

The Impact of Introducing *Mycoplasma genitalium* (MG) Testing for
Acute Non-Gonococcal Urethritis (NGU) and MG-Specific Treatment on
Persistent NGU Cases

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Abstract

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Mycoplasma genitalium (MG) is a common cause of non-gonococcal urethritis (NGU), particularly in persistent cases that often result from undetected and not optimally treated infections. In response to rising local prevalence of macrolide resistance, the Public Health-Seattle & King County (PHSKC) Sexual Health Clinic (SHC) began MG testing at first NGU presentation in 2018 and treating MG infections with doxycycline followed by moxifloxacin, a non-macrolide antibiotic. We conducted a pre-post analysis using data from patients assigned male sex at birth who were diagnosed with NGU at the PHSKC SHC between October 1, 2013 and December 31, 2023 to evaluate the impact of introducing MG testing and targeted treatment on persistent NGU cases. Data were collected from electronic health records. Statistical significance of differences in characteristics between Period 1 (prior to the introduction of MG testing for acute NGU cases and MG-specific therapy) and Period 2 (after the introduction of MG testing for acute NGU cases and MG-specific therapy) and visits with acute NGU and persistent NGU were assessed using Pearson's chi-square or Fisher's exact tests and Wilcoxon rank sum tests. Multivariable Poisson regression with generalized estimating

equations and robust standard errors was used to estimate the prevalence ratio (PR) of visits for persistent NGU in Period 2 relative to Period 1. Among 5,060 NGU visits over both periods of time, 205 (4.1%) were classified as persistent NGU. Adjusting for race/ethnicity, *Chlamydia trachomatis* nucleic acid amplification test results at acute NGU visits, and human immunodeficiency virus status, the introduction of MG testing plus MG-specific therapy (Period 2) was associated with a non-significant 12% reduction in the prevalence of persistent NGU relative to the time period prior to this introduction (Period 1; adjusted PR: 0.88, 95% confidence interval: 0.67-1.16, $p=0.353$). Introducing MG testing and sequential doxycycline and moxifloxacin treatment for MG infections was associated with a modest, non-significant reduction in persistent NGU. These findings suggest that recommending MG testing at first presentation of NGU and providing targeted treatment for MG infections may not result in fewer persistent NGU cases.

INTRODUCTION

Mycoplasma genitalium (MG), identified in 1981 in patients with non-gonococcal urethritis (NGU),¹ accounts for 15%-30% of symptomatic NGU²⁻⁴ and up to 40% of persistent NGU,^{3,5} the latter often due to undetected and not optimally treated infections. In 2015, the Centers for Disease Control and Prevention (CDC) did not recommend MG testing but indicated that it could be considered in urethritis cases, specifying treatment with a single dose of azithromycin (a macrolide antibiotic) instead of doxycycline when MG was suspected.⁶ Subsequently, in 2019, MG was placed on the CDC Watch List of Antimicrobial Resistance Threats.⁷ With consistent evidence that MG caused urethritis² and rising macrolide resistance, the 2021 update to the CDC Sexually Transmitted Infections (STI) Treatment Guidelines changed guidance for managing MG. MG testing was recommended, but only in people with persistent NGU, and treatment preferably with moxifloxacin (a fluoroquinolone) when information on macrolide resistance was not available.³ Limiting MG testing to only people who had failed initial treatment was designed to reduce antibiotic pressure on MG by treating only people with moxifloxacin who had not been cured with an initial antibiotic.

At the Public Health-Seattle and King County (PHSKC) Sexual Health Clinic (SHC), between 2007 and 2011, a randomized clinical trial found low microbiologic cure rates for single-agent MG treatment with azithromycin (40%), similar to doxycycline (30%).⁸ The low effectiveness of azithromycin was largely due to high prevalence of macrolide resistance; 41.3% of MG infections in this trial contained macrolide resistance mutations (MRM) prior to treatment.⁹ In contrast, between 2003 and 2007, four observational studies reported nearly 100% cure rates for MG with moxifloxacin, which has since been increasingly used to treat MG infections, particularly when macrolide resistance is suspected or confirmed.¹⁰ Historically, first-line therapy for NGU in the PHSKC SHC was azithromycin, which had been associated with 80% clinical cure rates from 2007-2011.⁸ In 2018, in response to rising local prevalence of macrolide

resistance, the PHSKC SHC moved to diverge from the CDC STI Treatment Guidelines and introduce MG testing at acute NGU visits, as well as change from azithromycin to doxycycline as first-line therapy for NGU. Under this protocol change, patients assigned male sex at birth with NGU and MG infections received a 7-day regimen of doxycycline empirically at the time of NGU diagnosis, followed by a 7-day regimen of moxifloxacin.

