Risk Factors and Antimicrobial Resistance Profiles of *Neisseria gonorrhoeae* Associated with Repeat Gonococcal Infections in Patients Attending Public Health Seattle and King County Sexual Health Clinic, 2017 to 2020

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Abstract

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This study sought to determine what characteristics were risk factors associated with repeat gonococcal infection (GCI) in one US sexual health clinic (SHC) and compared the resistance profiles of *Neisseria gonorrhoeae* (*Ng)* isolates from repeat GCI patients versus patients with single GCI. This is a secondary analysis of the Centers for Disease Control and Prevention's Strengthening the United States Response to Resistant Gonorrhea (SURRG) surveillance data from February 2017 to December 2020 for persons seeking care at the Public Health–Seattle & King County (PHSKC) SHC who were diagnosed with gonorrhea. A gonorrhea-positive case was defined as the presence of *Ng* confirmed by a positive lab culture result or nucleic acid amplification test (NAAT) in a specimen collected from one or more anatomical sites (e.g., urethra, cervix, rectum, pharynx). Univariable and multivariable logistic regression was used to evaluate the association between potential correlates and repeat GCI, the outcome of interest. Using chi-square test to assess proportion of antibiotic-resistant (AR) Ng isolates between

patients with repeat GCI and single GCI, we compared an alternative hypothesis which assumed that the proportion of *Ng* isolates from repeat GCI will be higher than the proportion of AR *Ng* isolates from single GCI. Between February 2017 and December 2020, 2,219 unique SHC patients had at least one episode of gonorrhea. Of these 2,219 patients, 577 had a repeat GCI and 1,642 patients had no additional positive results. Among the 2,219 individual patients, 2,003 (90.3 %) were men and 169 (7.6 %) were women. Among men, 1,605 (72.3%) reported only male sex partners. In the bivariable model, documented history of gonorrhea in the Washington State STD surveillance registry (which started in 2007) at the time of the initial GCI in this dataset had the strongest association with repeat GCI (OR=2.1; 95% CI: 1.7, 2.6). Self-reported history of gonorrhea ever (OR=1.4; 95%CI: 1.1, 1.8), documented history of gonorrhea in the registry (OR=2.1; 95% CI: 1.7, 2.6), current pre-exposure prophylaxis use (OR=1.6; 95% CI: 1.3, 2.0) and history of non-injection recreational drug use in previous 12 months (OR=1.7; 95% CI: 1.3, 2.1) remained statistically significant and were positively associated with repeat GCI in the multivariable model. There was no gentamicin resistance recorded for either single or repeat GCI. Of the seven antibiotics used for agar dilution AST, gonococcal isolates from repeat GCI had higher proportion of resistance for penicillin (repeat= 18.0%, single 11.2%; p-value 0.001), tetracycline (repeat= 32.2%, single 19.9%; p-value <0.001), and ciprofloxacin (repeat= 55.1%, single 36.1%; p-value <0.001). Gonorrhea prevention interventions to increase routine testing and prevention counselling should target men, MSMs, people with a history of gonorrhea and people older than 25 years, who face an increased risk for repeat GCI.

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DEDICATION

Dedicated to my mom, Celestina Nwanne, you have always inspired me and to the memory of my father Boniface Nwanne.

INTRODUCTION

According to the World Health Organization (WHO), there were nearly 87 million people aged 15-49 years with new gonorrhea cases in the world in 2016 (Rowley et al., 2019) and the rate of gonorrhea is increasing disproportionately among indigenous populations, sex workers, racial or ethnic minority groups and international travelers (Kirkcaldy et al., 2019). With 616,392 cases of gonorrhea reported to the Centers for Disease Control and Prevention (CDC) in 2019, gonorrhea is the second most common reportable sexually transmitted disease (STD) in the United States (US). Rates of reported gonorrhea have increased by 92% since 2009 (Centers for Disease Control and Prevention: Division of STD Prevention, 2021b). Moreover, there was 5.7% increase in the rate of reported gonorrhea cases between 2018-2019 among all racial and ethnic groups, males, females and in all regions in the US (Centers for Disease Control and Prevention: Division of STD Prevention, 2021b). The economic burden to the US health system for the treatment of STDs each year is an estimated $16 billion, and untreated gonorrhea can be responsible for short- to long-term infertility in men, ectopic pregnancy, and pelvic inflammatory disease in women (National Center for HIV/AIDS, Viral Hepatitis, STD, 2016; Soge et al., 2016). Among men, the rate of gonorrhea increase was higher, possibly due to increased transmission, increased screening, or both, among gay, bisexual, and other men who have sex with men (MSM) (Centers for Disease Control and Prevention: Division of STD Prevention, 2021b).

