

Impact of Viral Load Monitoring on Retention and Viral Suppression: A Regression Discontinuity Analysis of South Africa’s National Laboratory Cohort

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Web Appendix 1. Analysis replicated using a viral load threshold of 400 copies/mL.

In some cases, South African providers may use the viral load value of 400 copies/mL as a threshold indicator for repeat viral load testing within 6-months. We replicated the methods of our primary analysis in a sub-analysis to compare repeat viral load testing within 6-months for viral load tests just below and just above 400 copies/mL, and the effect of repeat viral load testing on retention and suppression based on this threshold.

For this sub-analysis, we first identified the clinics in the 99th percentile of number of eligible viral load tests (4,375 lab results or more). For each clinic, we visually assessed histograms of viral load values for each test year. If there was bunching around 400, this clinic was assumed to have utilized a viral load test with a lower detectable limit (LDL) of 400 copies/mL. Lab tests from these clinics in the year in which they used 400 LDL were excluded from analyses. Only lab tests from the remaining clinics were used in the sub-analysis. This was to ensure no clinics that used a LDL of 400 copies/mL were included in the analysis, as in this case the viral load value is not a continuous variable across the threshold of 400 copies/mL.

Viral load Values of 0 were excluded, as these were often recoded from other values below the LDL. We additionally limited the analysis to viral load values less than 1,000 copies/mL in order to focus on the 400 copies/mL threshold. Data-driven CCT-bandwidths were selected for each outcome model.

Results of this sub analysis indicate repeat viral load testing within 6-months was more common overall than in the full sample, with a risk difference at the threshold of 6.1 percentage points (95% CI: 2.0%-10.0%) (Web Table 2). ITT effects were mostly similar to the primary analysis, although the negative risk difference was slightly greater for retention at 24-months, and a negative risk difference was found for retention and suppression at 18-months. Given the smaller sample size, estimates were less precise than the primary analysis with wider confidence intervals (Web Table 2).

Web Appendix 2. Sensitivity Analyses

In sensitivity analyses, we excluded patients' first viral load tests (as all first viral load tests, regardless of value, are supposed to be followed by a subsequent viral load test within 6-months) (Web Table 3). We tested for effect measure modification by stratifying our primary analysis by first recorded CD4 count (<50 versus 50-200 versus >200 cells) (Web Tables 4-6) and by clinic size (using quartiles) (Web Tables 7-10). We additionally replicated our analysis at the individual patient-level (allowing patients to enter the study only once), restricting to only first viral load tests (Web Table 11), as well as restricting to only second viral load tests (Web Table 12). We also repeated our primary analysis using bandwidths twice and one-half the size of the data-driven bandwidths (Web Tables 13-14). We additionally repeated our primary analysis using CCT bias-corrected estimates and confidence intervals, which are robust to "large" bandwidth choices (Web Table 15)

Finally, we tested the potential scenario of our CACE findings being overestimated if some patients could receive adherence counseling without receiving a repeat viral load (Web Table B16). We imagine a hypothetical scenario where for every person who had a repeat viral load test and adherence counseling, there is one person with only adherence counseling and no repeat viral load test. In this case, our first stage ITT effect would actually reflect 50% of the true population. We tested the impact of this scenario on our 12-month retention and suppression outcomes by multiplying our first stage ITT effect by 2 (i.e. 2 times as many patients actually received the intervention of viral load monitoring than were identified in our data).

We found little meaningful difference from our primary analysis in ITT effects when we used CCT bias-corrected estimates, restricted to only first or second viral loads, excluded first viral loads, restricted to viral load value range of 400-5,000 copies/mL, and used $\frac{1}{2}$ and 2 times the optimal bandwidth. Results were slightly attenuated when setting the bandwidth to 2 times the optimal bandwidth (Web Table 14), and slightly stronger with $\frac{1}{2}$ times the optimal bandwidth (Web Table 13). When we stratified by CD4 count, we found that the effect of repeat viral load testing on 12-month suppression, and combined 12-month suppression and retention was greater among patients with first CD4 counts < 50 cells and ≥ 200 cells compared to those with CD4 counts between 50-200 cells. (Web Tables 4-6). In addition, this stratified analysis revealed negative effects on combined 24-month suppression and retention for patients with first CD4 counts <50 cells, though results were imprecise with large confidence intervals. When stratifying by clinic size, effects for combined suppression and retention at 12-months were slightly larger for smaller clinics (first and second quartile) compared to larger clinics (third and fourth quartile), although wide confidence intervals indicate imprecise estimates (Web Tables 7-10). Finally, if 50% of patients receiving adherence counseling do not have a repeat viral load, we still see intensive viral monitoring targeted to patients with VL>1000 copies/mL increased the probability of being retained and virally suppressed at 12 months by 42.6 percentage points (Web Table 16).

