Predictors of failure to achieve virologic suppression within one year after HIV diagnosis among people living with HIV in King County, WA: A surveillance-based analysis

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Abstract

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Health departments are increasing efforts toward rapid linkage to care after HIV diagnosis, with the goal of achieving optimal viral suppression early on.[11] Their role in optimizing and implementing publicly funded prevention programs for their jurisdictions[10] gives them unique access to surveillance data which is required for a population-based approach. Using surveillance data, identify factors that are associated with failure to achieve viral suppression in the first year after HIV diagnosis. We studied a population-based cohort of individuals newly diagnosed with HIV in King County, WA from January 1, 2013 to June 30, 2016. We examined, using Poisson regression, the association between the variables and two outcome groups (achieved and did not achieve suppression, defined as <200 copies per milliliter). We used a Kaplan-Meier curve to graphically present the difference in time (months) to virologic suppression for all independent variables associated with failure to achieve suppression at $p<0.05$. Individuals who had no plan for HIV care at the time of partner services interview were more likely than individuals with a plan to fail to achieve suppression [RR 1.19 (95% CI: 1.04-1.37)]. Individuals with unstable housing were more likely that individuals with stable housing to fail to achieve suppression [RR 1.21 (95% CI: 1.06-1.38)]. If patients are not suppressed at 7 months, they are unlikely to achieve suppression in one-year and need additional intensive interventions. The findings from this study can inform health department interventions to intervene early with at-risk individuals in order to improve viral suppression.

Background

According to the Centers for Disease Control and Prevention (CDC), an estimated 1.1 million adults and adolescents in the United States were living with human immunodeficiency virus (HIV) at the end of 2015, while approximately 40,000 people received a new diagnosis in 2016.[1] People living with HIV (PLWH) need to know they are HIV infected, be engaged in regular HIV care, and receive and adhere to effective antiretroviral therapy (ART) in order to achieve viral suppression. Together, these steps are known as the HIV care continuum or treatment cascade.[2] Gaps in the care continuum, which can lead to failure to achieve virologic suppression in a timely manner after diagnosis, include late linkage to care, poor engagement in care, and late initiation of or lack of effective adherence to ART.[3] Early retention in care and achievement of viral suppression in the first year after diagnosis has been identified as important for long-term viral load suppression[4], which reduces HIV-related morbidity and mortality, preventing the onward transmission of the disease.[4-6] However, as of 2014, only 48% of people living in the United States had achieved a suppressed viral load.[7] This rate signifies a significant gap in one of the goals of the World Health Organization (WHO) objectives, to ensure at least 90% of those on ART are virologically suppressed by the year 2020.[8]

In July 2010, the Obama Administration released a National HIV/AIDS Strategy (NHAS) for the United States to refocus national attention on responding to the domestic HIV epidemic with three specific goals: 1) reduce HIV incidence, 2) increase access to care and optimize health outcomes among PLWH, and 3) reduce HIV-related disparities.[9] Viral suppression is a central goal of care and prevention, which contribute to each of these goals. By using medication that achieves this outcome and prevents the spread of the disease, individuals move along the care

continuum. Health departments are important for NHAS implementation because of their role in optimizing and implementing publicly funded prevention programs for their jurisdictions.[10] They have unique access to surveillance data, which is required for a population-based approach. To achieve these goals health departments are increasing efforts toward rapid linkage to care after diagnosis, with the goal of achieving optimal viral suppression early on.[11]

While there has been significant research on individual patient-oriented variables that are gaps or may create gaps in the care continuum,[3,12-16] little evidence is available to guide health department efforts to intervene earlier in the course of care disengagement. Most published literature on this topic is limited to specific populations, includes many patients diagnosed with HIV for >1 year, or focuses on predictor variables collected within the context of a specific study. With health department HIV prevention and care programs increasing focus on rapid linkage to care after diagnosis, initiating ART to achieve viral suppression as quickly as possible after diagnosis has become a major goal.[11] However, linkage to care is only the first step in this process, and some patients fail to fully engage even after successful linkage. Given that the first year after HIV infection is a crucial time for achieving viral suppression,[4] the goal of our study was to identify factors associated with failure to achieve viral suppression in the first year after HIV diagnosis.