Since 2009, the rate of reported gonorrhea in Washington State has increased, especially in large urban counties like King and Pierce that had higher incidence rates than the overall Washington State rate (State Department of Health, 2013). Among 70 counties and independent cities in the US, King County ranked 17th with a rate of 201.3 per 100,000, and Seattle and King County recorded 4710 cases of gonorrhea in 2019 (Centers for Disease Control and Prevention: Division of STD Prevention, 2019a; Public Health, 2019).

The rate of *Neisseria gonorrhoeae* (*Ng*) antimicrobial resistance (AMR) is increasing, making treatment of gonococcal infection (GCI) with antibiotics more challenging (Unemo & Shafer, 2014). Multiple data sources, including the US Gonococcal Isolate Surveillance Project (GISP) suggest that the number of antibiotics available to treat GCI is decreasing as *Ng* isolates become more resistant to available antibiotics (Kirkcaldy et al., 2013, 2016; Wi et al., 2017). In response to increasing resistance of antibiotics to *Ng,* the CDC recently modified its gonorrhea treatment guidelines for the treatment of uncomplicated urogenital, anorectal, and pharyngeal gonorrhea from 250 mg ceftriaxone with 1 gram of azithromycin, to an increased single dose (500 mg intramuscular) of ceftriaxone (St Cyr et al., 2020), removing azithromycin from the recommended regimen. The higher dose of ceftriaxone is needed to increase serum concentrations of ceftriaxone to achieve the minimum inhibitory concentration (MIC) required for effective treatment of gonorrhea at all anatomic sites; pharyngeal infection, in particular, has been shown to be difficult to treat (Chisholm et al., 2010; Doan et al., 2019; St. Cyr et al., 2020; Wind et al., 2017).

Repeat GCI can occur when there is exposure to partner(s) with untreated gonorrhea. (Brunham & Plummer, 1990). In the US and other industrialized countries where STD reporting is routine, it was found that the median proportion of repeat GCI among men and women can range from 7% to 12% within a year, with younger age consistently associated with repeat GCI among men and women (Fung et al., 2007a; Hosenfeld et al., 2009). An effective gonorrhea control strategy to break the cycle of repeat infection would be to identify and screen the populations at high risk for repeat GCI and their sexual networks. Consequently, CDC recommends targeted screening and testing for people at risk of a repeat GCI including those with previous gonorrhea infection, MSM and people with new or multiple sex partners, irrespective of whether they believe their new or multiple sex partners were treated for gonorrhea (Frieden et al., 2009; St. Cyr et al., 2020). As it is consistent with previous studies in the US, United Kingdom, South Africa and the Netherlands, repeat GCI in the US is prevalent

among men, especially MSM, adolescents and young adults, non-White ethnic minority populations and people with multiple sex partners (Brooks et al., 1978; Fernando et al., 2015; Fung et al., 2007b; Medina-Marino et al., 2020; Noble et al., 1977; Wijers et al., 2020). Exposure to GCI and other STDs increases the chances of acquisition and spread of HIV (Mathebula et al., 2020; Rowley et al., 2019).

This study sought to determine what characteristics were risk factors associated with repeat GCI in one US sexual health clinic (SHC), so that proactive steps can be taken to reduce the risk of reinfection for people most at risk. We are not aware of any studies that have looked at the AMR of isolates of *Ng* found in patients with repeat GCI. Therefore, we intend to compare the resistance profiles of *Ng* isolates from repeat GCI patients versus patients with single GCI. This has significant surveillance and clinical implications, especially as we explore innovative strategies for combating antibiotic resistant *Ng* (Kirkcaldy et al., 2016; Starnino et al., 2008).

METHODS

Study design

This is a retrospective study nested in the ongoing CDC's Strengthening the United States Response to Resistant Gonorrhea (SURRG) surveillance project, which began in 2017 (Centers for Disease Control and Prevention: Division of STD Prevention, 2016). The surveillance supported by SURRG seeks to improve national gonorrhea surveillance, increase infrastructure to support culturing of *Ng* isolates and antimicrobial susceptibility testing (AST), in order to promote prompt identification of resistant gonorrhea and to uncover the epidemiological factors contributing to resistant gonorrhea (Centers for Disease Control and Prevention: Division of STD Prevention, 2016).