Web Table 1. Demographic and Clinical Factors Just Above and Below the Eligibility Threshold of 400 copies/mL (n=61,024)

Characteristic	Just below 400 copies/mL	Just above 400 copies/mL	Risk/Mean Difference (95% CI)^a
Age (years)	36.37	35.87	0.5 (-1.4, 35.7)
Female (%)	62.7%	64.8%	2.1% (-1.9%, 6.1%)
Earliest CD4 Count	275.4	288.5	13.1 (-9.0, 35.3)
Days since entry to care	1,128.1	1,184.7	56.6 (-32.4, 145.6)
VL test year			
2013	22.8%	24.3%	1.5% (-3.3%, 6.2%)
2014	57.5%	57.4%	0.1% (-5.1%, 4.8%)
2015	19.9%	18.2%	1.7% (-5.5%, 2.2%)
Province ^b			
GP	50.1%	54.6%	4.5% (-1.1%, 10.0%)
KZ	49.9%	45.4%	-4.5% (-10.0%, 1.1%)
Clinic Size (patients/year)	7,546.0	7,670.1	124.1 (-248.5 to 496.7)

^aEstimates derived from separate local linear regression models for each covariate using data-driven optimal bandwidths and rectangular kernel.

^bOnly clinics from Gauteng and KwaZulu-Natal province included in 400 copies/mL threshold analysis

Web Table 2. HIV Outcomes Above and Below Threshold of 400 copies/mL (n=61,024)

Characteristic (%)	Just below 400 copies/mL	Just above 400 copies/mL	ITT Risk Difference ^a	Bandwidth (copies/mL)	CACE RD ^b [RD/ First Stage RD]
Repeat VL testing within 6-months (first stage RD)	32.1%	38.2%	6.1% (2.0%, 10.0%)	121.8	N/A
Retained at 12-months	74.3%	76.9%	2.6% (1.5%, 6.7%)	95.4	44.0% (-29.3%, 100%)
Retained at 18-months ^d	68.5%	67.2%	-1.3% (-5.7%, 3.1%)	117.6	-25.1% [-100.0%, 65.1%]
Retained at 24-months ^e	66.7%	64.0%	-2.7% (-8.4%, 3.0%)	104.6	-40.5% [-100.0%-57.1%]
Retained and suppressed at 12-months	56.4%	59.7%	3.3% (-1.2%, 7.8%)	102.4	65.7% (-36.7%, 100.0%]
Retained and suppressed at 18-months ^d	52.4%	50.2%	-2.2% (-7.2%, 2.7%)	108.7	-41.9% [-100.0%, 64.3%]
Retained and suppressed at 24-months ^e	47.7%	47.0%	-0.7% (-7.6%, 6.1%)	82.5	-8.6% (-85.9%, 68.7%)
Transferred clinics at least once	15.1%	15.2%	0.1% (-0.4%, 3.7%)	89.5	1.3% (-64.9%, 67.6%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters; CACE, complier average causal effect

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bComplier Average Causal Effect (CACE) estimates use outcome optimal bandwidth (not first stage bandwidth). CACE Risk Differences and 95% Confidence Intervals estimated using two-stage least squares regression. Square brackets are used where the CACE 95% CI exceeds the logical bounds of 1.0.

^cNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^d48,016 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^e32,821 VL values had at least 30-month follow-up time and were included in 24-month outcomes