Similarly, in 2020, the San Francisco City Clinic (SFCC) made these two changes simultaneously and introduced MG testing at acute NGU visits and treatment with moxifloxacin for MG infections, at the same time implementing doxycycline as first-line therapy for NGU. In the two-year period after the introduction of MG testing and targeted MG treatment (2020-2021), visits for persistent NGU were 60% lower than they were in the preceding two years (2018-2019).¹¹ While these findings suggest that the identification of MG infections and more effective treatment led to the reduction in persistent NGU visits, results from a single clinic may not be generalizable to other settings. Therefore, using data from a large SHC in Seattle, Washington, we evaluated, over a longer timeframe, the impact of introducing MG testing at acute NGU visits and sequential therapy with doxycycline followed by moxifloxacin on persistent NGU cases with the goal of informing MG testing and treatment guidelines. Additionally, we compared visits with persistent NGU to those with acute NGU to characterize people with persistent NGU.

METHODS

Study Setting and Design

The PHSKC SHC is located at the Harborview Medical Center in Seattle, Washington. It offers scheduled appointments and limited walk-in services for human immunodeficiency virus (HIV) and STI testing and treatment. The PHSKC SHC provides care for all people, regardless of background or ability to pay, and sees over 600 NGU cases per year.

The PHSKC SHC introduced MG testing and MG-specific therapy in November 2018. We performed a pre-post analysis using SHC data from electronic health records (EHR) collected between October 1, 2013 and October 31, 2018 (Period 1, prior to the introduction of MG testing for acute NGU cases and MG-specific therapy) and compared this to December 1, 2018 and December 31, 2023 (Period 2, after the introduction of MG testing and MG-specific therapy).

Study Population

Patients assigned male sex at birth, aged 18 years and older, who were diagnosed with NGU at the PHSKC SHC between October 1, 2013 and December 31, 2023 were included.

Data Sources and Definitions

All clinical and behavioral data were sourced from the EHR, which comprised clinician-elicited data, self-reported data collected via a computer-assisted self-interviewing check-in kiosk located in the PHSKC SHC waiting room, and laboratory results. Patients were not typically asked to re-complete the kiosk if their visit occurred within 30 days of a prior visit. Therefore, where timeframes aligned for these visits, we imputed missing self-reported responses using the most recent prior responses.

Certain data elements were only available via self-report: history of *Neisseria gonorrhoeae* (GC), *Chlamydia trachomatis* (CT), and syphilis in the past 12 months (yes, no). Other data elements recorded in the EHR consistently from 2013-2023 included age (years); NGU diagnosis; sex (male, female, unknown); ethnicity (Hispanic, non-Hispanic, unknown, not reported); race (White, Asian, Black, multiracial, Native American or Alaska Native, Native Hawaiian or Pacific Islander, unknown, not reported); herpes diagnosis; syphilis diagnosis; and MG, GC, and CT nucleic acid amplification test (NAAT) results (positive, negative, unknown). Antibiotic use in the past month (yes, no) was defined by aggregating specific antibiotics used in the past month (2013-2015) and a combination of dates and recorded antibiotics (2015-2023).

HIV status was recorded in the EHR via self-report (ever had an HIV test [yes, no] and the result of their last test [positive, negative, unknown]) and clinician interview (positive, negative, unknown, never tested). When discrepancies were present, we prioritized the self-reported data; if the self-reported data were missing, we used the clinician-elicited data. We classified patients as positive, negative, or unknown or never tested.

Gender was also recorded via self-report and clinician interview. From 2013 to 2014, response options were limited to male and female. From 2015 to 2023, response options were expanded to include transgender female, transgender male, non-binary, and not listed. We prioritized the self-reported data when discrepancies were present and used the clinician-elicited data if the self-reported data were missing. We classified patients as male, female, transgender female, transgender male, non-binary, or unknown or not reported.

Data on gender/sex of sexual partners were not collected at every visit; when available, data were also recorded via self-report and clinician interview. Prior to 2015, response options for gender of sexual partners in the past 12 months were limited to men only, women only, men and women, and none. From 2015 to 2023, additional options included transgender men, transgender women, non-binary, unknown, and not listed. Number of male or female sexual partners and number of new male or female sexual partners in the past 2 or past 12 months were also collected. To create a single measure for gender/sex of sexual partners, we first classified patients who reported any sex with a man at any visit as men who have sex with any men (MSM). We classified those who were not classified as MSM but who reported sex with a transgender man, transgender woman, or non-binary person at any visit as men who have sex with another gender/sex type. We then classified men who reported only sex with a woman at any visit as men who have sex with only women (MSW). The remaining patients were classified as men who have sex with an unknown or a not reported gender/sex type.

Number of female and male sexual partners in the past 2 months was recorded via self-report and clinician elicitation, as described above for gender/sex of sexual partners. We resolved discrepancies using the same systematic process applied to HIV status and gender. We calculated the total number of sexual partners in the past 2 months by summing the number of male and female sexual partners.

Data Analysis

Although some patients in Period 1 were tested for MG, this testing was performed within other research studies or at clinician discretion rather than routinely at acute NGU visits. Therefore, we excluded visits with MG NAAT results in Period 1. First, we compared characteristics of all patient-visits assigned male sex at birth before and after the introduction of MG testing and MG-specific treatment for acute NGU to evaluate whether there were large differences in people assigned male sex at birth in the two time periods.