Setting and population

King County is one of eight jurisdictions in the US funded by the CDC to participate in SURRG as part of the expansion of its over three decades of national surveillance of gonococcal antimicrobial resistance (Centers for Disease Control and Prevention: Division of STD Prevention, 2016). This is a multi-center surveillance and public health intervention project designed to rapidly detect and control the emergence and spread of antimicrobial-resistant *Ng*. The Public Health–Seattle & King County (PHSKC) SHC is the only categorical SHC in the whole of Washington State and accepts walk-ins from members of the public who are 18 years and older and have concerns about a possible sexually transmitted infection (STI).

Criteria for inclusion in SURRG in the PHSKC SHC

SURRG data includes all patients at the PHSKC SHC presenting without symptoms or with symptoms of gonorrhea (e.g., painful sensation when urinating, vaginal discharge) with confirmed lab culture result or testing positive for gonorrhea by nucleic acid amplification test (NAAT).

Data collection and management

This is a secondary analysis of SURGG data from February 2017 to December 2020 for persons seeking care at the PHSKC SHC (located in the Harborview Medical Center) who were diagnosed with gonorrhea. A gonorrhea-positive case was defined as the presence of *Ng* confirmed by a positive lab culture result or NAAT in a specimen collected from one or more anatomical sites (e.g., urethra, cervix, rectum, pharynx). Persons with ≥2 GCI occurring >14 days apart from February 2017 to December 2020 were considered to have repeat GCI. Repeat cases within <14 days of initial infection were presumed to be duplicate reporting of the initial infection and were excluded from this analysis.

SURRG combines demographic and behavioral data from two sources: 1) the Washington State STD Surveillance Registry, or Public Health Information Management System (PHIMS), which includes partner services interview data, and 2) the PHSKC SHC medical record. Data on agar dilution antimicrobial susceptibility to a panel of 7 antibiotics were obtained from the University of Washington Neisseria Reference Laboratory and merged with patient records from the SURRG demographic and behavioral dataset. Variables including age, race, sex, and gender of sext partners are primarily collected on the case report form in Washington State. Other variables, such as self-reported history of GCI and PrEP use are collected through partner services interviews. This secondary analysis of SURRG data did not involve any patient contact and is de-identified; therefore, it is not considered human subjects research and is exempt from institutional review board review. Data were analyzed using STATA® software (Version 16, 2020, Stata Corp).

Data analysis

Aim 1: To identify risk factors associated with repeat gonococcal infections (GCI) among patients attending Public Health—Seattle & King County (PHSKC) Sexual Health Clinic (SHC). We used descriptive statistics to present demographic (age, gender, race/ethnicity), behavioral (sexual orientation, number of sex partners, history of injection and non-injection drug use) and clinical characteristics (current pre-exposure prophylaxis (PrEP) use, result of last HIV result, antibiotic use in the previous 12 months, see Table 1). Univariable and multivariable logistic regression was used to evaluate the association between potential correlates and repeat GCI, the outcome of interest. Statistically significant variables (variables associated with GCI with a p-value of ≤ 0.05) from univariate analysis were included in the multivariable analysis to estimate the independent effect of covariates on repeat GCI while controlling for potential confounders such as age, race, and gender. Odds ratios and 95% confidence intervals (CI) were calculated

for all covariates in the regression models. A p value of 0.05 was considered statistically significant.

Aim 2. To compare antimicrobial resistance (AMR) profiles of *Neisseria gonorrhoeae* (*NG*) isolates from patients with single GCI to patients with repeat GCI. Antimicrobial resistance data for *Ng* isolates from all SURRG patients enrolled were interpreted using the Clinical and Laboratory Standards Institute (CLSI) breakpoints (Clinical and Laboratory Standards Institute, 2020) and CDC GISP published breakpoints for antibiotics that do not have established CLSI resistance breakpoints. Minimum inhibitory concentrations for the *Ng* isolates to seven antibiotics (penicillin, tetracycline, gentamicin, ceftriaxone, ciprofloxacin, azithromycin, and cefixime) were interpreted as previously described (Kirkcaldy et al., 2013; Soge et al., 2016). Using CLSI guideline, we defined resistance to penicillin as MIC ≥2μg/mL, tetracycline as MIC ≥2μg/mL and ciprofloxacin as MIC ≥1μg/mL. Resistance to ceftriaxone and cefixime has not been defined by CLSI so ceftriaxone and cefixime with breakpoint of MIC ≥0.125μg/mL and MIC ≥0.25μg/mL respectively were referred to as having reduced susceptibility while resistance to gentamicin was defined as having MIC ≥32μg/mL as described previously by CDC (Kirkcaldy et al., 2014). We used the chi-square test to test for a difference in the proportion of isolates that met resistance criteria from patients with repeat GCI (using the *Ng* isolate from the repeat infection) and single GCI. We compared an alternative hypothesis which assumed that the proportion of AR *Ng* isolates from repeat GCI will be higher than the proportion of resistance of *Ng* isolates from single GCI against a null hypothesis which assumed that proportion of resistance of *Ng* isolates from repeat GCI will be equal to proportion of resistance of *Ng* isolates from single GCI. We reported proportions for each antibiotic between patients with single and repeat GCI and p-values from the chi-square test.