Web Table 3. Excluding First Viral Load (VL) Tests: HIV Outcomes Above and Below Threshold of 1,000 copies/mL (n=114,227)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	29.0%	37.9%	8.9% (6.2%, 11.5%)
Retained at 12-months	71.7%	74.2%	2.5% (-0.2%, 5.2%)
Retained at 18-months ^c	67.0%	68.1%	1.1% (-1.7%, 3.8%)
Retained at 24-months ^d	65.0%	64.3%	-0.7% (-4.2%, 2.8%)
Retained and suppressed at 12-months	43.3%	47.4%	4.1% (0.9%, 7.2%)
Retained and suppressed at 18-months ^c	43.0%	44.6%	1.6% (-1.5%, 4.7%)
Retained and suppressed at 24-months ^d	44.0%	43.5%	-0.5% (-3.5%, 2.6%)
Transferred clinics at least once	20.0%	20.9%	0.9% (-1.5%, 3.3%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c89,699 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d67,191 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 4. Stratified by CD4 Count: HIV Outcomes Above and Below Threshold of 1,000 copies/mL for patients with first CD4 tests <50 cells (n=13,316)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	30.2%	37.1%	6.9% (0.05%, 13.7%)
Retained at 12-months	62.6%	70.6%	8.0% (-0.1%, 16.2%)
Retained at 18-months ^c	62.2%	68.9%	6.7% (-2.7%, 16.1%)
Retained at 24-months ^d	64.3%	55.9%	-8.4% (-21.3%, 4.6%)
Retained and suppressed at 12-months	39.6%	43.4%	3.8% (-4.2%, 11.9%)
Retained and suppressed at 18-months ^c	43.1%	44.1%	1.0% (8.8%, 10.9%)
Retained and suppressed at 24-months ^d	52.3%	41.9%	-10.4% (-23.3%, 2.6%)
Transferred clinics at least once	23.3%	21.3%	-2.0% (-9.2%, 5.1%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c10,906 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d8,402 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 5. Stratified by CD4 Count: HIV Outcomes Above and Below Threshold of 1,000 copies/mL for patients with first CD4 tests 50-200 cells (n=188,788)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	27.8%	9.6%	37.4% (5.9%, 13.3%)
Retained at 12-months	70.8%	71.1%	0.3% (-3.7%, 4.4%)
Retained at 18-months ^c	64.1%	65.0%	0.9% (-3.5%, 5.3%)
Retained at 24-months ^d	59.6%	57.7%	-1.9% (-6.5%, 2.8%)
Retained and suppressed at 12-months	43.0%	45.8%	2.8% (-1.7%, 7.3%)
Retained and suppressed at 18-months ^c	39.3%	42.6%	3.3% (-1.3%, 7.8%)
Retained and suppressed at 24-months ^d	39.4%	39.5%	0.1% (-4.6%, 4.7%)
Transferred clinics at least once	20.4%	21.9%	1.5% (-1.7%, 4.6%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^b47,036 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^c35,916 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 6. Stratified by CD4 Count: HIV Outcomes Above and Below Threshold of 1,000 copies/mL for patients with first CD4 tests ≥ 200 cells (n=120,684)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	23.4%	30.4%	7.0% (4.6%, 9.4%)
Retained at 12-months	58.0%	61.6%	3.6% (1.0%, 6.2%)
Retained at 18-months ^c	54.9%	56.9%	1.9% (-1.0%, 4.9%)
Retained at 24-months ^d	51.9%	52.7%	0.8% (2.4%, 4.1%)
Retained and suppressed at 12-months	33.0%	38.5%	5.5% (2.6%, 8.4%)
Retained and suppressed at 18-months ^c	34.2%	35.6%	1.4% (-1.7%, 4.5%)
Retained and suppressed at 24-months ^d	33.0%	34.1%	1.1% (-2.3%, 4.5%)
Transferred clinics at least once	17.5%	17.3%	-0.2% (-2.3%, 2.0%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c93,761 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d69,299 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 7. Stratified by Clinic Size (Quartiles): HIV Outcomes Above and Below Threshold of 1,000 copies/mL for clinics in the first size quartile (<659 patients/year) (n=47,822)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	19.1%	24.4%	5.3% (1.6%, 9.0%)
Retained at 12-months	61.8%	63.7%	2.9% (-1.8%, 5.6%)
Retained at 18-months ^c	58.1%	58.9%	0.8% (-3.5%, 5.1%)
Retained at 24-months ^d	53.4%	56.6%	3.2% (-1.5%, 7.8%)
Retained and suppressed at 12-months	32.4%	35.2%	2.8% (-1.0%, 6.6%)
Retained and suppressed at 18-months ^c	32.1%	34.1%	2.0% (2.1%, 6.1%)
Retained and suppressed at 24-months ^d	31.8%	34.7%	2.9% (1.5%, 7.2%)
Transferred clinics at least once	20.7%	22.3%	1.6% (-1.4%, 4.5%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c38,595 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d28,808 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 8. Stratified by Clinic Size (Quartiles): HIV Outcomes Above and Below Threshold of 1,000 copies/mL for clinics in the second size quartile (660-1,350 patients/year) (n=47,643)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	21.5%	27.1%	5.6% (2.3%, 8.8%)
Retained at 12-months	59.9%	66.3%	6.4% (1.3%, 11.5%)
Retained at 18-months ^c	58.6%	59.1%	0.5% (-0.5%, 5.8%)
Retained at 24-months ^d	53.6%	51.4%	-2.2% (-7.5%, 3.1%)
Retained and suppressed at 12-months	35.7%	42.8%	7.1% (2.4%, 11.8%)
Retained and suppressed at 18-months ^c	37.6%	38.6%	1.0% (-3.8%, 5.7%)
Retained and suppressed at 24-months ^d	36.2%	38.1%	1.9% (-2.6%, 6.5%)
Transferred clinics at least once	17.7%	18.5%	0.8% (-2.6%, 4.3%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c38,391 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d28,828 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 9. Stratified by Clinic Size (Quartiles): HIV Outcomes Above and Below Threshold of 1,000 copies/mL for clinics in the third size quartile (1,351-2,834 patients/year) (n=47,712)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	26.8%	35.3%	8.4% (4.7%, 12.1%)
Retained at 12-months	63.0%	64.8%	1.8% (-2.0%, 5.6%)
Retained at 18-months ^c	61.5%	60.3%	-1.2% (5.5%, 3.0%)
Retained at 24-months ^d	58.9%	54.9%	-4.5% (-9.4%, 0.4%)
Retained and suppressed at 12-months	39.6%	42.5%	2.9% (-1.4%, 7.1%)
Retained and suppressed at 18-months ^c	39.8%	40.5%	0.7% (-4.3%, 5.7%)
Retained and suppressed at 24-months ^d	42.2%	37.1%	-5.0% (10.5%, 0.4%)
Transferred clinics at least once	17.7%	16.9%	0.8% (-4.1%, 2.6%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c37,982 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d28,442 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 10. Stratified by Clinic Size (Quartiles): HIV Outcomes Above and Below Threshold of 1,000 copies/mL for clinics in the fourth size quartile (2,835-25,477 patients/year) (n=47,677)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months (first stage RD)	33.4%	44.7%	11.3% (7.3%, 15.3%)
Retained at 12-months	60.3%	62.9%	2.6% (-0.9%, 6.1%)
Retained at 18-months ^c	55.9%	60.7%	4.8% (-.5%, 9.2%)
Retained at 24-months ^d	54.6%	56.8%	2.2% (-2.9%, 7.4%)
Retained and suppressed at 12-months	38.0%	41.2%	3.2% (-1.4%, 7.8%)
Retained and suppressed at 18-months ^c	35.6%	41.9%	6.2% (1.7%, 10.7%)
Retained and suppressed at 24-months ^d	36.5%	39.5%	3.0% (2.0%, 7.9%)
Transferred clinics at least once	18.1%	19.4%	1.3% (-2.1%, 4.6%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c35,967 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d26,899 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 11. Replicated at the Person-level (First viral loads only): HIV Outcomes Above and Below Threshold of 1,000 copies/mL (n=77,537)

