

The impact of short message service reminders on returning to test for HIV
at a community center in Seattle, WA

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Abstract

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Objectives: Using data from Gay City, a community testing center in Seattle, we assessed the impact of short message service (SMS) text reminders on returning for a second HIV test. In addition, we investigated whether certain client characteristics were associated with return.

Methods: We evaluated data on HIV testing between September 2016 and December 2019. Clients who tested at least once and provided a phone number are included in analyses, and all clients could opt to receive SMS text reminders at three or six months after first test. Poisson regression models were constructed to identify correlates of returning for a second HIV test and to assess the impact of SMS reminders on returning to test.

Results: During the period of study, 5,458 clients tested non-anonymously at Gay City. Of these, 1,463 (27.3%) returned for a second HIV test. Participants were less likely to return if they identified as cisgender women (adjusted relative risk [aRR]=0.17; 0.05, 0.53) or gender non-conforming (aRR=0.34; 0.20, 0.56), when compared to cisgender men, or if they identified as bisexual (aRR=0.76; 0.64, 0.90) or straight (aRR=0.38; 0.24, 0.61), when compared to gay clients. At first visit, 1,086 clients opted to receive an SMS reminder (20.8%) for subsequent testing. Of those who received reminders, 30.8% returned for an HIV test in the study period compared to 26.4% of those who did not opt to receive SMS reminders (aRR=1.02; 0.97, 1.09).

Conclusion: Few clients returned for a second HIV test during the period of study, and no association between SMS reminders and return was observed. Returning to test was not uniform, with some sexual and gender identities less likely to return in the period of study.

Background

In 2016, an estimated 1.1 million people in the United States (US) were living with the human immunodeficiency virus (HIV), and of these, one in seven were not aware of their infection.¹ HIV incidence is not evenly distributed among the US population. In 2018, more than half of all new diagnoses occurred in individuals under the age of 35, and 69% occurred in gay, bisexual, and other men who have sex with men (MSM).¹ Transgender and gender non-conforming individuals also experience disproportionately high incidence of HIV, although fewer analyses have been conducted on these groups.²⁻⁴ Early detection of HIV is important to an individual's health and to prevent transmission to others. Treatment that occurs early in the course of an HIV infection has increased immunologic benefit, which is associated with less severe disease outcomes. In addition, individuals who achieve viral suppression are unable to transmit HIV to others.⁵⁻⁸

The US Centers for Disease Control and Prevention (CDC) and US Preventive Services Task Force both recommend that all persons be screened for HIV at least once in their lives, and the CDC suggests that some individuals at higher risk for HIV acquisition, including MSM, be screened at least annually.^{6,9,10} Screening every three or six months is recommended in various communities based on behavioral factors associated with increased HIV acquisition risk, use of pre-exposure prophylaxis (PrEP), and local epidemiology.¹⁰⁻¹² In Seattle and King County, MSM and transgender and non-binary persons are recommended to test every three months if they report behaviors associated with increased risk of HIV acquisition, such as having ten or more sexual partners, being diagnosed with a bacterial sexually transmitted infection (STI), or using methamphetamine in the past year.^{13,14}

Despite recommendations for frequent HIV screening, some individuals face barriers to initiating or maintaining routine testing. These include not feeling at risk of infection, not knowing where to receive specialized care, internalized HIV-related stigma, and anticipated HIV-related

stigma.^{15–18} Some testing centers have turned to short message service (SMS) reminders as a way to provide positive encouragement and reinforce testing at recommended intervals.^{15,19–21} Prior research has found SMS reminders effective for increasing knowledge of modes of HIV transmission, antiretroviral treatment (ART) adherence, and attendance at scheduled ART appointments.^{21–24} Given that 95% of adults in the US own a cell phone, many testing centers view SMS reminders as a feasible tool to normalize routine testing and ensure client return.^{20,22,25–27} However, studies of SMS reminders' impacts on improving routine HIV testing have yielded mixed results, with moderate benefit observed in several but not all settings.^{19,22,24–26,28–30}

Understanding what drives routine testing can inform programmatic efforts to support regular HIV tests, especially for subpopulations who report behaviors or experience structural inequities that are associated with greater risk of HIV acquisition.^{13,31–33} This analysis investigates whether those who received an SMS reminder after their initial visit were more likely to return to test at Gay City, a lesbian, gay, bisexual, transgender, and queer (LGBTQ) community center in Seattle. In addition, demographic, behavioral, and clinical characteristics associated with returning for a second HIV test were assessed.

Methods

Study design and population

This retrospective cohort study includes data from individuals who utilized HIV testing services at Gay City, a community-based HIV testing center in Seattle. Gay City is located in the heart of Seattle's historically LGBTQ neighborhood and offers free HIV and STI testing at local events and at four primary locations: the wellness center, a nearby thrift store, and two local bathhouses. Testing at the wellness center is by appointment only and available to individuals who identify as transgender, gender non-binary, two spirit, or men who report having sex with

men. Walk-up appointments are available at other locations and community events and are not limited to individuals of particular sexual or gender identities. Starting in September of 2016, Gay City initiated an opt-in SMS reminder program. When filling out post-visit contact forms, clients responded to the prompt, “*Send me a one-time reminder to get tested in...*” by selecting three months, six months, both, or neither. Gay City staff recorded these requests in an SMS reminder program and not in medical records. For analyses, SMS reminders were limited to those that were recorded as successfully sent within six months of a client’s first visit in the study period. The six-month cutoff was used to avoid inclusion of reminders associated with later visits. This analysis utilized data from clients who tested for HIV between September 1st, 2016 and December 31st, 2019 at any of the locations or events. Client visits were included in analyses if: 1) a valid chart number, date of visit, and 10-digit phone number were recorded; 2) an HIV test was performed and the initial test during the period of study was negative; and 3) the first visit by each client occurred before October 2, 2019, allowing at least 90 days of study follow-up (Figure 1). All visit records from the same client were compiled and matched to SMS reminder records using phone numbers as unique client identifiers.

Data collection and variable definitions

Clients completed self-administered paper or computer-based surveys on demographic, behavioral, and clinical characteristics before each testing appointment. The survey was updated in July 2018, when some questions were adapted to be more inclusive or approachable and others were omitted. The methods of categorizing data for analysis across the time period of study are described below for select factors.

