

# Changes in viral suppression status among US HIV-infected patients receiving care

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**Objective:** To examine changes in viral suppression status among HIV patients receiving care in 2014 and the extent of viral suppression among persons with infrequent care visits.

**Methods:** Using data reported to the National HIV Surveillance System from 33 jurisdictions with complete reporting of CD4<sup>+</sup> and viral load tests, we created four viral suppression status groups based on their first and last viral loads in 2014: both suppressed, first unsuppressed and last suppressed (improved), first suppressed and last unsuppressed (worsened), and both unsuppressed. We also calculated the number and percentage of persons whose sole viral load in 2014 was suppressed and had a suppressed viral load at their last test in 2013.

**Results:** Among 339 515 persons with at least two viral load tests in 2014, 72.6% had all viral loads suppressed (durably suppressed); 75.5% had the first and last tests suppressed, 10.5% improved, 4.2% worsened, and 9.9% had both unsuppressed. Among 92 309 persons who had only one viral load test in 2014, 69 960 (75.8%) were suppressed and, of those, 53 834 (76.9%) also had a suppressed viral load at their last test in 2013.

**Conclusion:** National surveillance data show that the majority of patients in HIV care during 2014 were durably suppressed. More showed improved compared with worsened viral suppression status. Some patients who have less frequent care visits have sustained viral suppression. Yet one in 10 who was in regular care did not have a suppressed viral load in 2014, indicating missed opportunities for clinical interventions to help patients achieve and sustain viral suppression.

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*AIDS* 2017, **31**:2421–2425

**Keywords:** change in viral suppression, HIV infection, persons living with HIV

## Introduction

Viral loads can fluctuate over time depending on patients' access to treatment, retention in care, response to HIV treatment, and medication adherence behavior. An increasing number of studies have called for using longitudinal data to investigate viral load dynamics and

transmission risk potentials [1–5]. One important aspect of examining viral load dynamics is to gain a better understanding of changes in viral suppression status. To examine changes in viral suppression status, one recent publication used a matched-pairs approach by using patient's first and last viral load tests from a cohort of HIV patients from six US clinics. The matched-pairs approach

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Received: 22 June 2017; revised: 20 September 2017; accepted: 25 September 2017.

DOI:10.1097/QAD.0000000000001660

generated four groups: sustained viral suppression (both viral loads suppressed), improved viral status (first unsuppressed, last suppressed), worsened viral status (first suppressed, last unsuppressed), and never achieved viral suppression (both viral loads unsuppressed). The study found that, among the 10 942 cohort patients, 69.7% had sustained viral suppression, 13.3% improved, 5.6% worsened, and 11.4% had never achieved viral suppression [1]. Although these findings are informative, clinical cohorts may not be representative of all persons with diagnosed HIV receiving care in the United States. Examining changes in viral suppression status using data from the National HIV Surveillance System (NHSS) can inform national HIV care and prevention efforts for improving health outcomes of persons living with HIV and mitigating HIV transmission.

One limitation of previously published studies that examined longitudinal viral load status is excluding patients who had only one viral load during an observation period (e.g., 12 months or 24 months) from the analyses [1,2]. It is plausible that some patients who receive stable HIV medical care may have sustained viral suppression even though they have less frequent clinic visits and the time interval between two viral load tests is longer [6]. If there is a sizable number of HIV patients who were virally suppressed but had less frequent viral load testing (i.e., only one viral load test) within a calendar year, excluding those patients from analyses on longitudinal viral load status may affect the estimate of the percentage of persons with suppressed viral loads. Therefore, it is important to investigate the extent of viral suppression in the prior year among people who had only one viral load test during the calendar year of study.

In this study, we used Centers for Disease Control and Prevention NHSS data and the matched-pairs approach to examine the changes in viral suppression status among HIV patients receiving care in 2014. We also used longitudinal viral load data to assess whether patients who had infrequent care visits (i.e., only one viral load test in 2014) had their last viral load suppressed in prior year.

## Methods

We included data reported to NHSS through June 2016 from 33 jurisdictions with complete reporting of CD4<sup>+</sup> and viral load tests. The analytic cohort included persons who were aged at least 13 years with HIV infection diagnosed by year-end 2013, whose most recent known residence was in the 33 jurisdictions and who were alive at year-end 2014, and had at least one viral load test in 2014 [7].