RESULTS

Between February 2017 and December 2020, 2,219 unique SHC patients had at least one episode of gonorrhea, defined as a positive NAAT or culture from a specimen collected from any anatomic site. Of these 2,219 patients, 577 had a repeat GCI, as defined by a positive NAAT and culture occurring ≥14 days after an initial GC positive test, and 1,642 patients had no additional positive results.

Patient age ranged from 16 years to 82 years, with a mean age of 33.4 years. Among the 2,219 individual patients, 2,003 (90.3 %) were men and 169 (7.6 %) were women. Among men, 1,605 (72.3%) reported only male sex partners. The population of patients with any GCI was diverse by race comprising mainly of people identifying as White 1278 (57.6%), Black 425 (19.2%), and Hispanic/Latino 365 (16.5), with the all the population been non-Hispanic/Latino (Table 1).

In the bivariable model, documented history of gonorrhea in the Washington State STD surveillance registry (which started in 2007) at the time of the initial GCI in this dataset had the strongest association with repeat GCI (OR=2.1; 95% CI: 1.7, 2.6). Self-reported history of gonorrhea ever (OR=1.4; 95%CI: 1.1, 1.8), documented history of gonorrhea in the STD registry (OR=2.1; 95% CI: 1.7, 2.6), current PrEP use (OR=1.6; 95% CI: 1.3, 2.0) and history of non-injection recreational drug use in previous 12 months (OR=1.7; 95% CI: 1.3, 2.1) remained statistically significant and were positively associated with repeat GCI in the multivariable model.

Agar dilution antimicrobial susceptibility testing (AST) data for the seven antibiotics tested was only available for 749 episodes of single GCI and 450 episodes of repeat GCI (Table 3). Of the seven antibiotics used for agar dilution AST, higher proportion of isolates were resistant among people with repeat GCI for penicillin (repeat= 18.0%, single 11.2%; p-value 0.001), tetracycline (repeat= 32.2%, single 19.9%; p-value <0.001), and ciprofloxacin (repeat= 55.1%, single 36.1%; p-value <0.001. There was no gentamicin resistance recorded for either single or repeat GCI.

DISCUSSION

This analysis provides insights into patients attending PHSKC SHC presenting without symptoms or with symptoms of gonorrhea confirmed with culture and NAAT. Our analysis showed that people who identify as men —who made up the largest number of people attending the PHSKC SHC— had more repeat GCI than those who identify as women. Having a history of gonorrhea ever—documented in the STD surveillance registry—was the variable most strongly associated with repeat GCI. There was no gentamicin resistance recorded for any GCI, while a greater proportion of gonococcal isolates from patients with repeat GCI were resistant to penicillin, tetracycline, and ciprofloxacin.

In contrast to studies that had found younger age as having more repeat GCI, those within the younger age group (<25 years) among our patients had fewer repeat GCI compared to young adults (<25 to 34 years) (Fung et al., 2007b; Pattanasin et al., 2020; Rose et al., 2017). In our study, age was not a statistically significant predictor of repeat GCI in either bivariable or multivariable logistic regression models. There are other studies that did not find age as a statistically significant predictor of repeat GCI, but still showed an increased trend of repeat GCI among people in younger age groups (Bernstein et al., 2006; De et al., 2007).

Even though there were few people identifying as Black among our SHC patients, we found that identifying as Black was predictive of repeat GCI but only statistically significant in the bivariable logistic regression model. This is consistent with evidence from other studies in the US that being Black or non-White increases the risk of repeat GCI (Fung et al., 2007b; Hughes et al., 2013; Thomas et al., 2000). For many studies in which race/ethnicity did not predict repeat GCI, about 80% of their study population identified as Black, limiting power to detect differences by race/ethnicity (Bernstein et al., 2004, 2006).