Second, we restricted the main analysis to NGU visits, excluding those visits where patients had an initial NGU diagnosis but a subsequent positive NAAT test for GC. We defined an NGU diagnosis as the presence of urethral symptoms plus ≥ 5 polymorphonuclear leukocytes per high-power field (PMN/hpf) over 3 fields on urethral Gram stain or a positive leukocyte esterase test (≥ 1 leukocyte in urinalysis). We defined persistent NGU as a second diagnosis of NGU within 30 days of a prior clinical diagnosis of NGU. To avoid counting persistent NGU cases twice, we additionally excluded visits classified as a second persistent NGU visit within 30 days of an initial persistent NGU visit. We compared characteristics of NGU diagnosis visits between Period 1 and Period 2 to evaluate whether there were differences in people with NGU diagnoses before and after the change in protocol, excluding one month between the two time periods (November 2018) to ensure a clean division between the two approaches. We also compared visits with acute NGU diagnoses to those with persistent NGU diagnoses to characterize people who experienced persistent NGU.

Characteristics reported in categories were reported as counts and proportions; characteristics reported in continuous units were reported as medians and interquartile ranges. We used Pearson's chi-square or Fisher's exact tests and Wilcoxon rank sum tests to determine statistical significance of differences in characteristics.

We used multivariable Poisson regression with generalized estimating equations (GEE) and robust standard errors to estimate the prevalence ratio (PR) of visits for persistent NGU in Period 2 (after the introduction of routine MG testing plus MG-specific therapy) relative to Period 1, specifying an exchangeable working correlation structure to account for within-patient correlation. Using backward stepwise selection, we evaluated characteristics for inclusion in the multivariable model that were associated with time period (before and after the introduction of MG testing plus MG-specific therapy), as well as with persistent NGU, at $p \leq 0.1$. Characteristics with $p < 0.05$ were retained in the final multivariable model. We did not adjust for antibiotic use because all visits with persistent NGU were expected to have received antibiotics for their acute NGU diagnosis.

We performed all data management and analysis using R version 4.5.1;¹² RStudio version 2025.5.1.513;¹³ and R packages *pacman*,¹⁴ *tidyverse*,¹⁵ *gtsummary*,¹⁶ *flextable*,¹⁷ and *geepack*.¹⁸ This secondary analysis of deidentified SHC data was reviewed and approved by the University of Washington Institutional Review Board.

RESULTS

Overall visits

From October 1, 2013 to December 31, 2023, patients assigned male sex at birth attended 89,158 visits at the PHSKC SHC for any reason. After excluding 779 visits during November 2018 and 1,490 visits with MG NAAT results in Period 1, 86,889 visits remained: 42,019 visits in Period 1 and 44,870 visits in Period 2.

NGU was diagnosed at more visits in Period 1 (2,816 [6.7%]) than in Period 2 (2,330 [5.2%]; Supplementary Table). Compared to Period 1, there was a higher proportion of visits by MSM (74.4% vs. 69.0%), a lower proportion of visits among HIV-negative patients (67.8% vs. 71.2%), and a lower proportion of visits by patients diagnosed with herpes (1.3% vs. 0.6%) than in Period 2. Although univariable analyses of additional characteristics showed a statistically significant difference between Period 1 and Period 2, these differences were minor for age, ethnicity, race, number of sexual partners in the past 2 months, antibiotic use in the past month, syphilis diagnosis, history of CT and GC in the past 12 months, and CT NAAT results.

Characteristics of NGU visits

NGU diagnoses were recorded in 5,146 visits over the entire study period. Of these, 56 (1.1%) had positive GC NAAT results and were excluded. An additional 30 (0.6%) visits classified as a second persistent NGU diagnosis within 30 days of a visit classified as persistent NGU were excluded, resulting in a total of 5,060 visits included in the main analysis. The mean number of visits per patient was 1.43, and 23.8% (838/3,520) of unique patients had multiple visits. Most visits were by patients who were non-Hispanic (83.8%), White (50.4%), over 25 years of age (86.9%), and classified as MSM (64.0%).

The proportion of persistent NGU visits was somewhat greater in Period 1 (4.4% [122/2,651]) than in Period 2 (3.6% [83/2,204], $p=0.19$; Table 1). Compared to Period 1, there was a higher proportion of visits by Black patients (32.3% vs. 29.5%) than in Period 2. There was a somewhat lower proportion of visits by HIV-infected people (4.8% vs. 6.2%) in Period 2 than Period 1. CT was detected at acute NGU visits in 14.6% of visits in Period 1 compared to 16.3% in Period 2. In Period 2, MG was detected at acute NGU visits in 14.6% of visits. Number of sexual partners in the past 2 months, herpes diagnosis at acute NGU visits, syphilis diagnosis at acute NGU visits, and history of GC, CT, and syphilis in the past 12 months did not significantly differ before and after the introduction of MG testing for acute NGU and MG-specific treatment.