We conducted a retrospective cohort study evaluating the association between viral suppression and demographic and behavioral characteristics of individuals diagnosed with HIV in King County, WA. Since the intent of this analysis is to inform public health practice, we focused on

variables available to the health department in HIV surveillance and partner services data and known to be associated with suppression failure.[3,12-16]

Methods

Population

Our analysis includes individuals newly diagnosed with HIV and reported to the health department in King County, WA from January 1, 2013, through June 30, 2016.

Data Sources

For this analysis, we used HIV case surveillance, partner services, and laboratory surveillance data (the results of CD4 counts and viral loads). HIV case surveillance and partner services data were collected as part of routine public health activities undertaken by Public Health—Seattle & King County (PHSKC). Washington State law requires health care providers to report all newly diagnosed HIV and AIDS cases and laboratories to report tests confirming HIV infections, HIV RNA quantitation (viral loads) of any value, and CD4+T-lymphocyte test results of any value to the Washington State Department of Health.[17] All data are matched bimonthly against the Enhanced HIV/AIDS Reporting System (eHARS), a Web-based platform that enables HIV surveillance data to be securely entered, stored, managed, and reported to the CDC.[18] As of 2015, CD4 count reporting in King County was 95% complete and viral load reporting was 97% complete.[19]

PHSKC attempts to contact all individuals newly diagnosed with HIV in order to provide assistance notifying partners of possible contact to HIV and to assist the newly diagnosed individual with linking to HIV care. During the period of this analysis, all contacted individuals were offered participation in the PHSKC One-on-One program, where they received their first

CD4 and VL testing, met with a medical provider for education about HIV and HIV treatment, and were assisted with scheduling the first HIV care appointment.[20] PHSKC disease intervention specialists (DIS) conduct a Partner Services interview (PS) with all newly diagnosed individuals who are successfully contacted. The interview is designed to facilitate partner notification and collect information used for HIV epidemiologic monitoring. Our analysis included all individuals who received a Partner Services interview and were over the age of 18.

Outcome Measure

The outcome measure for this study was failure to achieve viral suppression within one-year after diagnosis. We define suppression failure as having no viral load with <200 copies per milliliter in the year after the initial diagnosis as reported to surveillance. We divided participants into two groups (achieved suppression and did not achieve suppression). Any individuals who had no viral load values reported after diagnosis were assumed not to have achieved suppression in the first year.

Independent Variables

We included variables identified *a priori* as associated with linkage to care, retention in care, and/or viral suppression in prior studies. These factors include having a plan for HIV care, housing stability, and drug-usage.[6,7,12,15,21,22] We also included additional variables that we hypothesized could impact the likelihood of viral suppression. These included whether individuals were born in the United States, were English-speaking, and had ever exchanged sex for money or drugs. Although mental health disorders are well recognized as a predictor of engagement in care, this information is not available in HIV surveillance or assessed in the partner services interview. In terms of specific data sources, we used surveillance data to define age at diagnosis, gender, race, transmission category, diagnosing facility, value of first viral load,

value of first CD4 count, and time from initial HIV diagnosis to first suppressed viral load (<200 copies per milliliter). We used partner services data to define whether participants were born in the U.S., spoke English, ever exchanged sex for money or drugs, had a plan for HIV care, what their housing status was for last three months (permanent/stable, non-permanent/unstable, institutionalized, other), substance use in the past year, lifetime history of injection drug use, and the number of partners they had shared injection equipment with in the past year.