Current PrEP use for HIV prevention predicted repeat GCI in our bivariable and multivariable logistic regression models. Recent studies of sexual behavior and incidence of HIV and STDs among MSM have reported increased engagement in condom-less sex and sex with

multiple partners among people using daily PrEP (Jamie et al., 2020; Pattanasin et al., 2020; River et al., 2020), accompanied by an increased incidence of STDs (Hoornenborg et al., 2019; Vuylsteke et al., 2019). It has been difficult to determine whether this relationship is causal, because regular STI screening is part of PrEP care and therefore patients taking PrEP are often screened more frequently than those not taking PrEP.

Data from the GISP shows increasing resistance over time for antibiotics like azithromycin and ciprofloxacin, which are no longer recommended drugs for treatment of uncomplicated gonorrhea (Centers for Disease Control and Prevention: Division of STD Prevention., 2019; Kirkcaldy et al., 2016). We found that isolates with resistance to ciprofloxacin, penicillin, and tetracycline were common among patients with repeat GCI. In our analysis we found that the proportion of *Ng* isolates with reduced susceptibility to ceftriaxone and cefixime from patients with repeat GCI were not significantly greater than the proportion of reduced *Ng* isolates in patients with single GCI. Even though our data were collected before the recent change in gonorrhea treatment guideline, it is reassuring to note that our findings support the use of ceftriaxone as an effective drug for the treatment of gonorrhea as it showed ceftriaxone susceptibility was not higher among patients with repeat GCI. This study provides useful resistance information about the difference in susceptibility between patients with repeat GCI and patients with single GCI.

Our analysis had a few limitations. Coronavirus disease 2019 (COVID-19) may have impacted the number of repeat GCI cases detected in 2020 compared with other years. This is because from April – June 2020 when King County had the first surge of COVID-19 cases, telemedicine was used for consultations and in-person testing services were drastically reduced at the PHSKC SHC. It is also possible that the 1,642 patients with single GCI who did not have an additional positive result could have been screened at another clinic for repeat GCI. In addition, we did not have genotypic data and so could not confirm if the *Ng* strains found in people with repeat GCI were different from the ones found in people with single GCI or if repeat

GCI tended to be with the same strain as the initial infection. . In future, genomic studies should be carried out to ascertain the different genotypes of isolates from single and repeat GCI to identify the predominant *Ng* strain types associated with repeat GCI in the SURRG patients.

In conclusion, interventions should target men, MSMs, people with a documented history of gonorrhea and people older than 25 years who face an increased risk for repeat GCI to increase routine testing and prevention counselling. Continuous surveillance for antimicrobial susceptibility trends is essential to ensure effective gonorrhea treatment guidelines in the future.

Table 1: Characteristics of Single and Repeat Gonococcal Infections Among Patients Attending PHSKC SHC, Feb. 2017 — Dec. 2020.

	Single infection N (%)	Repeat Infection N (%)	Any infection N (%)
	1642	577	2219
Age category (years)			
<25	312 (19)	95 (16.5)	407 (18.3)
25 to 34	734 (44.7)	278 (48.2)	1012 (45.6)
35 to 49	429 (26.1)	152 (26.3)	581 (26.2)
>50	167 (10.2)	52 (9)	219 (9.9)
Gender			
Male	1448 (88.2)	555 (96.2)	2003 (90.3)
Female	154 (9.4)	15 (2.6)	169 (7.6)
Female-to-male transgender	5 (0.3)	—	5 (0.2)
Male -to-female transgender	12 (0.7)	—	12 (0.5)
Other gender identity (including non-binary, unspecified)	23 (1.4)	7 (1.2)	30 (1.4)
Race			
White	933 (56.8)	345 (59.8)	1278 (57.6)

Black	330 (20.1)	95 (16.5)	425 (19.2)
Asian	161 (99.8)	53 (9.2)	214 (9.64)
American Indian or Alaskan Native	30 (1.8)	13 (2.3)	43 (1.9)
Native Hawaiian or Other Pacific Islander	37 (2.3)	11 (1.9)	48 (2.2)
Hispanic or Latino	249 (15.2)	116 (20.1)	365 (16.5)
Self-reported history of gonorrhea (ever)			
No	663 (40.4)	156 (27.1)	819 (36.9)
Yes	595 (36.2)	196 (34)	791 (35.7)
Unknown	384 (23.4)	225 (39)	609 (27.4)
Documented history of gonorrhea in registry			
No	1122 (68.3)	291 (50.4)	1413 (63.7)
Yes	520 (31.7)	286 (49.6)	806 (36.3)
History of sex work in the previous 12 months			
No	1126 (68.6)	419 (72.6)	1545 (69.6)