Options for gender identity initially included male, female, transgender male, and transgender female. Starting in July 2018, options included gender non-conforming, non-binary, transgender male, transgender female, cisgender male, cisgender female, trans feminine, and trans

masculine. With the new question format, clients were also able to select all gender identity options that applied and write in additional identities. For this analysis, cisgender clients are those who identified as cisgender, or as only male or female without specifying their identity further. Any individuals who selected gender non-conforming or non-binary were categorized as such, regardless of any additional identities selected. Sexual orientation was ascertained by asking clients if they identified as lesbian, gay, bisexual, queer, or straight, with the option to write in additional identities. In July 2018, pansexual was added to the list above. Race and ethnicity were ascertained by allowing clients to check all identities that applied. For this analysis, individuals who selected more than one identity were categorized as having multiple racial or ethnic identities. Education was assessed as the highest level completed, and place of residence was determined based on client self-reported ZIP code.

Clients were asked whether they had ever been diagnosed with chlamydia, gonorrhea, or syphilis, and if they responded in the affirmative, they were asked when the most recent diagnosis occurred. STI diagnosis in the last twelve months was categorized from the difference between last diagnosis and date of initial HIV test, and individuals who did not report a year of last diagnosis were categorized as missing. Data on month and year of last diagnosis were available for most, and the specific date of diagnosis was imputed as the 15th of the reported month. For those who provided only a year, the date was imputed as June 15th. Use of methamphetamine, poppers, and heroin in the last twelve months were categorized using the same approach as that used for STIs. Ascertainment of PrEP use changed over time as follows: clients were asked if they had ever used PrEP from the beginning of the study period to July 2018, PrEP use was not assessed between July 2018 and April 2019, and clients were asked about PrEP use in the prior twelve months beginning in April 2019 on. Similarly, condomless sex measures changed during the study as follows: a series of questions regarding condomless sex were asked between study initiation and July 2018, no comparable question was asked

from July 2018 to March 2019, and condomless sex in the last twelve months was assessed beginning in March 2019. Clients were asked about the number of sex partners in the past year and for this analysis were categorized by whether they reported ten or more sexual partners to be consistent with local testing recommendations.^{13,14}

Prior work among MSM in Seattle identified factors associated with increased risk of HIV acquisition.^{13,34} Based on these data and local guidelines, Gay City has established criteria for PrEP initiation, which include all men and transgender persons who have sex with men who report any of the following in the last twelve months: a bacterial STI diagnosis (gonorrhea, chlamydia or syphilis), methamphetamine use, ten or more sexual partners, or condomless sex with a person of positive or unknown HIV status.³⁵ Due to modifications in data collection described above, information was not available for all components; therefore, this analysis used a modified version of these criteria to classify individuals as potentially eligible to initiate PrEP. Clients met modified criteria if they were transgender, a man, or both and reported one or more of the following in the last twelve months: a bacterial STI diagnosis (gonorrhea, chlamydia or syphilis), methamphetamine use, or ten or more sexual partners.

Statistical analysis

Descriptive statistics were used to summarize client characteristics. Categorical variables were reported as counts and percentages, and continuous variables were reported as medians and interquartile (IQR) ranges. The baseline visit was defined as the first visit in the study period. For each baseline characteristic, the association with return for a subsequent HIV test was assessed using Poisson regression models with the log-link function. Poisson regression was chosen to approximate relative risk (RR), as returning for a second test did not satisfy the rare outcome assumption necessary to approximate RRs using odds ratios from logistic regression. Sandwich robust standard errors were used to calculate confidence intervals (CIs).³⁶

Multivariable correlates analyses included characteristics identified in prior literature as being associated with return for a second test (age, sexual orientation, education level, housing status, whether client had a prior HIV test, whether client sees a healthcare provider regularly). In addition, factors hypothesized to influence return for testing at Gay City (testing location, whether client met modified PrEP criteria) and characteristics associated with return in unadjusted models – but not correlated with a factor already included in the model – were included in analyses (gender identity and place of residence; p -value < 0.05).

To address missing values of covariates, multivariate imputation by chained equations (MICE) was employed. Missing covariate values were conditioned on variables with complete observations, relaxing the assumption that data were missing completely at random. The use of imputed data also bolstered study power over what would be available through a complete cases analysis.³⁷ All factors from the multivariable correlates analysis were included in MICE models, as were duration until return and whether an SMS reminder was sent. The “mice” package in R was used to impute ten datasets.^{38,39} Distributions of imputed variables did not differ meaningfully from observed values, and qualitative assessment of convergence plots found models successfully converged.

To assess SMS reminders’ impact on returning for an HIV test, analyses focused on the durations between tests recommended for individuals at high risk of HIV acquisition: three to four months and six to seven months.^{10,11,14} HIV tests that occurred within 42 days of the baseline test were excluded as they may have been confirmatory and related to the first visit. The proportion of clients who ever returned for a second HIV test during the study period was calculated, stratified by whether the client opted to receive SMS reminders. In addition, the proportion of clients returning at specific intervals was assessed; intervals included less than

three months, three to four months, four to six months, six to seven months, and seven or more months.

The relative risk (RR) of returning was estimated, comparing those who received SMS reminders to those who did not. Results are presented as RRs and 95% confidence intervals. Multivariable models controlled for characteristics included in the adjusted correlates analyses of returning to test. Poisson models for all ten imputed datasets were constructed using the `glm.mids` function in R, and estimates from each imputed dataset were pooled using Rubin's Rules.³⁸ With imputed data, the analysis was sufficiently powered ($\beta=0.80$) to observe a minimum RR of 1.09, or 0.92, for returning ever in the study period.⁴⁰ All analyses were performed using R: A language and environment for statistical computing.³⁹ The University of Washington Human Subjects Division approved this study's protocol without the requirement of participant informed consent.

Results

During the study period, there were 11,908 visits to Gay City's testing locations by clients who chose not to test anonymously (Figure 1). Visits that did not have a date, record number, or phone number recorded or that did not feature an HIV test were excluded ($n=3,056$), as were clients who had a positive HIV test during their first visit ($n=41$). For the 5,458 clients included in analyses, characteristics at first HIV test are summarized in Tables 1 and 2. Clients predominantly identified as cisgender male, gay, non-Hispanic white, and under the age of 35. A large proportion of clients reported completing a college degree or higher, residing in Seattle, having health insurance, and having had a prior HIV test. Of the total study sample, 27.3% returned for one or more additional HIV tests during the study period ($n=1,463$).