We measured having a plan for HIV care by whether the newly diagnosed individual, at the time of partner services interview, reported having a plan of which doctor to see, having scheduled a visit, or having already completed an appointment for HIV care after diagnosis. Finally, we determined housing status based on individuals' report of their housing situation at the time of the partner services interview, categorized as permanent/stable housing or non-permanent/unstable housing. We used information collected during partner services interviews to determine if individuals had used cocaine, crack, heroin, meth, nitrates, any injection drug use (IDU), or shared injection equipment in the last year.

Statistical Analyses

We calculated descriptive statistics including means, medians, and frequencies to summarize continuous and categorical data. We performed univariate analyses in which we compared the two outcome groups (achieved and did not achieve suppression) based on age at diagnosis, value of first viral load, race, gender, and transmission category using a t-test for continuous variables and Pearson's chi-squared test for categorical variables. We used Poisson regression to calculate the relative risks for all variables that were associated with failure to achieve suppression at $p<0.05$ in the univariate analyses. Finally, we used a Kaplan-Meier curve to graphically present the difference in time (months) to virologic suppression for all independent variables associated

with failure to achieve suppression. All analyses were performed in STATA 14. This study was approved by the University of Washington institutional review board.

Results

A total of 851 cases were reported to Public Health – Seattle & King County as diagnosed with HIV infection between January 1, 2013 and June 30, 2016. Of the 851 participants whose cases were reported, 557 completed partner services interviews, and 8 were <18 years of age for a final analysis population of 549. Participants ranged in age from 18 to 78 years (mean: 36, SD=12.13). Compared to individuals who completed partner services interviews (the study population), those who did not complete an interview were more likely to be men (79% vs 89%; p<0.001), non-Hispanic white (42% vs 51%; p<0.001), and men who have sex with men (MSM) (52% vs 71%; p<0.001). Individuals who completed partner services were also older (38; SD=11.56 vs 36; SD=12.13; p=0.06), had a lower median value of first recorded viral load (36641 copies/ml; IQR=198123 vs 53215 copies/ml; IQR=247260; p<0.001), and higher median CD4 count (396; IQR=375 vs 387; IQR=307; p=0.97).

Of the 549 PLWH included in analysis, 480 (87%) achieved viral suppression within the first year after diagnosis and 69 (13%) did not. Demographic characteristics of the study population are summarized in Table 1, stratified by suppression success and failure. Overall, the population was predominantly male (89%), about half were non-Hispanic white (51%), and the most common transmission category was MSM. Compared to individuals who achieved viral suppression, those who failed to achieve viral suppression did not differ significantly by gender (p=0.62), race (p=0.84), or by transmission category (p=0.09).

Table 2 shows risk factors examined as being potentially associated with VL suppression failure. Individuals who had no plan for HIV care at the time of the partner services interview were more likely than individuals with a plan to fail to achieve suppression [RR 1.19 (95% CI: 1.04-1.37)]. Individuals with unstable housing were more likely that individuals with stable housing to fail to achieve suppression [RR 1.21 (95% CI: 1.06-1.38)]. Foreign birth, English language, and transmission category were not significantly associated with viral suppression, nor was substance use, injection equipment sharing, or exchanging sex for money or drugs. In multivariate analysis, we included the two factors having significance and found having no plan for HIV care at time of interview was the only factor showing association with VL suppression failure.

Using a Kaplan-Meier failure curve and risk table (Figure 1), we examined suppression progression for individuals who had one or both of the two significant risk factors for failing to achieve suppression: unstable housing and/or no plan for HIV care at 3, 6, 9 and 12 months (Figure 1). Even in this group, 78% achieved suppression at one year. The population with one or more of the significant risk factors was 25% suppressed (33 people) at 2.8 months, 50% suppressed (63 people) at 5.1 month, 75% suppressed (95 people) at 9.9 months, and 78% suppressed (99 people) at one year. However, at one year, only 78% of the population with one or more significant risk factors were suppressed as compared to 91% of the population without these risk factors (Figure 2).

