.665	0.645, 0.684			
	−0	0.371	0.354, 0.387	−0.294	−0.316, −0.271	<.001
	+0	0.623	0.606, 0.640	0.252	0.236, 0.268	<.001
	6	0.816	0.805, 0.827	0.193	0.179, 0.208	<.001
	36	0.804	0.791, 0.816	−0.013	−0.025, −0.001	0.035
High PHQ only	−12	0.658	0.641, 0.675			
	−0	0.357	0.343, 0.370	−0.324	−0.359, −0.288	<.001
	+0	0.581	0.566, 0.596	0.241	0.215, 0.267	<.001
	6	0.793	0.783, 0.803	0.202	0.177, 0.227	<.001
	36	0.814	0.804, 0.825	−0.017	−0.039, 0.005	0.128
Stimulant use only	−12	0.627	0.595, 0.660			
	−0	0.304	0.279, 0.328	−0.168	−0.205, −0.131	<.001
	+0	0.544	0.515, 0.574	0.189	0.163, 0.216	<.001
	6	0.746	0.726, 0.766	0.134	0.110, 0.159	<.001
	36	0.729	0.706, 0.752	−0.001	−0.023, 0.020	0.897
Housing instability only	−12	0.580	0.548, 0.613			
	−0	0.413	0.386, 0.440	−0.301	−0.321, −0.282	<.001
	+0	0.602	0.574, 0.630	0.225	0.211, 0.239	<.001
	6	0.737	0.717, 0.756	0.212	0.199, 0.225	<.001
	36	0.735	0.712, 0.758	0.021	0.011, 0.031	<.001
All comorbidities	−12	0.533	0.500, 0.565			
	−0	0.328	0.303, 0.353	−0.204	−0.237, −0.171	<.001
	+0	0.479	0.450, 0.508	0.151	0.126, 0.175	<.001
	6	0.622	0.598, 0.646	0.143	0.118, 0.167	<.001
	36	0.664	0.639, 0.689	0.043	0.020, 0.065	<.001

[*] −0 months denotes time before MCC enrollment, while +0 months denotes time right after MCC enrollment.

Table 3.

Difference in estimated VS probability for each comorbidity archetype minus the archetype with no comorbidities at the given time point with 95% CI

Comorbidity archetype[a]	Time point[b]	Difference	95% CI	p
Stimulant use only	−12 months	−0.037	−0.067, −0.007	.015
Housing instability only	−12 months	−0.084	−0.114, −0.054	<.001
High PHQ-9	−12 months	−0.007	−0.026, 0.013	.500
All comorbidities	−12 months	−0.132	−0.174, −0.091	<.001
Stimulant use only	−0 months	−0.067	−0.091, −0.044	<.001
Housing instability only	−0 months	0.042	0.017, 0.067	.001
High PHQ-9	−0 months	−0.014	−0.031, 0.002	.091
All comorbidities	−0 months	−0.043	−0.075, −0.010	.011
Stimulant use only	+0 months	−0.078	−0.106, −0.051	<.001
Housing instability only	+0 months	−0.021	−0.047, 0.005	.118
High PHQ-9	+0 months	−0.041	−0.059, −0.024	<.001
All comorbidities	+0 months	−0.144	−0.181, −0.107	<.001
Stimulant use only	6 months	−0.070	−0.089, −0.051	<.001
Housing instability only	6 months	−0.080	−0.098, −0.062	<.001
High PHQ-9	6 months	−0.023	−0.034, −0.012	<.001
All comorbidities	6 months	−0.195	−0.223, −0.166	<.001
Stimulant use only	36 months	−0.074	−0.096, −0.053	<.001
Housing instability only	36 months	−0.068	−0.089, −0.048	<.001
High PHQ-9	36 months	0.011	−0.001, 0.023	.083
All comorbidities	36 months	−0.139	−0.170, −0.109	<.001

[a] The reference archetype is those with no comorbidities

[b] −0 months denotes time immediately before MCC enrollment, and +0 months denotes the time right after MCC enrollment.