Characteristic (%)	First VL Just below 1,000 copies/mL	First VL Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months of first VL (first stage RD)	19.1%	25.5%	6.4% (3.5%, 9.3%)
Retained at 12-months	48.6%	51.6%	3.0% (-0.7%, 6.8%)
Retained at 18-months ^b	46.3%	47.9%	1.6% (-2.3%, 5.6%)
Retained at 24-months ^c	41.6%	41.1%	-0.5% (-4.9%, 4.0%)
Retained and suppressed at 12-months	25.7%	31.9%	6.2% (2.6%, 9.8%)
Retained and suppressed at 18-months ^b	26.8%	29.4%	2.6% (-1.0%, 6.2%)
Retained and suppressed at 24-months ^c	26.3%	26.9%	0.6% (-3.4%, 4.5%)
Transferred clinics at least once	16.9%	16.3%	-0.6% (-3.1%, 1.8%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c62,004 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d46,426 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 12. Replicated at the Person-level (Second viral loads only): Retention and Suppression Outcomes Above and Below Threshold of 1,000 copies/mL (n=34,395)

Characteristic (%)	First VL Just below 1,000 copies/mL	First VL Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months of first VL (first stage RD)	23.9%	31.5%	7.6% (3.1%, 12.2%)
Retained at 12-months	66.3%	69.5%	3.2% (-0.8%, 7.2%)
Retained at 18-months ^b	61.4%	65.3%	3.9% (-1.4%, 9.3%)
Retained at 24-months ^c	59.7%	59.4%	-0.3% (-6.7%, 6.1%)
Retained and suppressed at 12-months	40.2%	44.6%	4.4% (-0.3%, 9.1%)
Retained and suppressed at 18-months ^b	40.0%	45.0%	5.0% (-0.8%, 10.7%)
Retained and suppressed at 24-months ^c	39.3%	41.8%	2.4% (-4.3%, 9.2%)
Transferred clinics at least once	19.0%	22.0%	3.0% (-1.2%, 7.1%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c27,363 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d20,421 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 13. Replicated With ½ Optimal Bandwidth: HIV Outcomes Above and Below Threshold of 1,000 copies/mL (n=191,764)