Discussion

In an evaluation of factors associated with failure to achieve viral suppression within the first year after HIV diagnosis among persons diagnosed in King County, we found that individuals who lacked stable housing and a plan for their HIV care were less likely to achieve viral

suppression. We estimated suppression in both the sample with and without one of the risk factors begins to taper at roughly 7-7½ months (Figure 2). However, even among the group of individuals with these factors, the majority reached suppression within one year (74%).

A key strength of this study is that it is population-based. We used data available to the local health department, which is broadly available and can be collected from individuals newly diagnosed with HIV. The main limitation of the study is that it was limited to one jurisdiction with HIV epidemiology and demographics that are not reflective of the nation as a whole. Because of this, it has unknown generalizability. We also did not have comprehensive data on factors that might be associated with viral suppression, such as mental health issues. Drug use data were incomplete, and some data obtained through PS interviews may be subject to recall bias. We may not have captured newly diagnosed cases because of our reliance on surveillance data. However, case-reporting in King County is over 95% complete.[19] Nonetheless, this study is an important contribution because it addresses a gap in the literature related to suppression failure early in the course of HIV infection and its implications for public health practice. The primary focus of the study was to inform a public health intervention in the area and has used information that is typically collected through health departments nationwide.

Linking to care quickly after diagnosis allows for early initiation of ART and improved survival.[23] In addition to increasing the likelihood of a patient achieving viral suppression, the use of ART also reduces HIV transmission to others and acts as a barrier to "treatment as prevention", which is aimed to reduce HIV transmission rates nationally[23]. Homelessness has been shown to contribute to lack of appointment attendance and inability to maintain a strict

ART adherence.[24] Therefore, establishing housing for seropositive PLWH may improve viral suppression and have a positive impact on patient outcomes and quality of life.[25]

Data to Care (D2C) uses HIV surveillance and other data to identify PLWH needing medical or other services and facilitating linkage to these services.[26] King County, WA currently utilizes D2C, has a short mean time from diagnosis to suppression, and in general is successful moving individuals along the care continuum. A strength of this study, the use of surveillance and partner services data available to health departments, allows the evaluation of successful linkage to care efforts and identify PLWH who are failing to progress through the HIV care continuum earlier. The relevance of this study to King County lies in the ability to identify specific characteristics that will allow us to find individuals who are more likely to fail earlier, flag them for additional observation, and employ interventions if they are not suppressed by seven months. Linkage to housing services may be helpful in improving adherence and suppression rates if done early on after diagnosis. We currently ask DIS to include their prediction of suppression outcome based on a comprehensive review of the individual, which can be analyzed for validity in the future as an additional predictor of failure and need to connect those individuals with additional services.

We have determined it is important for care providers to target individuals with these characteristics to initiate their path along the care continuum at initial diagnosis. Then, regardless of risk factors, if a patient is not suppressed at 7 months, they are unlikely to achieve suppression in one-year and need additional intensive interventions.

In summary, we found that lacking a plan for HIV care and unstable housing at the time of partner services interview was associated with failure to achieve viral suppression in the first year after diagnosis among HIV-diagnosed PLWH in King County, WA. The findings from this study can inform health department interventions to intervene early with at-risk individuals in order to improve viral suppression.