Individuals were less likely to return for a second visit if they reported residence outside Seattle, not seeing a healthcare provider regularly, or testing at a community event, when compared to testing at the wellness center (Tables 1 and 2). Additionally, clients were less likely to return if they identified as cisgender women (7.5%) or gender non-conforming (13.5%), when compared to cisgender men (29.3%), or if they identified as bisexual (19.9%) or straight (8.9%), when compared to gay individuals (31.3%). Finally, those who did not meet modified PrEP criteria (30.0%) were less likely to return than those who did (34.2%). Not having had a prior HIV test and being homeless were negatively associated with return in unadjusted models, but the associations were not significant in adjusted analyses. Race and ethnicity, gonorrhea diagnosis, and syphilis diagnosis were not associated with return in unadjusted models.

In total, 20.8% of study clients received an SMS reminder (n=1,086; Table 3). Between three and four months of first visit, 6.4% of those who received a reminder returned for a second visit, compared to 5.4% of those who did not receive a reminder (adjusted relative risk [aRR]=1.16; 0.88, 1.52). Within seven months of first visit, 25.1% of those who received a reminder and 23.5% of those without a reminder had returned (aRR=1.04; 0.90, 1.19). During the entire study period, 30.8% of those with a reminder and 27.3% of those without a reminder returned for at least one additional HIV test (aRR=1.02; 0.97, 1.09; Table 4).

Discussion

Among clients seeking HIV testing services at an LGBTQ center and community events, most did not return for a second HIV test. Clients who met modified criteria to initiate PrEP and who regularly saw a healthcare provider were more likely to return, while bisexual and straight individuals were observed as less likely to test, in comparison to gay clients. When considering gender identities, gender non-conforming individuals were observed as less likely to return for testing than cisgender male clients. A higher proportion of individuals who received reminders

returned for testing in the study period, as well as specifically within seven months of their first test; however, these differences were not statistically significant. Ultimately, no association between SMS reminders and returning for testing was observed.

The finding that SMS reminders had no impact on return for testing is consistent with results of some previous research.^{19,25,41} In a recent study of MSM in King County, investigators observed a non-significant trend between receiving SMS reminders and shorter durations since last reported HIV test.²⁵ In addition, a pilot study observed no association between mobile “buzzing” reminders and HIV retesting in rural Swaziland.⁴¹ However, other studies have observed positive associations in additional settings.^{24,26,30,42,43} Australian investigators found SMS reminders increased HIV and STI retesting rates, while two interventional studies have found that SMS reminders and health promotion messages improved the probability of reporting a recent HIV test.^{24,26,42}

Much of prior research focused on testing among predominantly white MSM. A strength of this study is the inclusion of various genders, sexual orientations, and races, which provides findings applicable to a wider population of testing clientele. Risk of HIV acquisition is heterogeneous and depends on behavioral and contextual factors.^{1,9,13,16,17,33} With many identities included in the study sample, this analysis finds that returning for testing also differs widely by subgroup. Our study should be interpreted in the context of several limitations. Foremost, the observational nature of this study may have permitted unmeasured confounders to bias findings. In addition, changes to data collection at Gay City affected covariate definitions over time, and results may be impacted by misclassification. Data were not available on some characteristics of interest, including transactional sex, condomless sex with partners of unknown or positive HIV status, and the number of male sex partners in the last year, limiting our ability to comment on their correlation with returning to test. Some study clients may have tested anonymously at Gay City

or visited other testing centers during the study period, and these visits were not captured in analyses. Linking visits by phone number may have imparted bias as well, as individuals could have reported different phone numbers at each test. Using phone numbers as identifiers also limited our sample size, as testing at some events, such as Seattle Pride, did not require phone numbers be recorded. Finally, individuals who chose to test anonymously were excluded, which limits generalizability of findings.

Despite no observed association between SMS reminders and returning to test in this study, community testing centers should consider offering many options for reminders, including SMS messages.²⁵ SMS reminders remain inexpensive and easy to implement, and centers can bolster existing programs by personalizing messages or incorporating health promotion content.^{24,26,30} Future research, including additional experimental trials, should compare the effectiveness of various reminder types. Investigators should also consider how reminders impact populations observed as less likely to return for testing, such as those who identify as bisexual and gender non-binary.⁴⁴

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References

1. Centers for Disease Control and Prevention. HIV in the United States and Dependent Areas | Statistics Overview | Statistics Center | HIV/AIDS | CDC. <https://www.cdc.gov/hiv/statistics/overview/atagance.html>. Published 2020. Accessed May 24, 2020.
2. Nguyen A, Katz KA, Leslie KS, Amerson EH. Inconsistent collection and reporting of gender minority data in HIV and sexually transmitted infection surveillance across the United States in 2015. *Am J Public Health*. 2018;108:S274-S276. doi:10.2105/AJPH.2018.304607
3. Reisner SL, Poteat T, Keatley JA, et al. Global health burden and needs of transgender populations: a review. *Lancet*. 2016;388(10042):412-436. doi:10.1016/S0140-6736(16)00684-X
4. Hughto JMW, Reisner SL, Mimiaga MJ. Characteristics of transgender residents of Massachusetts cities with high HIV prevalence. *Am J Public Health*. 2015;105(12):e14-e18. doi:10.2105/AJPH.2015.302877
5. Cohen MS, Chen YQ, McCauley M, et al. Antiretroviral Therapy for the Prevention of HIV-1 Transmission. *N Engl J Med*. 2016. doi:10.1056/NEJMoa1600693
6. CDC. *HIV Testing 101/Prueba Del VIH 101.*; 2019. www.cdc.gov/hiv/spanish. Accessed February 6, 2020.
7. Hall HI, Holtgrave DR, Tang T, Rhodes P. HIV transmission in the United States: Considerations of viral load, risk behavior, and health disparities. *AIDS Behav*. 2013;17(5):1632-1636. doi:10.1007/s10461-013-0426-z
8. Farnham PG, Gopalappa C, Sansom SL, et al. Updates of lifetime costs of care and quality-of-life estimates for HIV-infected persons in the United States: Late Versus early diagnosis and entry into care. *J Acquir Immune Defic Syndr*. 2013;64(2):183-189. doi:10.1097/QAI.0b013e3182973966
9. Owens DK, Davidson KW, Krist AH, et al. Screening for HIV Infection: US Preventive Services Task Force Recommendation Statement. *JAMA - J Am Med Assoc*. 2019;321(23):2326-2336. doi:10.1001/jama.2019.6587
10. DiNenno EA, Prejean J, Delaney KP, et al. Evaluating the evidence for more frequent than annual HIV screening of gay, bisexual, and other men who have sex with men in the united states: Results from a systematic review and CDC expert consultation. *Public Health Rep*. 2018;133(1):3-21. doi:10.1177/0033354917738769
11. Dinenno EA, Prejean J, Irwin K, et al. Recommendations for HIV screening of gay, bisexual, and other men who have sex with men — United States, 2017. *Morb Mortal Wkly Rep*. 2017;66(31):830-832. doi:10.15585/mmwr.mm6631a3
12. Paz-Bailey G, Hall HI, Wolitski RJ, et al. HIV testing and risk behaviors among gay, bisexual, and other men who have sex with men - United States. *Morb Mortal Wkly Rep*. 2013;62(47):958-962.
13. Menza TW, Hughes JP, Celum CL, Golden MR. Prediction of HIV acquisition among men who have sex with men. *Sex Transm Dis*. 2009;36(9):547-555. doi:10.1097/OLQ.0b013e3181a9cc41
14. Public Health -- Seattle & King County. HIV and Sexually Transmitted Infection (STI) Screening Recommendations For Men who Have Sex with Men (MSM) and Transgender and Non-Binary (TG/NB) Persons Who Have Sex with Men. 2018. <https://www.kingcounty.gov/depts/health/communicable-diseases/hiv-std/providers/testing-msm-trans.aspx>.
15. Adam PCG, De Wit JBF, Bourne CP, Knox D, Purchas J. Promoting regular testing: An examination of HIV and STI testing routines and associated socio-demographic, behavioral and social-cognitive factors among men who have sex with men in New South