Characteristics of persistent NGU visits

Of the 5,060 NGU visits, 205 (4.1%) were classified as persistent NGU (Table 2). Compared to visits with acute NGU, those with persistent NGU were more often by Black patients (40.5% vs. 30.4%, $p=0.027$). There was a lower proportion of visits among HIV-positive patients (3.4% vs. 5.7%, $p=0.031$) in persistent NGU visits than those with acute NGU. Antibiotic use in the past month was also substantially higher in persistent NGU visits than in acute NGU visits (89.3% vs. 4.8%, $p<0.001$). Somewhat more persistent NGU cases had CT than MG detected at their acute NGU visit (7.3% vs. 3.9% [Period 2 only for MG]).

MG testing plus MG-specific therapy and persistent NGU

In univariable analyses, the introduction of MG testing plus MG-specific therapy in Period 2 was associated with a non-significant 18% reduction in the prevalence of persistent NGU relative to Period 1 (crude PR: 0.82, 95% confidence interval [CI]: 0.62-1.07, $p=0.140$). Adjusting for race/ethnicity, CT NAAT results at acute NGU visits, and HIV status, the introduction of MG testing plus MG-specific therapy in Period 2 was associated with a non-significant 12% reduction in the prevalence of persistent NGU relative to Period 1 (adjusted PR: 0.88, 95% CI: 0.67-1.16, $p=0.353$).

DISCUSSION

Over a 10-year period, visits for persistent NGU in a large SHC in Seattle, Washington represented 4.1% of over 5,000 NGU visits. MG was detected in 14.6% of acute NGU visits after testing was introduced, whereas CT was detected 16.3%. Overall, there was a modest difference in the prevalence of persistent NGU before and after the introduction of MG testing and MG-specific therapy for acute NGU (4.4% vs. 3.6%), a relative reduction in prevalence of persistent NGU by 12% in adjusted analyses.

These findings are similar to prior evidence from the San Francisco study. However, while the proportion of persistent NGU cases decreased after the introduction of MG testing and MG-specific therapy in the PHSKC SHC, the decline was less pronounced than what was observed in San Francisco and not statistically significant (12% vs. 60% reduction).¹¹ This difference may be due in part to the greater proportion of persistent NGU visits in San Francisco prior to the change in protocol (8%) than in the PHSKC SHC (4.4%). Our study spanned a longer timeframe (10 vs. 4 years), increasing statistical power and enhancing generalizability, but this long timeframe may also have introduced variability that attenuated the observed effect size. Both studies used multivariable models with GEE and backward stepwise selection; however, we estimated PR using Poisson regression, while the San Francisco study reported an odds ratio (OR) from logistic regression. Although OR are not directly comparable to PR, both express the magnitude of difference, and these analytic differences would not likely explain the difference in results. The San Francisco study defined NGU based on the absence of gonorrhea (gram-negative intracellular diplococci on urethral Gram stain) and presence of urethritis (positive leukocyte esterase test or ≥ 10 white blood cells per high-power field on urethral Gram stain), a somewhat stricter definition than ours, which only required the presence of urethral symptoms plus ≥ 5 PMN/hpf on urethral Gram stain or a positive leukocyte esterase test. However, this small difference in NGU definitions would likely not account for the difference in results between clinics. Both San Francisco and the PHSKC SHC began introducing doxycycline post-exposure prophylaxis in 2020, which may have influenced results but would not explain the difference in magnitude of observed reductions.

The lower proportion of NGU cases attributed to MG in our study (14.6%) may partly explain the smaller observed impact of testing for and treating MG more effectively compared to the San Francisco study, where 18% of acute NGU cases had MG. Additionally, the prevalences of CT and MG among patients assigned male sex at birth with NGU was lower than those observed in

other prior studies conducted at the PHSKC SHC. A cohort study of MSW with NGU between 2014 and 2018 found CT and MG prevalence of 27% and 22%, respectively,¹⁹ and a separate cross-sectional study between 2014 and 2017 found a prevalence of 30% for CT and 20% for MG among patients assigned male sex at birth with NGU.²⁰ If the prevalences of MG and CT are declining over time in the PHSKC SHC, identifying and appropriately treating MG infections would have less impact over time.

While the proportion of MSM was higher in Period 2 than in Period 1 in our study (69.0% vs. 74.4%), the proportion of bisexual and gay/lesbian patients assigned male sex at birth in the San Francisco study remained similar across the two time periods (~48%). The prevalence of specific pathogens likely varies across sexual networks; thus, if MG prevalence is lower in MSM, introducing MG testing and MG-specific treatment in a setting with a greater proportion of MSM, differences in persistent NGU may have been more difficult to detect.

Where macrolide resistance is detected or unknown, the CDC STI Treatment Guidelines recommend sequential therapy with doxycycline followed by moxifloxacin for MG infections in people with persistent NGU.³ The rationale for limiting MG testing to persistent NGU cases includes a desire to limit unnecessary moxifloxacin use, given its potential for serious side effects and potential contribution to already increasing antimicrobial resistance. MG testing offers clear benefits, such as more effective treatment at the time of initial visits and reduced risk of transmission to sexual partners. However, it may also lead to overtreatment.²¹ In 30-40% of patients, empiric doxycycline given at NGU presentation eradicates MG before test results are available, making additional treatment unnecessary for that subset of patients.²¹

Furthermore, some patients are co-infected with MG and CT, and symptoms may be attributable to the CT infection, which doxycycline also eradicates. As treatment is not recommended for asymptomatic MG infections, it would not be provided in those cases.²¹ Despite these concerns,

our findings showed a non-significant reduction (12%) in persistent NGU after the introduction of MG testing and MG-specific therapy, in line with earlier evidence from the SFCC.