To examine changes in viral suppression status in a 12-month observation period, we created four groups based on first and last viral load tests in 2014 among those

who had at least two viral loads in 2014 (an indicator of regular HIV care): both suppressed, first unsuppressed and last suppressed (improved), first suppressed and last unsuppressed (worsened), and both unsuppressed. Changes in viral suppression status were also examined stratified by sex, race/ethnicity, transmission category, age, and diagnosis year.

For assessing whether some patients had infrequent care visits (i.e., only one viral load in 2014) but sustained viral suppression, we calculated the number and percentage of persons whose sole viral load in 2014 was suppressed and who also had a suppressed viral load at their last test in 2013, and the time interval between these two suppressed viral loads tests.

The definition of viral suppression in all analyses was less than 200 copies/ml, consistent with the definition used in the national indicator for viral suppression [8]. We also used the calendar year (i.e., 2014) to be consistent with the time period used in the national indicator [8]. Multinomial logistic regressions were conducted to identify differences between groups. All analyses were performed in SAS version 9.3 (SAS Institute Inc., Cary, North Carolina, USA).

## Results

A total of 912 915 persons aged at least 13 years with HIV infection diagnosed by year-end 2013 were alive at the end of 2014. In total, 69% (630 965) resided in the 33 jurisdictions based on the most recent address as of year-end 2014. The demographic characteristics were similar among the persons from the 33 jurisdictions compared with all persons living with diagnosed HIV (Table 1).

Among the 630 965 persons, 339 515 (53.8%) had at least two viral load tests, 92 309 (14.6%) had only one viral load test, and 199 141 (31.6%) did not have any viral load test in 2014. The median number of viral load tests was two in 2014. Among 339 515 persons who had at least two viral load tests, 40.1% had two viral loads, 33.2% had three viral loads, 17.1% had four viral loads, and 9.5% had five and more viral loads and, overall, 246 643 (72.6%) had all viral loads suppressed in 2014. The proportion of persons with all viral loads suppressed in 2014 decreased as the number of viral load tests increased: 79.2%, 76.1%, 67.1%, and 42.8% for those with two, three, four, and five and more tests, respectively.

Further examination of the changes in viral suppression status (Table 2) showed that 75.5% had first and last viral load tests suppressed, 10.5% improved, 4.2% worsened, and 9.9% had both unsuppressed. For all of the demographic strata, there were higher percentage of persons in care who had both first and last viral load tests

**Table 1. Characteristics of persons aged at least 13 years with HIV infection diagnosed at year-end 2013 and alive through 2014 from 33 US jurisdictions with complete viral load reporting, compared with all HIV-diagnosed persons aged at least 13 years from 50 states and District of Columbia and from 28 jurisdictions without complete reporting.**

Characteristics	All 50 states and District of Columbia		33 jurisdictions with complete viral load reporting		28 jurisdictions without complete viral load reporting	
	N	%	N	%	N	%
Total	912 915	100	630 965	100	281 950	100
Sex						
Male	690 286	75.6	484 031	76.7	206 255	73.2
Female	222 629	24.4	146 934	23.3	75 695	26.8
Race/ethnicity						
Hispanic/Latino	188 890	20.7	135 519	21.5	53 371	18.9
Black/African-American	386 049	42.3	265 551	42.1	120 498	42.7
White	289 308	31.7	193 740	30.7	95 568	33.9
Other races	48 668	5.3	36 155	5.7	12 513	4.4
Transmission category						
MSM	423 050	46.3	301 658	47.8	121 392	43.1
Injection drug use-Male	61 888	6.8	41 554	6.6	20 334	7.2
Injection drug use-Female	37 117	4.1	24 225	3.8	12 892	4.6
MSM and injection drug use	45 638	5.0	32 833	5.2	12 805	4.5
Heterosexual contact-Male	57 389	6.3	32 261	5.1	25 128	8.9
Heterosexual contact-Female	117 000	12.8	71 474	11.3	45 526	16.1
Other	170 833	18.7	126 960	20.1	43 873	15.6
Age at the end of 2013						
13–24	38 553	4.2	27 183	4.3	11 370	4.0
25–34	129 992	14.2	92 851	14.7	37 141	13.2
35–44	200 126	21.9	139 648	22.1	60 478	21.4
45–54	316 313	34.6	216 199	34.3	100 114	35.5
≥55	227 931	25.0	155 084	24.6	72 847	25.8