16. Wales, Australia. *AIDS Behav.* 2014;18(5):921-932. doi:10.1007/s10461-014-0733-z
17. Stassek L. HIV Testing Among Young Latino Men Who Have Sex with Men (MSM): The Role of HIV-Related Stigma and Internalized Homosexual Stigma. 2014.
18. Wise JM, Ott C, Azuero A, et al. Barriers to HIV Testing: Patient and Provider Perspectives in the Deep South. *AIDS Behav.* 2019;23(4):1062-1072. doi:10.1007/s10461-018-02385-5.
19. Fuqua V, Chen YH, Packer T, et al. Using social networks to reach black MSM for HIV testing and linkage to care. *AIDS Behav.* 2012;16(2):256-265. doi:10.1007/s10461-011-9918-x
20. Norton BL, Person AK, Castillo C, Pastrana C, Subramanian M, Stout JE. Barriers to Using Text Message Appointment Reminders in an HIV Clinic. *Telemed e-Health.* 2014;20(1):86-89. doi:10.1089/tmj.2012.0275
21. Khosropour CM, Lake JG, Sullivan PS. Are MSM willing to SMS for HIV prevention? *J Health Commun.* 2014;19(1):57-66. doi:10.1080/10810730.2013.798373
22. Mayer J, Fontelo P. Meta-Analysis on the Effect of Text Message Reminders for HIV-Related Compliance. *AIDS Care.* 2017;29(4):409-417. doi:10.1080/09540121.2016.1214674.
23. Van Velthoven MHMMT, Brusamento S, Majeed A, Car J. Scope and effectiveness of mobile phone messaging for HIV/AIDS care: A systematic review. *Psychol Heal Med.* 2013;18(2):182-202. doi:10.1080/13548506.2012.701310
24. Hall AK, Cole-Lewis H, Bernhardt JM. Mobile Text Messaging for Health: A Systematic Review of Reviews. *Annu Rev Public Health.* 2015;26:393-415. doi:10.1146/annurev-publhealth-031914-122855
25. Govender K, Beckett S, Masebo W, et al. Effects of a Short Message Service (SMS) Intervention on Reduction of HIV Risk Behaviours and Improving HIV Testing Rates Among Populations located near Roadside Wellness Clinics: A Cluster Randomised Controlled Trial in South Africa, Zimbabwe and Mozambique. *AIDS Behav.* 2019;23:3119-3128. doi:10.1007/s10461-019-02427-6
26. Ronen K, Golden MR, Dombrowski JC, Kerani RP, Bell TR, Katz DA. Uptake and Impact of Short Message Service Reminders via Sexually Transmitted Infection Partner Services on Human Immunodeficiency Virus/Sexually Transmitted Infection Testing Frequency Among Men Who Have Sex With Men. *Sex Transm Dis.* 2019;46(10):641-647. doi:10.1016/j.physbeh.2017.03.040
27. Bourne C, Knight V, Guy R, Wand H, Lu H, McNulty A. Short message service reminder intervention doubles sexually transmitted infection/HIV re-testing rates among men who have sex with men. *Sex Transm Infect.* 2011;87:229-231. doi:10.1136/sti.2010.048397
28. Pew Research Center. *January 2018 Core Trends Survey.*; 2018.
29. Wolpaw BJ, Mathews C, Chopra M, Hardie D, Lurie MN, Jennings K. Diagnosis and counselling of patients with acute HIV infection in South Africa. *Sex Transm Infect.* 2011;87(1):71-72. doi:10.1136/sti.2009.041475
30. Njuguna N, Ngure K, Mugo N, et al. The Effect of Human Immunodeficiency Virus Prevention and Reproductive Health Text Messages on Human Immunodeficiency Virus Testing among Young Women in Rural Kenya: A Pilot Study. *Sex Transm Dis.* 2016;43(6):353-359.
31. Nyatsanza F, McSorley J, Murphy S, Brook G. "It's all in the message": The utility of personalised short message service (SMS) texts to remind patients at higher risk of STIs and HIV to reattend for testing-a repeat before and after study. *Sex Transm Infect.* 2016;92(5):393-395. doi:10.1136/sextrans-2015-052216
32. Katz DA, Swanson F, Stekler JD. Why do men who have sex with men test for HIV infection? Results from a community-based testing program in Seattle. *Sex Transm Dis.* 2013;40(9):724-728. doi:10.1097/01.olq.0000431068.61471.af