This study had several limitations. First, since MG testing at acute NGU visits was introduced at a similar time as the change in first-line therapy for NGU from azithromycin to doxycycline, we could not isolate the individual impact of MG testing or treatment with moxifloxacin on persistent NGU. Second, due to the nature of the pre-post study design and thus lack of a separate comparison group, it is difficult to attribute observed differences in persistent NGU prevalence to the introduction of MG testing and targeted treatment. Third, since NGU diagnoses were recorded using a checkbox, we assumed that the absence of a clinical diagnosis indicated the absence of NGU, which may have introduced some misclassification. Fourth, we could not account for patients who sought care at multiple clinics; if they sought care for persistent NGU at another clinic after first being diagnosed at the PHSKC SHC, the number of persistent NGU cases would be underestimated. We also assumed that their first NGU visit to the SHC represented an acute case, which may have further underestimated the number of persistent NGU cases. Finally, data collection procedures within the EHR underwent changes. Although we had to make several assumptions to resolve discrepancies and missing data, the PHSKC SHC's standardized data integration methods likely maintained relative consistency across the two time periods and minimized misclassification due to these changes.

This study also had several strengths. First, it spanned 10 years and included over 5,000 NGU visits, which resulted in good statistical power and enhanced generalizability to similar settings. Second, we used EHR data, which incorporated clinician-elicited data, self-reported data, and laboratory results, allowing for comprehensive characterization of people with persistent NGU. Finally, the PHSKC SHC defined NGU based on rigorous clinical criteria, which minimized misclassification and provided comparability across the two time periods.

Introducing MG testing and sequential therapy with doxycycline followed by moxifloxacin for MG infections was associated with a modest, non-significant reduction in persistent NGU. These findings suggest that recommending MG testing at first presentation of NGU rather than only in people with persistent NGU and providing targeted treatment for MG infections may not result in fewer persistent NGU cases. Although early identification and more effective treatment of MG may prevent prolonged symptoms and repeat clinical visits, improve patient quality of life and reduce the risk of adverse sexual and reproductive outcomes in female sexual partners exposed to MG infections, there is not yet conclusive evidence that it reduces healthcare utilization. Additional studies in other settings should investigate the impact of introducing routine MG testing for people with NGU and providing targeted treatment.

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Table 1. Characteristics of visits from patients assigned male sex at birth with NGU at the Public Health-Seattle and King County Sexual Health Clinic in Period 1 (October 2013-October 2018) and Period 2 (December 2018-December 2023).

Characteristic	Period 1 N=2,773 patient-visits ¹	Period 2 N=2,287 patient-visits ¹	p-value²
Persistent NGU	122 (4.4)	83 (3.6)	0.190
Age (in years)³			
Median (IQR)	34.0 (27.0, 44.0)	33.0 (27.0, 41.0)	0.053
<25	369 (13.3)	295 (12.9)	<0.001
25-35	1,184 (42.7)	1,112 (48.6)	
35+	1,220 (44.0)	880 (38.5)	
Ethnicity			0.003
Non-Hispanic	2,367 (85.4)	1,873 (81.9)	
Hispanic	254 (9.2)	267 (11.7)	
Unknown or not reported	152 (5.5)	147 (6.4)	
Race			<0.001
White	1,491 (53.8)	1,059 (46.3)	
Black	818 (29.5)	739 (32.3)	
Asian	133 (4.8)	159 (7.0)	
Multiracial	69 (2.5)	40 (1.7)	
NAAN	16 (0.6)	21 (0.9)	
NHPI	32 (1.2)	42 (1.8)	
Unknown or not reported	214 (7.7)	227 (9.9)	
Gender^{4,5}			<0.001
Male	2,567 (92.6)	2,235 (97.7)	
Transgender female	4 (0.1)	18 (0.8)	
Non-binary	11 (0.4)	33 (1.4)	
Unknown or not reported	191 (6.9)	1 (<0.1)	
Gender/Sex of Sexual Partners⁶			<0.001