suppressed compared with any of the other three viral suppression status groups (all  $P < 0.05$ ). The percentage of persons who showed an improved viral status was higher than the percentage of persons who showed worsened viral status across all strata (all  $P < 0.05$ ). A higher percentage of men, Whites, persons with HIV infection attributed to MSM, and persons 55 years and older, had both first and last viral load tests suppressed or showed an improved status, compared with their counterparts (i.e., women, race/ethnic groups other than White, transmission categories other than MSM, and persons younger than 55 years old, all  $P < 0.05$ ). Conversely, a lower percentage of men, Whites, MSM, and persons 55 years and older, had a worsened status or had both first and last viral load tests unsuppressed, compared with their counterparts (all  $P < 0.05$ ). Persons with HIV infection diagnosed in 2013 were less likely to have both first and last viral load tests suppressed but were more likely to show an improved viral suppression status when compared to persons with HIV infection diagnosed prior to 2013 (all  $P < 0.05$ ). Both groups were similar regarding the percentages of persons who showed a worsened status and who had first and last viral load tests unsuppressed. The pattern of changes in viral suppression status is consistent with the overall findings for those who had two, three, and four viral load tests. Compared with these three groups, the five and more viral load tests group had a lower proportion of persons with first and last viral load tests suppressed.

Among 92 309 persons who were excluded from the matched-pairs analysis because of having only one viral load test in 2014, 69 960 (75.8%) had viral suppression on their single viral load test in 2014. Of those 69 960 persons, 53 834 (76.9%) also had a suppressed viral load at their last test in 2013 and the time interval between the last viral load test in 2013 and the sole viral load test in 2014 was, on average, 9.15 months (median = 9 months, interquartile range, 6–12 months).

## Discussion

National surveillance data showed that three-fourth of persons who received regular HIV care (i.e., had at least two viral loads in 2014) had their first and last viral load tests suppressed during the calendar year. More than twice as many persons showed an improving than worsening viral suppression status and this pattern was consistent across the sex, race/ethnicity, transmission category, and age groups. The pattern of changes in viral suppression status in our findings is consistent to the pattern previously reported in a clinic cohort study [1]. Although these findings are encouraging, approximately one in 10 persons in regular HIV care nationally did not achieve viral suppression on their first and last viral load tests during the calendar year of 2014. Previous studies have shown that those who were in HIV care but not virally

**Table 2. Changes in viral suppression status during 2014 among persons aged at least 13 years with HIV infection diagnosed at year-end 2013, alive through 2014, and in HIV care, by selected characteristics, 33 US jurisdictions.**