32. Katz D, Dombrowski J, Buskin S, Golden M, Stekler J. HIV intertest interval among MSM in King County, Washington. *Sex Transm Infect.* 2013;89(1):32-37. doi:doi:10.1136/sextrans-2011-050470
33. Marcus JL, Snowden JM. Words Matter: Putting an End to “unsafe” and “risky” Sex. *Sex Transm Dis.* 2020;47(1):1-3. doi:10.1097/OLQ.0000000000001065
34. Katz DA, Dombrowski JC, Bell TR, Kerani RP, Golden MR. HIV Incidence among Men Who Have Sex with Men Following Diagnosis with Sexually Transmitted Infections. *Sex Transm Dis.* 2016;43(4):249-254. doi:10.1097/OLQ.0000000000000423
35. Stekler JD, McMahan V, Ballinger L, et al. HIV Pre-exposure Prophylaxis Prescribing Through Telehealth. *J Acquir Immune Defic Syndr.* 2018;77(5):e40-e42. doi:10.1097/QAI.0000000000001621
36. Zeileis A. Econometric Computing with HC and HAC Covariance Matrix Estimators. *J Stat Softw.* 2004;11(10):1-17.
37. Sterne JAC, White IR, Carlin JB, et al. Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. *BMJ.* 2009;339(7713):157-160. doi:10.1136/bmj.b2393
38. van Buuren S, Groothuis-Oudshoorn K. mice: Multivariate Imputation by Chained Equations in R. *J Stat Softw.* 2011;45(3):1-67. <https://www.jstatsoft.org/v45/i03/>.
39. R Core Team. R: A language and environment for statistical computing. 2019. <https://www.r-project.org/>.
40. Qiu W. powerMediation: Power/Sample Size Calculation for Mediation Analysis. 2020. <https://cran.r-project.org/package=powerMediation>.
41. Kliner M, Knight A, Mamvura C, Wright J, Walley J. Using no-cost mobile phone reminders to improve attendance for HIV test results: A pilot study in rural Swaziland. *Infect Dis Poverty.* 2013;2(1):2-8. doi:10.1186/2049-9957-2-12
42. Ybarra ML, Prescott TL, Phillips GL, Bull SS, Parsons JT, Mustanski B. Pilot RCT results of an mHealth HIV prevention program for sexual minority male adolescents. *Pediatrics.* 2017;140(1). doi:10.1542/peds.2016-2999
43. Downing SG, Cashman C, McNamee H, Penney D, Russell DB, Hellard ME. Increasing chlamydia test of re-infection rates using SMS reminders and incentives. *Sex Transm Infect.* 2013;89(1):16-19. doi:10.1136/sextrans-2011-050454
44. Jeffries IV WL. HIV testing among bisexual men in the United States. *AIDS Educ Prev.* 2010;22(4):356-370. doi:10.1521/aeap.2010.22.4.356

Appendix I: Tables and Figures

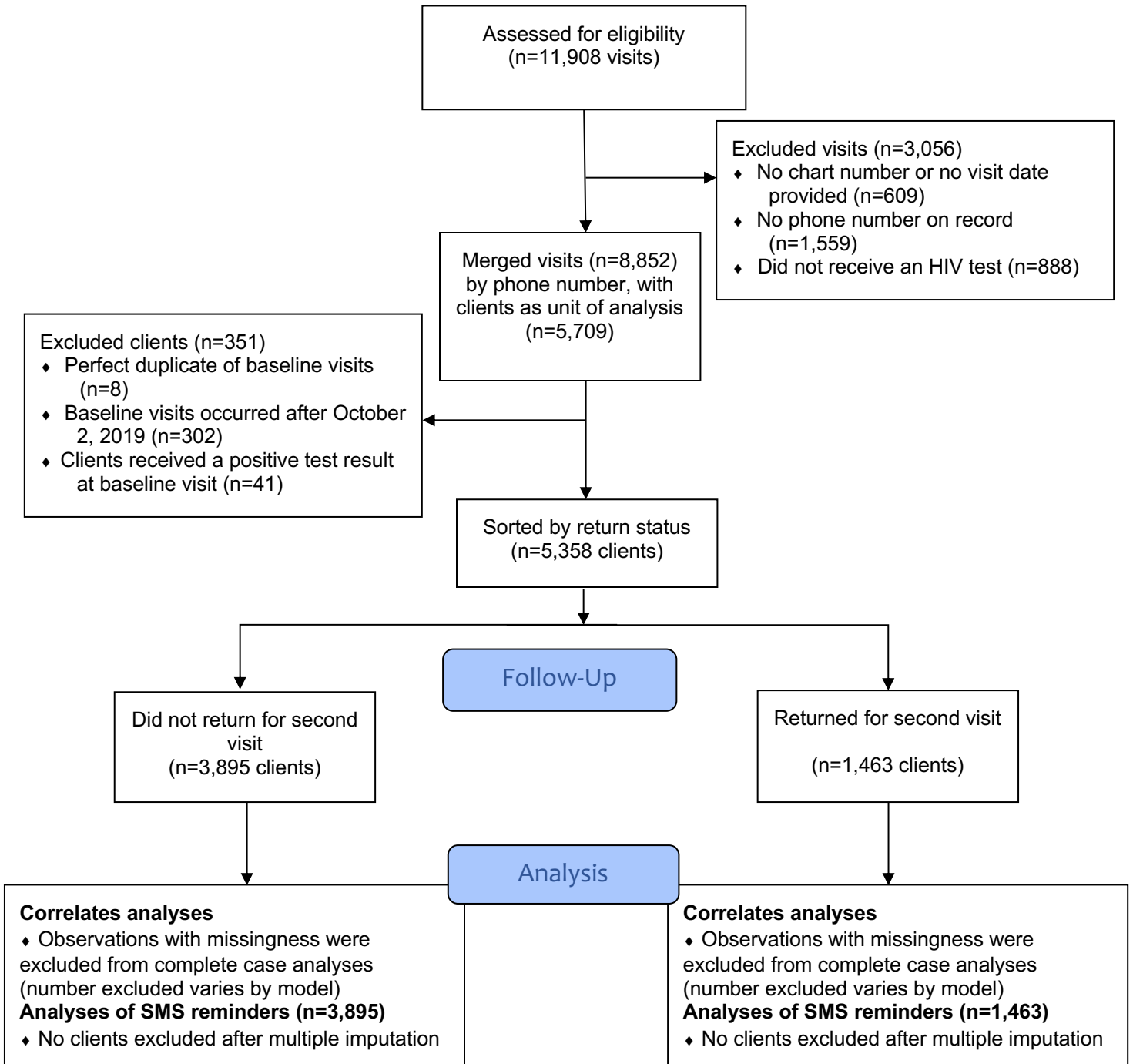


Figure 1: Flowchart of participant selection.
SMS: short message service

Table 1. Baseline demographic characteristics of HIV testing clients who returned and did not return for a second test visit, and analysis of each characteristic's association with return; a Seattle community testing center; Sep 2016 - Dec 2019 (N = 5,358)