Characteristic	Period 1 N=2,773 patient-visits ¹	Period 2 N=2,287 patient-visits ¹	p-value ²
Any men	1,698 (61.2)	1,538 (67.2)	
Only women	1,059 (38.2)	692 (30.3)	
Another	7 (0.3)	42 (1.8)	
Unknown or not reported	9 (0.3)	15 (0.7)	
Number of Sexual Partners (in past 2 months)³			
Median (IQR)	2.0 (1.0, 4.0)	2.0 (1.0, 4.0)	0.022
0	63 (2.3)	38 (1.7)	0.071
1	642 (23.2)	495 (21.6)	
2-3	1,082 (39.0)	859 (37.6)	
4-9	631 (22.8)	549 (24.0)	
10+	176 (6.3)	167 (7.3)	
Unknown or not reported	179 (6.5)	179 (7.8)	
HIV Status			<0.001
Negative	2,133 (76.9)	1,645 (71.9)	
Positive	173 (6.2)	110 (4.8)	
Unknown or not tested	467 (16.8)	532 (23.3)	
Antibiotic Use (in past month)	279 (10.1)	137 (6.0)	<0.001
Herpes Diagnosis (at acute NGU visits)⁷	24 (0.9)	13 (0.6)	0.217
Syphilis Diagnosis (at acute NGU visits)⁷	16 (0.6)	20 (0.9)	0.210
CT History (in past 12 months)	534 (23.3)	483 (23.6)	0.798
GC History (in past 12 months)	404 (17.6)	397 (19.4)	0.128
Syphilis History (in past 12 months)	120 (5.2)	107 (5.2)	0.999
MG NAAT Result (at acute NGU visits)			-
Negative	-	1,819 (79.5)	

Characteristic	Period 1 N=2,773 patient-visits ¹	Period 2 N=2,287 patient-visits ¹	p-value ²
Positive	-	334 (14.6)	
Unknown or not tested	2,773	134 (5.9)	
CT NAAT Result (at acute NGU visits)			<0.001
Negative	1,582 (57.1)	1,847 (80.8)	
Positive	405 (14.6)	372 (16.3)	
Unknown or not tested	786 (28.3)	68 (3.0)	

Abbreviations: NGU=Non-gonococcal urethritis; IQR=Interquartile range; NAAN=Native American or Alaska Native; NHP=Native Hawaiian or Pacific Islander; HIV=Human immunodeficiency virus; MG=*Mycoplasma genitalium*; CT=*Chlamydia trachomatis*; NAAT=Nucleic acid amplification test.

¹All values are n (%) patient-visits, unless otherwise specified.

²Pearson's chi-squared tests were used to determine statistical significance, unless otherwise specified. p-values were based on univariable comparisons and did not account for within-patient correlation due to multiple visits.

³p-values derived from Wilcoxon rank sum tests.

⁴p-values derived from Fisher's exact tests.

⁵Transgender woman and non-binary response options were added beginning in 2015.

⁶Another gender or sex of sex partner included transgender men (n=42 in Period 1; n=92 in Period 2), transgender women (n=35 in Period 1; n=63 in Period 2), transgender men or women (n=0 in Period 1; n=22 in Period 2), and non-binary (n=14 in Period 1; n=137 in Period 2), response options added beginning in 2016.

⁷Herpes and syphilis were clinical diagnoses.

Table 2. Comparison of characteristics of visits from patients assigned male sex at birth at the Public Health-Seattle and King County Sexual Health Clinic with acute and persistent NGU, October 2013-December 2023.

NGU Diagnosis			
Characteristic	Acute NGU N=4,855 patient-visits ¹	Persistent NGU N=205 patient-visits ¹	p-value ²
Age (in years)³			
Median (IQR)	33.0 (27.0, 43.0)	32.0 (28.0, 40.0)	0.356
<25	639 (13.2)	25 (12.2)	0.171
25-35	2,190 (45.1)	106 (51.7)	
35+	2,026 (41.7)	74 (36.1)	
Ethnicity			
			0.282
Non-Hispanic	4,060 (83.6)	180 (87.8)	
Hispanic	505 (10.4)	16 (7.8)	
Unknown or not reported	290 (6.0)	9 (4.4)	
Race⁴			
			0.027
White	2,456 (50.6)	94 (45.9)	
Black	1,474 (30.4)	83 (40.5)	
Asian	279 (5.7)	13 (6.3)	
Multiracial	107 (2.2)	2 (1.0)	
NAAN	37 (0.8)	0 (0.0)	
NHPI	74 (1.5)	0 (0.0)	
Unknown or not reported	428 (8.8)	13 (6.3)	
Gender^{4,5}			
			0.004
Male	4,618 (95.1)	184 (89.8)	
Transgender female	19 (0.4)	3 (1.5)	
Non-binary	42 (0.9)	2 (0.1)	
Unknown or not reported	176 (3.6)	16 (7.8)	
Gender/Sex of Sexual Partners^{4,6}			
			0.345