Characteristics	All persons who had at least two VLs in 2014 N	First and last VL tests suppressed		VL status improved		VL status worsened		First and last VL tests unsuppressed	
		N	%	N	%	N	%	N	%
Total	339 515	256 176	75.5	35 665	10.5	14 172	4.2	33 502	9.9
Sex									
Male (referent)	260 249	200 212	76.9	26 499	10.2	10 350	4.0	23 188	8.9
Female	79 266	55 964	70.6	9 166	11.6	3 822	4.8	10 314	13.0
Race/ethnicity									
Black/African-American	135 008	91 734	67.9	17 320	12.8	7 018	5.2	18 936	14.0
Hispanic/Latino	76 248	58 576	76.8	7 786	10.2	3 236	4.2	6 650	8.7
Other races	22 289	16 699	74.9	2 412	10.8	913	4.1	2 265	10.2
White (referent)	105 970	89 167	84.1	8 147	7.7	3 005	2.8	5 651	5.3
Transmission category									
MSM (referent)	170 999	135 322	79.1	16 454	9.6	6 027	3.5	13 196	7.7
Injection drug use-Male	19 922	14 205	71.3	2 266	11.4	1 073	5.4	2 378	11.9
Injection drug use-Female	13 300	8 898	66.9	1 630	12.3	793	6.0	1 979	14.9
MSM and injection drug use	19 820	13 882	70.0	2 416	12.2	1 100	5.5	2 422	12.2
Heterosexual contact-Male	16 826	12 237	72.7	1 924	11.4	795	4.7	1 870	11.1
Heterosexual contact-Female	40 478	29 268	72.3	4 506	11.1	1 788	4.4	4 916	12.1
Other	58 170	42 364	72.8	6 469	11.1	2 596	4.5	6 741	11.6
Age at the end of 2013									
13–24	14 634	7 929	54.2	2 766	18.9	895	6.1	3 044	20.8
25–34	48 293	31 350	64.9	7 325	15.2	2 378	4.9	7 240	15.0
35–44	73 332	53 060	72.4	8 693	11.9	3 171	4.3	8 408	11.5
45–54	119 063	92 704	77.9	11 144	9.4	4 942	4.2	10 273	8.6
≥55 (referent)	84 193	71 133	84.5	5 737	6.8	2 786	3.3	4 537	5.4
Diagnosis year									
Diagnosed in 2013	16 410	10 025	61.1	3 923	23.9	569	3.5	1 893	11.5
Diagnosed prior to 2013 (referent)	323 105	246 151	76.2	31 742	9.8	13 603	4.2	31 609	9.8
Number of VL tests in 2014									
2	136 422	108 095	79.2	8 923	6.5	5 205	3.8	14 199	10.4
3	112 574	88 443	78.6	10 658	9.5	4 391	3.9	9 082	8.1
4	58 257	42 329	72.7	8 119	13.9	2 580	4.4	5 229	9.0
5 or more (referent)	32 262	17 309	53.7	7 965	24.7	1 996	6.2	4 992	15.5

VL, viral load.

suppressed had a high level of cumulative plasma HIV burden that increases the risk of HIV transmission [2,3]. Additionally, 31.6% of 630 965 HIV-diagnosed persons did not have any viral load test in 2014 and were not considered in HIV care. Many of these persons may not have had a suppressed viral load. These findings highlight the need for intensified linkage and retention in care efforts to increase the number of patients who receive viral load testing and clinical intervention if needed.

Comparable to the percentage of persons who had first and last viral load tests suppressed, three-fourth of persons who received HIV medical care had their sole viral load test in 2014 suppressed. Of these, three in four persons also had a suppressed viral load at their last test in 2013 and the average interval between the two suppressed viral load tests was 9 months. We also found that the proportion of persons with all viral loads suppressed in 2014 decreased as the number of viral load tests increased in 2014, suggesting that patients who were sicker were monitored more often. In light of HIV treatment guidelines of testing viral load less often among those who have been

shown to be adherent to HIV medication and have suppressed viral load [6], our finding provides additional evidence that some patients who have less frequent care visits have achieved and sustained viral suppression. Future studies that examine sustained viral suppression using longitudinal data may consider including data from patients with only one viral load test in a calendar year.

Limitations of this analysis warrant comment. First, receipt of HIV care was measured by documentation of having viral load tests performed during 2014. Having a viral load test does not necessarily mean that the person actually received appropriate medical care. Although NHSS does not collect patient-level data on antiretroviral therapy and clinic attendance to verify individual treatment and care status, the ultimate health outcome is viral suppression, which has been continuously monitored in NHSS. Second, we used data from 33 jurisdictions with complete reporting of viral load data. Persons whose latest address on record was in the 33 jurisdictions but who moved outside of these areas were excluded from this analysis.

In conclusion, the majority of patients in HIV care during 2014 were durably suppressed. Three-quarters had their first and last viral load tests suppressed and more showed an improved than worsened viral suppression status. Some patients who have less frequent care visits have achieved and sustained viral suppression. Yet one in 10 did not have a suppressed viral load in their first and last tests within a 12-month period, highlighting the need for clinical interventions to help those patients achieve and sustain viral suppression.

## Acknowledgements

Study concept: N.C.; study design: N.C., G.M., H.I.H.; data analysis: T.T.; data interpretation: all authors; drafting of manuscript: N.C.; revision of manuscript: all authors; final approval of manuscript: all authors.

The work was supported by the Division of HIV/AIDS Prevention at the US Centers for Disease Control and Prevention.

## Conflicts of interest

There are no conflicts of interest.

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