		Tested once at Gay City (n = 3895)	Tested twice or more at Gay City (n = 1463)	All clients (n = 5358)	Unadjusted RR (95% CI)	p-value	Adjusted RR¹ (95% CI)	p-value
Gender identity²	Woman	308 (7.9)	40 (2.7)	348 (6.5)	--	--	--	--
	<i>Transgender</i>	86 (2.2)	22 (1.5)	108 (2.0)	0.70 (0.48, 1.01)	0.06	0.75 (0.50, 1.12)	0.16
	<i>Cisgender</i>	222 (5.7)	18 (1.2)	240 (4.5)	0.26 (0.16, 0.40)	<0.001	0.17 (0.05, 0.53)	0.002
	Man	3091 (79.4)	1277 (87.3)	4368 (81.5)	--	--	--	--
	<i>Transgender</i>	63 (1.6)	22 (1.5)	85 (1.6)	0.88 (0.61, 1.27)	0.50	0.64 (0.43, 0.96)	0.03
	<i>Cisgender</i>	3028 (77.7)	1255 (85.8)	4283 (79.9)	REF	REF	REF	REF
	GNC/non-binary	160 (4.1)	25 (1.7)	185 (3.5)	0.46 (0.32, 0.67)	<0.001	0.34 (0.20, 0.56)	<0.001
	Missing	336 (8.6)	121 (8.3)	457 (8.5)	--	--	--	--
Age (years)	16-25	1127 (28.9)	462 (31.6)	1589 (29.7)	REF	REF	REF	REF
	25-34	1600 (41.1)	580 (39.6)	2180 (40.7)	0.92 (0.82, 1.02)	0.09	0.88 (0.79, 0.98)	0.02
	35-44	485 (12.5)	154 (10.5)	639 (11.9)	0.83 (0.71, 0.97)	0.02	0.86 (0.73, 1.01)	0.07
	≥45	391 (10.0)	148 (10.1)	539 (10.1)	0.94 (0.81, 1.11)	0.48	0.95 (0.81, 1.12)	0.56
	<i>Continuous</i>	29 [24, 35]	28 [24, 35]	28 [24, 35]	1.00 (0.99, 1.00)	0.14	--	--
	Missing	292 (7.5)	119 (8.1)	411 (7.7)	--	--	--	--
Sexual orientation	Gay³	2200 (56.5)	1002 (68.5)	3202 (59.8)	REF	REF	REF	REF
	Lesbian	21 (0.5)	4 (0.3)	25 (0.5)	0.51 (0.21, 1.26)	0.14	1.73 (0.61, 4.92)	0.30
	Bisexual	504 (12.9)	125 (8.5)	629 (2.3)	0.61 (0.52, 0.71)	<0.001	0.76 (0.64, 0.90)	0.002
	Pansexual⁴	104 (2.7)	18 (1.2)	122 (2.3)	--	--	--	--
	Queer	228 (5.9)	119 (8.1)	347 (6.5)	1.10 (0.94, 1.28)	0.25	1.21 (1.02, 1.43)	0.03
	Straight	255 (6.5)	25 (1.7)	280 (5.2)	0.29 (0.20, 0.42)	<0.001	0.38 (0.24, 0.61)	<0.001

		Tested once at Gay City (n = 3895)	Tested twice or more at Gay City (n = 1463)	All clients (n = 5358)	Unadjusted RR (95% CI)	p-value	Adjusted RR ¹ (95% CI)	p-value
Sexual orientation (continued)	Additional⁵	108 (2.8)	30 (2.1)	138 (2.6)	0.69 (0.50, 0.96)	0.03	1.32 (0.93, 1.86)	0.12
	Missing	475 (12.2)	140 (9.6)	615 (11.5)	--	--	--	--
Race/ Ethnicity	NH white	1962 (50.4)	712 (48.9)	2677 (50.0)	REF	REF	--	--
	Hispanic/Latinx	415 (10.7)	160 (10.9)	575 (10.7)	1.04 (0.90, 1.21)	0.58	--	--
	NH Asian	388 (10.0)	165 (11.3)	553 (10.3)	1.12 (0.97, 1.29)	0.13	--	--
	NH Black	219 (5.6)	70 (4.8)	289 (5.4)	0.91 (0.73, 1.12)	0.37	--	--
	NH Middle Eastern/ Asian Indian/ North African	53 (1.4)	23 (1.6)	76 (1.4)	1.13 (0.80, 1.60)	0.48	--	--
	NH Native Hawaiian/ Pacific Islander	34 (0.9)	9 (0.6)	43 (0.8)	0.78 (0.44, 1.41)	0.41	--	--
	NH American Indian/ Alaska Native	20 (0.5)	7 (0.5)	27 (0.5)	0.97 (0.51, 1.84)	0.93	--	--
	Additional⁵	54 (1.4)	14 (1.0)	68 (1.3)	0.77 (0.48, 1.23)	0.38	--	--
	Multiple race/ethnicity indicated⁶	443 (11.4)	176 (12.0)	619 (11.6)	1.06 (0.93, 1.22)	0.28	--	--
	Missing	307 (7.9)	124 (8.5)	431 (8.0)	--	--	--	--
Education (highest completed)	MS or less	19 (0.5)	5 (0.3)	24 (0.4)	0.71 (0.33, 1.56)	0.40	0.89 (0.35, 2.27)	0.80
	Some HS	87 (2.2)	17 (1.2)	104 (1.9)	0.56 (0.36, 0.87)	0.01	0.94 (0.62, 1.42)	0.78
	HS graduate	419 (10.8)	128 (8.7)	547 (10.2)	0.80 (.68, 0.94)	0.008	0.96 (0.81, 1.15)	0.68
	Attended college or TS	999 (25.6)	365 (24.9)	1364 (25.5)	0.91 (0.82, 1.02)	0.11	0.97 (0.87, 1.09)	0.65