Characteristic	NGU Diagnosis		p-value ²
	Acute NGU N=4,855 patient-visits ¹	Persistent NGU N=205 patient-visits ¹	
Any men	3,093 (63.7)	143 (69.8)	
Only women	1,690 (34.8)	61 (29.8)	
Another	48 (1.0)	1 (0.5)	
Unknown or not reported	24 (0.5)	0 (0.0)	
Number of Sexual Partners (in past 2 months)^{3,4}			
Median (IQR)	2.0 (1.0, 4.0)	2.0 (1.0, 4.0)	0.765
0	100 (2.1)	1 (0.5)	0.152
1	1,087 (22.4)	50 (24.4)	
2-3	1,861 (38.3)	80 (39.0)	
4-9	1,124 (23.2)	56 (27.3)	
10+	334 (6.9)	9 (4.4)	
Unknown or not reported	349 (7.2)	9 (4.4)	
HIV Status			0.031
Negative	3,609 (74.3)	169 (82.4)	
Positive	276 (5.7)	7 (3.4)	
Unknown or not tested	970 (20.0)	29 (14.1)	
Antibiotic Use (in past month)	233 (4.8)	183 (89.3)	<0.001
Herpes Diagnosis (at acute NGU visits)^{4,7}	37 (0.8)	0 (0.0)	0.403
Syphilis Diagnosis (at acute NGU visits)^{4,7}	36 (0.7)	0 (0.0)	0.402
CT History (in past 12 months)	967 (23.3)	50 (27.8)	0.161
GC History (in past 12 months)	760 (18.3)	41 (22.8)	0.128
Syphilis History (in past 12 months)⁴	222 (5.3)	5 (2.8)	0.169
MG NAAT Result (at acute NGU visits)			0.116

NGU Diagnosis			
Characteristic	Acute NGU N=4,855 patient-visits ¹	Persistent NGU N=205 patient-visits ¹	p-value ²
Negative	1,752 (36.1)	67 (32.7)	0.005
Positive	326 (6.7)	8 (3.9)	
Unknown or not tested	2,777 (57.2)	130 (63.4)	
CT NAAT Result (at acute NGU visits)			
Negative	3,278 (67.5)	151 (73.7)	
Positive	762 (15.7)	15 (7.3)	
Unknown or not tested	815 (16.8)	39 (19.0)	

Abbreviations: NGU=Non-gonococcal urethritis; IQR=Interquartile range; NAAN=Native American or Alaska Native; NHPI=Native Hawaiian or Pacific Islander; HIV=Human immunodeficiency virus; MG=*Mycoplasma genitalium*; CT=*Chlamydia trachomatis*; NAAT=Nucleic acid amplification test.

¹All values are n (%) patient-visits, unless otherwise specified.

²Pearson's chi-squared tests were used to determine statistical significance, unless otherwise specified. p-values were based on univariable comparisons and did not account for within-patient correlation due to multiple visits.

³p-values derived from Wilcoxon rank sum tests.

⁴p-values derived from Fisher's exact tests.

⁵Transgender woman and non-binary response options were added beginning in 2015.

⁶Another gender or sex of sex partner included transgender men (n=42 in Period 1; n=92 in Period 2), transgender women (n=35 in Period 1; n=63 in Period 2), transgender men or women (n=0 in Period 1; n=22 in Period 2), and non-binary (n=14 in Period 1; n=137 in Period 2), response options added beginning in 2016.

⁷Herpes and syphilis were clinical diagnoses.

Table 3. Association between the introduction of MG testing in patients with acute NGU plus MG-specific treatment and persistent NGU, October 2013-December 2023.

Characteristic	N	Adjusted PR ¹	95% CI	p-value
Period				
1 (October 2013-October 2018)	2,773	Ref	Ref	Ref
2 (December 2018-December 2023)	2,287	0.88	0.67, 1.16	0.353
Race/Ethnicity²				
Hispanic	521	Ref	Ref	Ref
NH Black	1,536	1.77	1.06, 2.98	0.030
NH Another	448	1.10	0.55, 2.21	0.786
NH White	2,348	1.20	0.71, 2.02	0.489
Unknown or not reported	207	0.31	0.07, 1.31	0.110
CT NAAT Results (at acute NGU visits)				
Negative	3,429	Ref	Ref	Ref
Positive	777	0.44	0.26	0.002
Unknown or not tested	854	0.99	0.69	0.974
HIV Status				
Negative	3,778	Ref	Ref	Ref
Positive	283	0.59	0.30, 1.14	0.114
Unknown or not tested	999	0.66	0.46, 0.95	0.027

Abbreviations: MG=*Mycoplasma genitalium*; NGU=Non-gonococcal urethritis; PR=Prevalence ratio; CI=Confidence interval; NH=Non-Hispanic; HIV=Human immunodeficiency virus; NAAN=Native American or Alaska Native; NHPI=Native Hawaiian or Pacific Islander; CT=*Chlamydia trachomatis*; NAAT=Nucleic acid amplification test.

¹Adjusted for race/ethnicity, CT NAAT results at acute NGU visits, and HIV status.

²NH another race/ethnicity included Asian (n=284), multiracial (n=98), NAAN (n=31), and NHPI (n=35).

Supplementary Table. Characteristics of patient-visits assigned male sex at birth at the Public Health-Seattle and King County Sexual Health Clinic between Period 1 (October 2013-October 2018) and Period 2 (December 2018-December 2023).