Table 1. Demographics

	Total (n = 549)	**Achieved Suppression (n = 480)**	**Did Not Achieve Suppression (n = 69)**	**p-Value[1]**
Value of First Viral Load, (Median, IQR) *	53215 (247260)	53052 (228615)	60850 (459341)	0.89
Age at HIV Diagnosis, years (Mean, SD)	36 (12.13)	36 (11.88)	37 (13.82)	0.68
Gender (%)				0.62
Male	486 (89)	423 (88)	63 (91)	
Female	59 (11)	53 (11)	6 (9)	
Transgender	4 (1)	4 (1)	0	
Race/Ethnicity (%)				0.84
White, non-Hispanic	279 (51)	241 (50)	38 (55)	
Black, non-Hispanic	109 (20)	95 (20)	14 (20)	
Hispanic	92 (17)	81 (17)	11 (16)	
Asian	42 (8)	38 (8)	4 (6)	
Pacific Islander	5 (1)	5 (1)	0	
American Indian/ Alaska Native	4 (1)	3 (1)	1 (1)	
Multi	18 (3)	17 (4)	1 (1)	
Transmission Category (%)				0.09
MSM	391 (71)	348 (73)	43 (62)	
IDU (IDU, MSM/IDU)	46 (8)	35 (7)	11 (16)	
Hetero	26 (5)	23 (5)	3 (4)	
No Risk Reported	86 (16)	74 (15)	12 (17)	

*6 people missing initial VL

[1] From Pearson's chi-squared test

IDU = Injection drug user

MSM = Men who have sex with men

Table 2. Risk Factor Characteristics

	Total (n = 549)	Achieved Suppression (n = 480)	Did Not Achieve Suppression (n = 69)	Risk Ratio[1] (95% CI)	p-Value
Plan for HIV care at time of Interview*[2] (%)					
Yes	456 (83)	408 (89)	48 (11)	REF	
No	72 (13)	54 (75)	18 (25)	1.19 (1.04-1.37)	0.01
Birthplace (%)					
U.S.	381 (69)	329 (86)	52 (14)	REF	
Foreign	155 (28)	138 (89)	17 (11)	1.03 (0.96-1.10)	0.38
English-speaking (%)					
Yes	479 (87)	420 (88)	59 (12)	REF	
No	48 (9)	39 (81)	9 (19)	1.08 (0.94-1.24)	0.29
Housing status (%)					
Permanent/Stable	442 (81)	395 (89)	47 (11)	REF	
Non-Permanent/Unstable	81 (15)	60 (74)	21 (26)	1.21 (1.06-1.38)	0.01
Drug use in past year (%)					
Cocaine					
Yes	40 (7)	35 (87)	5 (13)	0.99 (0.88-1.13)	0.99
Crack					
Yes	14 (3)	12 (86)	2 (14)	0.98 (0.79-1.21)	0.82
Heroin					
Yes	18 (3)	13 (3)	5 (7)	0.82 (0.61-1.09)	0.18
Meth					
Yes	81 (15)	69 (85)	12 (15)	0.96 (0.88-1.06)	0.46
Nitrates					
Yes	104 (19)	94 (90)	10 (10)	1.04 (0.96-1.12)	0.32
Any IDU					
Yes	40 (7)	33 (82)	7 (18)	0.94 (0.81-1.09)	0.40
None of the above					
Yes	333 (61)	289 (87)	44 (13)	1.02 (0.95-1.09)	0.58
Shared injection equipment					
Yes	156 (28)	137 (88)	19 (12)	0.88 (0.65-1.19)	0.39

Exchanged sex for money or drugs					
Yes	37 (7)	33 (89)	4 (11)	1.02 (0.91-1.15)	0.72

*Partner Services Interview

[1] From Poisson Regression

[2] Either completed one appointment with an HIV care provider or had a plan for seeing an HIV provider