		Tested once at Gay City (n = 3895)	Tested twice or more at Gay City (n = 1463)	All clients (n = 5358)	Unadjusted RR (95% CI)	p-value	Adjusted RR ¹ (95% CI)	p-value
Education (continued)	College graduate	1512 (38.8)	625 (42.7)	2137 (39.9)	REF	REF	REF	REF
	Post-graduate degree	537 (13.8)	204 (13.9)	741 (13.8)	0.94 (0.82, 1.08)	0.38	0.96 (0.83, 1.10)	0.53
	Missing	322 (8.3)	119 (8.1)	441 (8.2)	--	--	--	--
Housing status	Stable or unstable	3290 (84.5)	1311 (89.6)	4601 (85.9)	REF	REF	REF	REF
	Homeless	82 (2.1)	12 (0.8)	94 (1.8)	0.45 (0.26, 0.76)	<0.001	0.55 (0.30, 1.01)	0.05
	Missing	523 (13.4)	140 (9.6)	663 (12.4)	--	--	--	--
Place of residence	Seattle	2503 (64.3)	1026 (70.1)	3529 (65.9)	1.28 (1.14, 1.43)	<0.001	1.15 (1.03, 1.29)	0.02
	Outside Seattle	1009 (25.9)	298 (20.4)	1307 (24.4)	REF	REF	REF	REF
	Missing	383 (9.8)	139 (9.5)	522 (9.7)	--	--	--	--

Note: Data presented as count (%) and median [IQR] for descriptive statistics; data presented as relative risk (95% CI) for correlates analyses; baseline is defined as the first testing visit between September 1, 2016 and October 2, 2019.

HIV: human immunodeficiency virus; RR: relative risk; CI: confidence interval; REF: reference group; GNC: gender nonconforming; NH: non-Hispanic; MS: middle school; HS: high school; TS: trade school

¹ Adjusted models control for all other variables in the model.

² Clients were only able to identify as male, female, transgender male, or transgender female until July, 2018.

³ Includes individuals who identified as "homosexual."

⁴ Clients were not able to identify as pansexual prior to July, 2018. This category was merged with bisexual for the correlate analyses.

⁵ "Additional" is comprised of asexual individuals and those who provided write-in identities.

⁶ "Multiple race/ethnicity indicated" includes anyone who selected multiple races and ethnicities to describe their identity. Most common combinations were Hispanic/Latinx and white (n=195, 30.2%); Asian and white (n=109, 16.9%); Alaska Native/American Indian and white (n=87, 13.5%); and Black and white (n=70, 10.8%).

Table 2. Baseline clinical and behavioral characteristics of HIV testing clients who returned and did not return for a second test visit, and analysis of each characteristic's association with return; a Seattle community testing center; Sep 2016 - Dec 2019 (N = 5,358)

		Tested once at Gay City (n = 3895)	Tested twice or more at Gay City (n = 1463)	All clients (n = 5358)	Unadjusted RR (95% CI)	p-value	Adjusted RR ¹ (95% CI)	p-value
Testing location for baseline visit	Wellness center	2107 (54.1)	931 (63.6)	3038 (56.7)	REF	REF	REF	REF
	Thrift store	1335 (34.3)	418 (28.6)	1753 (32.7)	0.78 (0.70, 0.86)	<0.001	0.92 (0.83, 1.02)	0.13
	Bathhouses	163 (4.2)	40 (2.7)	203 (3.8)	0.64 (0.48, 0.85)	0.002	0.66 (0.38, 1.12)	0.13
	Events/Other	171 (4.4)	38 (2.8)	209 (3.9)	0.59 (0.44, 0.79)	<0.001	0.32 (0.11, 1.94)	0.04
	Missing	119 (3.1)	36 (2.5)	155 (2.9)	--	--	--	--
Ever had a prior HIV test	Yes	3098 (79.5)	1240 (84.8)	4338 (81.0)	1.53 (1.27, 1.84)	<0.001	1.20 (0.98, 1.47)	0.08
	No	426 (10.9)	98 (6.7)	524 (9.8)	REF	REF	REF	REF
	Missing	371 (9.5)	125 (8.5)	496 (9.3)	--	--	--	--
GC diagnosis in the last 12 months	Yes	226 (5.8)	105 (7.2)	331 (6.2)	1.13 (0.96, 1.34)	0.14	--	--
	No	3093 (79.4)	1202 (82.2)	4295 (80.2)	REF	REF	--	--
	Missing	576 (14.8)	156 (10.7)	732 (13.7)	--	--	--	--
CT diagnosis in the last 12 months	Yes	223 (5.7)	107 (7.3)	330 (6.2)	1.16 (0.98, 1.36)	0.08	--	--
	No	3077 (79.0)	1197 (81.8)	4274 (79.8)	REF	REF	--	--
	Missing	595 (15.3)	159 (10.9)	754 (14.1)	--	--	--	--
Syphilis diagnosis in the last 12 months	Yes	67 (1.7)	18 (1.2)	85 (1.6)	0.75 (0.50, 1.13)	0.17	--	--
	No	3279 (84.2)	1295 (88.5)	4574 (85.4)	REF	REF	--	--
	Missing	549 (14.1)	150 (10.3)	699 (13.0)	--	--	--	--

		Tested once at Gay City (n = 3895)	Tested twice or more at Gay City (n = 1463)	All clients (n = 5358)	Unadjusted RR (95% CI)	p-value	Adjusted RR ¹ (95% CI)	p-value
Number of sexual partners in the last 12 months	<10	1957 (50.2)	655 (44.8)	2612 (48.7)	REF	REF	--	--
	≥10	1272 (32.7)	633 (43.3)	1905 (35.6)	1.33 (1.21, 1.45)	<0.001	--	--
	<i>Continuous</i>	<i>8 [4, 14]</i>	<i>9 [6, 15]</i>	<i>8 [5, 15]</i>	<i>1.00 (1.00, 1.01)</i>	<i>0.005</i>	--	--
	Missing	666 (17.1)	175 (12.0)	841 (15.7)	--	--	--	--
Ever used PrEP ²	Yes	377 (9.7)	196 (13.2)	573 (10.7)	1.14 (1.01, 1.30)	0.04	--	--
	No	2095 (53.8)	896 (61.2)	2991 (55.8)	REF	REF	--	--
	Missing	1423 (36.5)	371 (25.4)	1794 (33.5)	--	--	--	--
Engaged in condomless sex in the last 12 months ³	Yes	1641 (42.1)	759 (51.9)	2400 (44.8)	1.00 (0.88, 1.14)	0.97	--	--
	No	436 (11.2)	201 (13.7)	637 (11.9)	REF	REF	--	--
	Missing	1818 (46.7)	506 (34.4)	2321 (43.3)	--	--	--	--
Currently has health insurance	Yes	2411 (61.9)	1031 (70.5)	3442 (64.2)	1.30 (1.16, 1.46)	<0.001	--	--
	No	974 (25.0)	291 (19.9)	1265 (23.6)	REF	REF	--	--
	Missing	510 (13.1)	141 (9.6)	651 (12.2)	--	--	--	--
Regularly sees a healthcare provider	Yes	1743 (44.7)	779 (53.2)	2522 (47.1)	1.24 (1.13, 1.36)	<0.001	1.14 (1.03, 1.25)	0.01
	No	1641 (42.1)	543 (37.1)	2184 (40.8)	REF	REF	REF	REF
	Missing	511 (13.1)	141 (9.6)	652 (12.2)	--	--	--	--
Meth use in last 12 months	Yes	146 (3.7)	33 (2.3)	179 (3.3)	0.63 (0.46, 0.86)	0.004	--	--
	No	3079 (79.1)	1268 (86.7)	4347 (81.1)	REF	REF	--	--
	Missing	670 (17.2)	162 (11.1)	840 (15.5)	--	--	--	--