Characteristic (%)	First VL Just below 1,000 copies/mL	First VL Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months of first VL (first stage RD)	25.5%	32.3%	6.8% (4.3%, 9.4%)
Retained at 12-months	61.5%	65.5%	4.1% (0.8%, 7.3%)
Retained at 18-months ^b	57.6%	58.4%	0.8% (-2.6%, 4.2%)
Retained at 24-months ^c	55.1%	52.9%	-2.2% (-6.0%, 1.5%)
Retained and suppressed at 12-months	36.3%	39.9%	3.6% (1.6%, 5.5%)
Retained and suppressed at 18-months ^b	36.4%	38.1%	1.7% (-1.8%, 5.2%)
Retained and suppressed at 24-months ^c	36.6%	34.7%	-1.8% (-5.3%, 1.6%)
Transferred clinics at least once	18.0%	18.7%	0.7% (-1.7%, 3.2%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c151,703 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d113,617 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 14. Replicated With 2x Optimal Bandwidth: HIV Outcomes Above and Below Threshold of 1,000 copies/mL (n=191,764)

Characteristic (%)	First VL Just below 1,000 copies/mL	First VL Just above 1,000 copies/mL	ITT Risk Difference ^a
Repeat VL testing within 6-months of first VL (first stage RD)	25.1%	33.6%	8.5% (7.3%, 9.8%)
Retained at 12-months	62.4%	64.3%	1.9% (0.3%, 3.6%)
Retained at 18-months ^b	58.8%	59.7%	0.9% (-0.8%, 2.6%)
Retained at 24-months ^c	55.3%	55.7%	0.4% (-1.4%, 2.3%)
Retained and suppressed at 12-months	36.3%	39.9%	3.6% (1.6%, 5.5%)
Retained and suppressed at 18-months ^b	37.3%	38.2%	0.9% (-0.7%, 2.7%)
Retained and suppressed at 24-months ^c	36.6%	36.7%	0.1% (-1.6%, 1.8%)
Transferred clinics at least once	19.2%	19.5%	0.3% (-0.9%, 1.5%)

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between VL tests just above 1,000 cells/mL and VL tests just below 1,000 cells/mL. Data driven CCT-bandwidth obtained using rdrobust package in STATA.

^bNegative outcome is having a VL test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no VL test in specified time interval.

^c151,703 VL values had at least 24-month follow-up time and were included in 18-month outcomes

^d113,617 VL values had at least 30-months follow-up time and were included in 24-month outcomes

Web Table 15. HIV-Related Outcomes for Patients with an Elevated Viral Load in South Africa Comparing those Above and Below Threshold of 1,000 copies/mL using Bias-Corrected Estimates (n=191,764)

Characteristic (%)	Just below 1,000 copies/mL	Just above 1,000 copies/mL	ITT Risk Difference using CCT bias-correction ^a	Bandwidth (copies/mL)
Repeat viral load testing within 6-months (first stage RD)	24.8%	32.8%	8.4% (6.2%, 10.3%)	197.6
Retained at 12-months	62.1%	65.0%	2.8% (0.3%, 5.6%)	136.0
Retained at 18-months ^d	58.5%	60.0%	1.2% (-1.6%, 4.1%)	161.9
Retained at 24-months ^e	54.7%	54.6%	-0.2% (-2.9%, 2.4%)	183.4
Retained and suppressed at 12-months	35.8%	41.6%	5.4% (2.8%, 9.1%)	93.7
Retained and suppressed at 18-months ^d	36.3%	38.5%	2.0% (-1.0%, 4.8%)	150.6
Retained and suppressed at 24-months ^e	36.6%	36.7%	0.2% (-2.2%, 2.7%)	202.2
Transferred clinics at least once	18.6%	18.9%	0.1% (-2.0%, 2.1%)	152.4

Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters;

^aDifference between viral load tests just above 1,000 cells/mL and viral load tests just below 1,000 cells/mL. Data driven Calonico, Cattaneo and Titiunik (CCT) bandwidth and bias-correction obtained using rdrobust package in STATA.

^cNegative outcome is having a viral load test in specified time interval that is ≥ 400 copies/mL. Excludes patients with no viral load test in specified time interval.

^d151,703 viral load values had at least 24-month follow-up time and were included in 18-month outcomes.

^e113,617 viral load values had at least 30-months follow-up time and were included in 24-month outcomes.

RD is risk difference. First stage risk difference represents the risk difference in repeat testing within 6-months for viral loads just above and just below 1,000 copies/mL.