Characteristic	Period 1 N=42,019 patient-visits ¹	Period 2 N=44,870 patient-visits ¹	p-value²
NGU Diagnosis⁶	2,816 (6.7)	2,330 (5.2)	<0.001
Age (years)³			
Median (IQR)	33.0 (27.0, 43.0)	32.0 (27.0, 40.0)	0.016
<25	6,362 (15.1)	5,432 (12.1)	<0.001
25-35	18,426 (43.9)	22,407 (49.9)	
35+	17,231 (41.0)	17,031 (38.0)	
Ethnicity			<0.001
Non-Hispanic	33,964 (80.8)	34,539 (77.0)	
Hispanic	5,724 (13.6)	7,564 (16.9)	
Unknown or not reported	2,331 (5.5)	2,767 (6.2)	
Race			<0.001
White	25,571 (60.9)	24,710 (55.1)	
Black	6,125 (14.6)	6,378 (14.2)	
Asian	3,394 (8.1)	4,784 (10.7)	
Multiracial	1,069 (2.5)	864 (1.9)	
NAAN	510 (1.2)	509 (1.1)	
NHPI	670 (1.6)	1,373 (3.1)	
Unknown or not reported	4,680 (11.1)	6,252 (13.9)	
Gender⁴			<0.001
Male	36,121 (86.0)	43,139 (96.1)	
Female	80 (0.2)	89 (0.2)	
Transgender female	148 (0.4)	490 (1.1)	
Transgender male	8 (<0.1)	15 (<0.1)	
Non-binary	318 (0.8)	1,076 (2.4)	

Characteristic	Period 1 N=42,019 patient-visits ¹	Period 2 N=44,870 patient-visits ¹	p-value²
Unknown or not reported	5,338 (12.7)	59 (0.1)	
Gender/Sex of Sexual Partners⁵			<0.001
Any men	28,989 (69.0)	33,396 (74.4)	
Only women	11,536 (27.5)	9,160 (20.4)	
Another	176 (0.4)	513 (1.1)	
Unknown or not reported	1,318 (3.1)	1,801 (4.0)	
Number of Sexual Partners (in past 2 months)³			
Median (IQR)	2.0 (1.0, 4.0)	2.0 (1.0, 5.0)	<0.001
0	2,549 (6.1)	2,543 (5.7)	<0.001
1	9,664 (23.0)	9,337 (20.8)	
2-3	13,195 (31.4)	13,424 (29.9)	
4-9	8,883 (21.1)	9,662 (21.5)	
10+	3,125 (7.4)	4,076 (9.1)	
Unknown or not reported	4,603 (11.0)	5,828 (13.0)	
HIV Status			<0.001
Negative	29,907 (71.2)	30,424 (67.8)	
Positive	3,307 (7.9)	1,934 (4.3)	
Unknown or not tested	8,805 (21.0)	12,512 (27.9)	
Antibiotic Use (in past month)	3,248 (7.7)	2,686 (6.0)	<0.001
Herpes Diagnosis⁶	566 (1.3)	290 (0.6)	<0.001
Syphilis Diagnosis⁶	1,922 (4.6)	1,522 (3.4)	<0.001
CT History (in past 12 months)	6,189 (19.5)	7,481 (20.3)	0.009
GC History (in past 12 months)	5,994 (18.9)	7,576 (20.6)	<0.001
Syphilis History (in past 12 months)	2,829 (8.9)	3,287 (8.9)	0.996

Characteristic	Period 1 N=42,019 patient-visits ¹	Period 2 N=44,870 patient-visits ¹	p-value ²
MG NAAT Result (among those tested)⁷			-
Negative	-	4,977/5,560 (89.5)	
Positive	-	583/5,560 (10.5)	
CT NAAT Result (among those tested)⁷			<0.001
Negative	10,511/11,502 (91.4)	14,767/15,903 (92.9)	
Positive	991/11,502 (8.6)	1,136/15,903 (7.1)	
GC NAAT Result (among those tested)⁷			0.204
Negative	10,609/11,501 (92.2)	14,736/15,903 (92.7)	
Positive	892/11,501 (7.8)	1,167/15,903 (7.3)	

Abbreviations: NGU=Non-gonococcal urethritis; IQR=Interquartile range; NAAN=Native American or Alaska Native; NHPI=Native Hawaiian or Pacific Islander; HIV=Human immunodeficiency virus; MG=*Mycoplasma genitalium*; CT=*Chlamydia trachomatis*; GC=*Neisseria gonorrhoeae*; NAAT=Nucleic acid amplification test; EHR=Electronic health record.

¹All values are n (%) patient-visits, unless otherwise specified.

²Pearson's chi-squared tests were used to determine statistical significance, unless otherwise specified. p-values were based on univariable comparisons and did not account for within-patient correlation due to multiple visits.

³p-values derived from Wilcoxon rank sum tests.

⁴Transgender woman and non-binary response options were added beginning in 2015.

⁵Another gender or sex of sex partner included transgender men, transgender women, and non-binary, response options added beginning in 2016.

⁶Herpes and syphilis were clinical diagnoses.

⁷MG, CT, and GC NAAT results are for all patient-visits, only some of which are acute NGU visits. Unknown or not tested were excluded from univariable comparisons for MG (n=39,310 in Period 2), CT (n=30,517 in Period 1; n=28,967 in Period 2), and GC (n=30,517 in Period 1; n=28,967 in Period 2) NAAT results.