Figure 1. Suppression Achievement for Population with ≥1 Significant Risk Factor

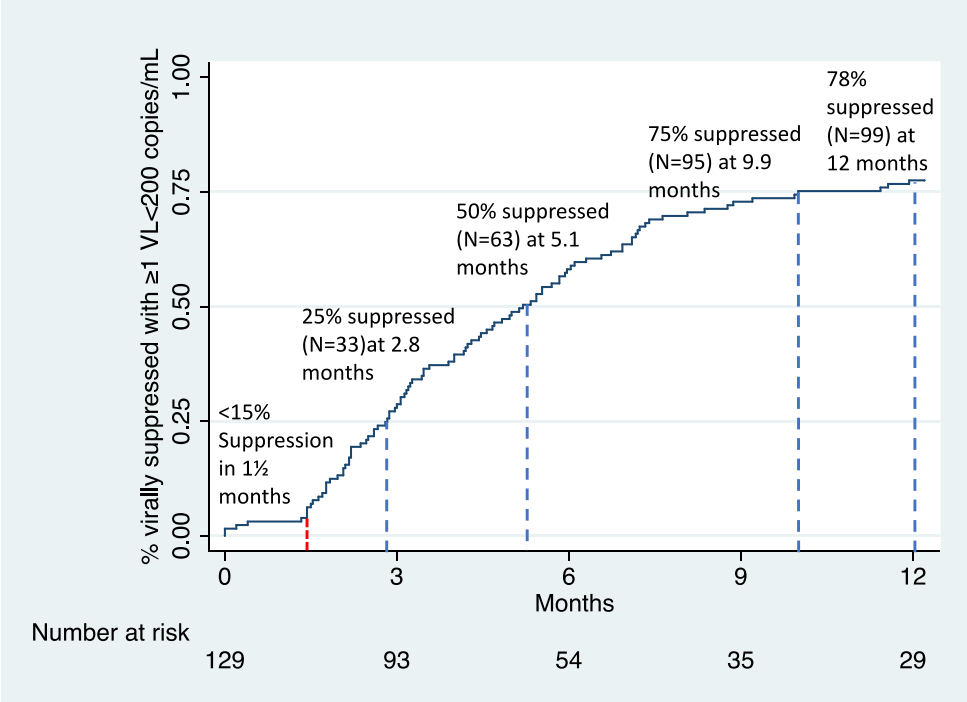
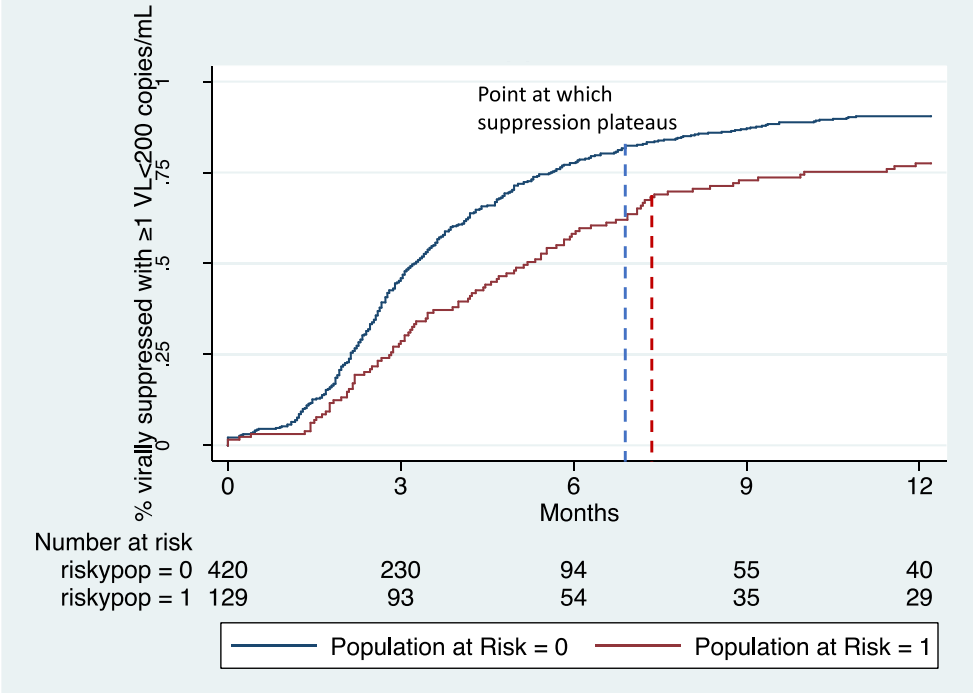


Figure 2. Viral Load Suppression Achievement



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