Web Table 16. Multiplying our first stage RD by 2 to assess potential overestimation of CACE RD (n=191,764)

Characteristic (%)	ITT Risk Difference ^a	Bandwidth (copies/mL)	CACE Risk Difference ^b [RD/ (first stage RDx2)]
Retained at 12-months	2.9% (0.6%, 5.2%)	136.0	19.0%
Retained and suppressed at 12-months	5.8% (3.0%, 8.6%)	93.7	42.6%

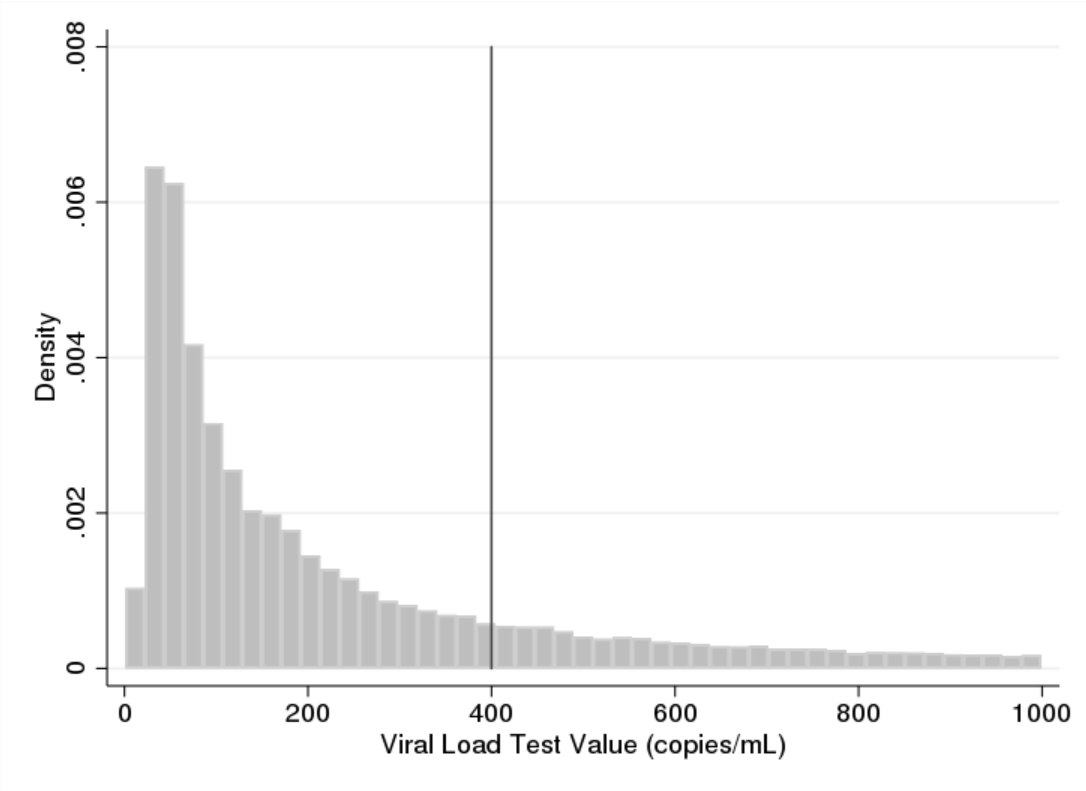
Abbreviations: RD, risk difference; CI, confidence interval; mL, milliliters; CACE, complier average causal effect

^aDifference between viral load tests just above 1,000 cells/mL and viral load tests just below 1,000 cells/mL. Data driven Calonico, Cattaneo and Titiunik (CCT) bandwidth obtained using rdrobust package in STATA.

^bComplier Average Causal Effect (CACE) estimates use outcome optimal bandwidth (not first stage bandwidth). CACE Risk Differences estimated by dividing the ITT risk difference by the first stage risk difference multiplied by two.