		Tested once at Gay City (n = 3895)	Tested twice or more at Gay City (n = 1463)	All clients (n = 5358)	Unadjusted RR (95% CI)	p-value	Adjusted RR¹ (95% CI)	p-value
Popper use in last 12 months	Yes	1008 (25.9)	452 (30.9)	1460 (27.2)	1.13 (1.03, 1.24)	0.01	--	--
	No	2258 (58.0)	852 (58.2)	3110 (58.0)	REF	REF	--	--
	Missing	629 (16.1)	159 (10.9)	788 (14.7)	--	--	--	--
Heroin use in last 12 months	Yes	40 (1.0)	6 (0.4)	46 (0.9)	0.45 (0.21, 0.95)	0.04	--	--
	No	3185 (81.8)	1294 (88.4)	4479 (83.6)	REF	REF	--	--
	Missing	670 (17.2)	163 (11.1)	833 (15.5)	--	--	--	--
Ever injected unprescribed drug or hormone⁴	Yes	115 (3.0)	20 (1.4)	135 (2.5)	0.52 (0.34, 0.78)	0.002	--	--
	No	3248 (83.4)	1300 (88.9)	4548 (84.9)	REF	REF	--	--
	Missing	532 (13.7)	143 (9.8)	675 (12.6)	--	--	--	--
Met modified criteria to initiate PrEP⁵	Yes	1452 (37.3)	698 (47.7)	2150 (40.1)	1.29 (1.18, 1.42)	<0.001	1.18 (1.07, 1.29)	0.001
	No	1705 (43.8)	573 (39.2)	2278 (42.5)	REF	REF	REF	REF
	Missing	738 (18.9)	192 (13.1)	930 (17.4)	--	--	--	--

Note: Data presented as count (%) or median [IQR] for descriptive statistics; data presented as relative risk (95% CI) for correlates analyses; baseline is defined as the first testing visit between September 1, 2016 and October 2, 2019.

HIV: human immunodeficiency virus; RR: relative risk; CI: confidence interval; REF: reference group; GC: gonorrhea; CT: chlamydia; PrEP: pre-exposure prophylaxis

¹ Adjusted models control for all other variables in the model.

² Data on ever use of PrEP were only available before July, 2018 and after April, 2019. After April, 2019, data relate only to use in the previous 12 months.

³ Data on condomless sex in the last 12 months were only available before July, 2018 and after March, 2019.

⁴ From July, 2018 to the end of study period, data on unprescribed injection drug use relate to only the last 5 years.

⁵ This category include all men and transgender individuals who report any of the following in the last 12 months: a gonorrhea diagnosis, a chlamydia diagnosis, a syphilis diagnosis, methamphetamine use, or ≥10 sexual partners. Criteria adapted from Gay City's.³⁵

Table 3: Proportion of clients who return for an HIV test, by duration until return and SMS reminder status; a Seattle community testing center; Sep 2016 - Dec 2019 (N = 5,358)

SMS reminder type	Duration until return					Return ever ²	Did not return
	Less than 3 months ¹	3 to 4 months	4 to 6 months	6 to 7 months	7 or more months		
Any SMS reminder³ (n=1086)	60 (5.5)	69 (6.4)	30 (2.8)	114 (10.5)	62 (5.7)	335 (30.8)	751 (69.2)
<i>Sent at 3 months⁴ (n=444)</i>	21 (4.7)	25 (5.6)	9 (2.0)	26 (5.9)	22 (5.0)	103 (23.2)	341 (76.8)
<i>Sent at 6 months⁵ (n=287)</i>	14 (4.9)	15 (5.2)	6 (2.1)	28 (9.8)	15 (5.2)	78 (27.2)	209 (72.8)
No SMS reminder⁶ (n=4272)	158 (3.7)	219 (5.1)	82 (1.9)	527 (12.3)	59 (1.4)	1128 (26.4)	3144 (73.6)
All clients (n=5358)	218 (4.1)	288 (5.4)	112 (2.1)	641 (12.0)	204 (3.8)	1463 (27.3)	3895 (72.7)

Note: Data presented as count (%).

HIV: Human immunodeficiency virus; SMS: short message service

¹ Less than 3 months is defined as between 43 and 90 days; all visits within 42 days are not counted as a return visit.

² Return ever in the full duration of follow-up.

³ Reminder sent within 27 weeks of first visit

⁴ Reminder sent between 12 and 14 weeks

⁵ Reminder sent between 25 and 27 weeks

⁶ Reminder sent after 27 weeks of first visit, or no reminder sent.

Table 4. Risk ratios of returning for a second HIV test, comparing those who did receive an SMS reminder at any time in the study period to those who did not; a Seattle community testing center; Sep 2016 - Dec 2019 (N = 5,358)

	Return in 3-4 months	Return in less than 7 months	Return ever ¹
Unadjusted	1.24 (0.95, 1.62)	1.09 (0.95, 1.24)	1.04 (0.98, 1.10)
Adjusted²	1.16 (0.88, 1.52)	1.04 (0.90, 1.19)	1.02 (0.97, 1.09)

Note: Data presented as risk ratios (95% Confidence Intervals).

HIV: Human immunodeficiency virus; SMS: short message service

¹ Return ever in the full duration of follow-up.

² Adjusted for gender, age category, sexual orientation, education, housing status, residence, site of initial HIV test, having ever tested for HIV before, and whether met modified criteria to initiate PrEP.