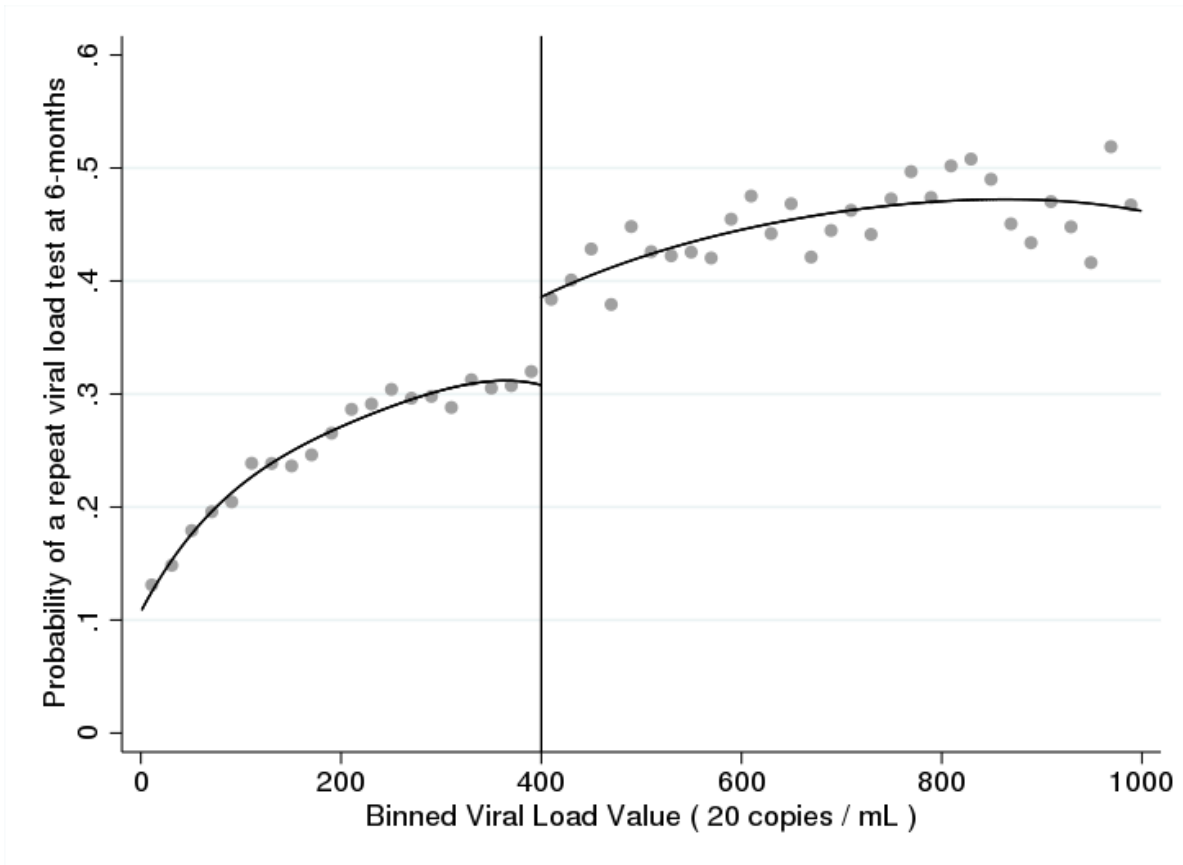
RD is risk difference. First stage risk difference represents the risk difference in repeat testing within 6-months for viral loads just above and just below 1,000 copies/mL.

Web Figure 1. Histogram of Viral Load Values with Threshold of 400 copies/mL



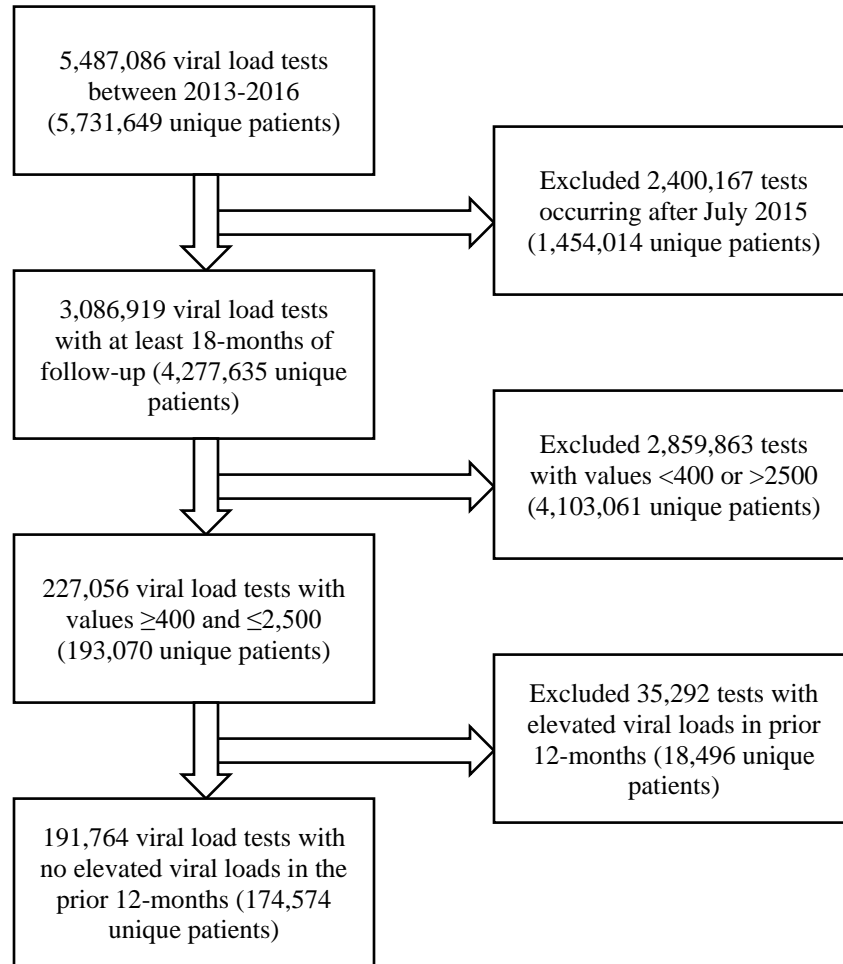
Plotted histogram of viral load lab test values to check for bunching on either side of the 400 copies/mL threshold. Lack of bunching around threshold suggests patients and providers did not systematically manipulate the assignment variable (viral load values) (n=61,024).

Web Figure 2. Probability of a repeat viral load within 6-months with viral load value threshold of 400 copies/mL



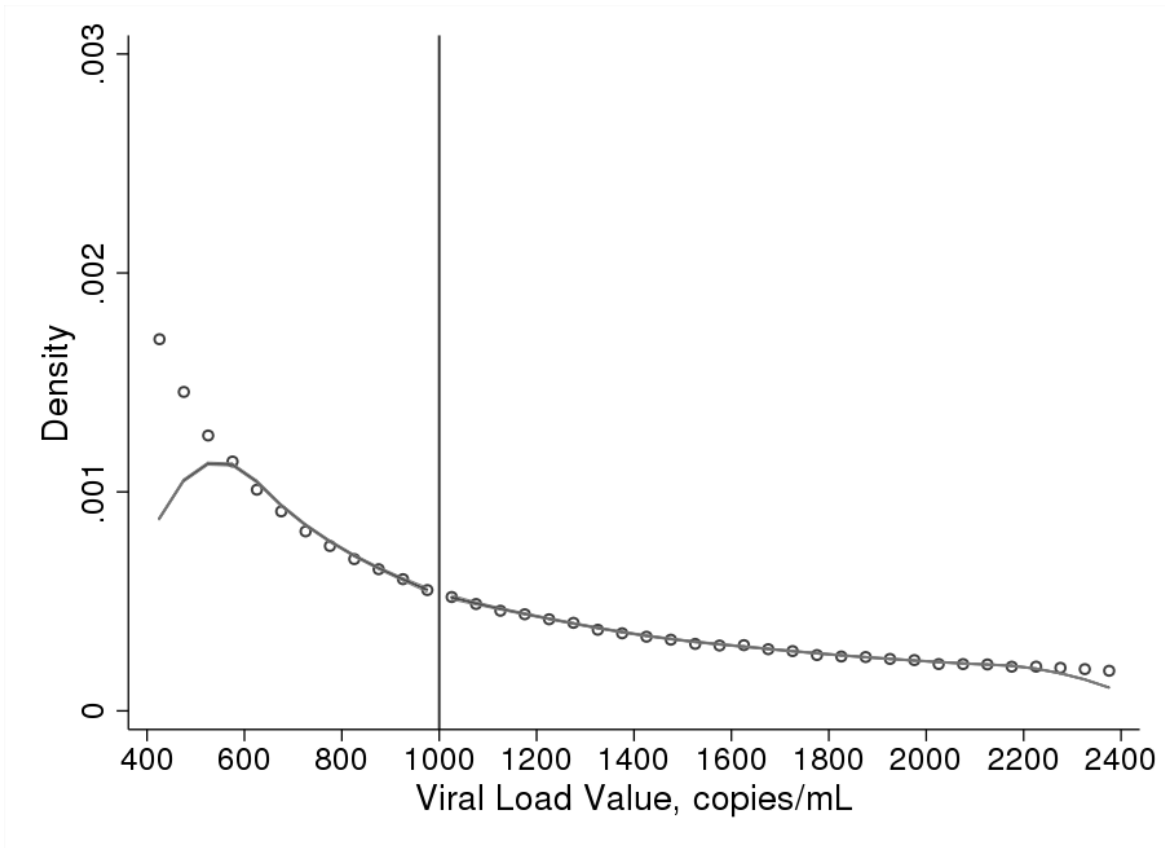
Probability of receiving a repeat VL within 6-months based on viral load values. Risk difference (RD) estimated using local linear regression model with a data-driven optimal bandwidth of 121.8 copies/mL. The RD at the threshold of 400 copies/mL is 6.1 percentage points (95% CI: 2.0 to 10.0).

Web Figure 3. Flowchart of viral load exclusions



Flowchart of inclusion and exclusion criteria for the sample of viral loads used as the units of observation in this analysis. The final sample includes 174,574 unique patients who contribute 191,764 separate “first” viral loads that are the units of analysis, and a total of 533,676 viral tests when including follow-up tests of interest.

Web Figure 4. McCrary Density Test



Plotted density of the binned viral load values (bins of 50 copies/mL), created using the STATA package DCdensity. If there is a density discontinuity at the threshold of 1,000 copies/mL, this suggests systematic manipulation of the assignment variable. The log-difference at the threshold is 0.1 (95% CI: -0.03, 0.04). There does not appear to be manipulation of the assignment variable viral load.