Yes	33 (2)	15 (2.6)	48 (2.1)
Unknown	483 (29.4)	143 (24.8)	626 (28.2)
History of injection drug use in the previous 12 months			
No	1319 (80.3)	450 (78)	1769 (79.7)
Yes	48 (2.9)	21 (3.6)	69 (3.1)
Unknown	275 (16.8)	106 (18.4)	381 (17.2)
History of non-injection recreational drug use in the previous 12 months			
No	594 (36.2)	146 (25.3)	740 (33.4)
Yes	799 (48.7)	330 (57.2)	1129 (50.9)
Unknown	249 (15.2)	101 (17.5)	350 (15.8)
Gender of sex partner			
Males only (includes F-to-M transgender)	1144 (69.7)	461 (80)	1605 (72.3)
Females only (includes M-to-F transgender)	234 (14.3)	41 (7.1)	275 (12.4)
More than 1 gender	119 (7.3)	49 (8.5)	168 (7.6)

Unknown gender	145 (8.8)	26 (4.5)	171 (7.7)
Prior HIV testing self-reported			
No	109 (6.6)	14 (2.4)	123 (5.5)
Yes	1476 (89.9)	541 (93.8)	2017 (90.9)
Unknown	57 (3.5)	22 (3.8)	79 (3.6)
Result of last HIV test			
Negative	1265 (77)	460 (79.7)	1725 (77.7)
Positive	189 (11.5)	75 (13)	264 (11.9)
Never tested	108 (6.58)	14 (2.4)	122 (5.5)
Unknown	80 (4.9)	28 (4.9)	108 (4.9)
Current PrEP use			
No	705 (43)	236 (41)	941 (42.4)
Yes	353 (21.5)	192 (33.3)	545 (24.6)
Not applicable (HIV positive)	191 (11.63)	78 (13.5)	269 (12.1)
Unknown	393 (23.93)	71 (12.31)	464 (20.91)
Antibiotic use during the previous 12 months			
No	317 (19.3)	126 (21.8)	443 (20)
Yes	39 (2.4)	12 (2.1)	51 (2.3)
Unknown	1286 (78.3)	439 (76.1)	1725 (77.7)

Table 2: Correlates of Repeat Gonococcal Infection Among Patients Attending PHSKC SHC Clinic, Feb. 2017 — Dec. 2020.

	Bivariable logistic regression		Multivariable logistic regression	
Variables	**Odds ratio (95% CI)**	**p-value**	**Odds ratio (95% CI)**	**Overall p-value**
Age category (years)				
<25	ref	—	ref	0.36
25 to 34	1.2 (1.0, 1.6)	0.110	1.2 (0.9, 1.6)	
35 to 49	1.2 (0.9, 1.6)	0.314	1.1 (0.8, 1.6)	
>50	1.0 (0.7, 1.5)	0.910	1.0 (0.6, 1.5)	
Gender				
Male	ref	—	ref	<0.001
Female	0.3 (0.1, 0.4)	<0.001	0.3 (0.2, 0.6)	
Other gender identity (including non-binary, unspecified)	0.8 (0.3, 1.9)	0.596	0.7 (0.3, 2.0)	
Race				
White	1.1 (0.9, 1.4)	0.214	1.0 (0.7, 1.3)	0.819
Black	0.8 (0.6, 1.0)	0.057	1.2 (0.8, 1.7)	0.319
Asian	0.9 (0.7, 1.3)	0.665	0.9 (0.6, 1.3)	0.467

American Indian or Alaskan Native	1.2 (0.6, 2.4)	0.524	1.3 (0.6, 2.8)	0.450
Native Hawaiian or Other Pacific Islander	0.8 (0.4, 1.7)	0.623	1.1 (0.5, 2.3)	0.820
Hispanic or Latino	0.9 (0.9, 1.0)	0.453	1.0 (0.9, 1.0)	0.491
Self-reported history of gonorrhea (ever)				
No	ref	—		<0.001
Yes	1.4 (1.1, 1.8)	0.006	0.9 (0.7, 1.2)	
Unknown	2.5 (2.0, 3.2)	<0.001	1.9 (1.4, 2.5)	
Documented history of gonorrhea in registry				
No	ref	—	ref	<0.001
Yes	2.1 (1.7, 2.6)	<0.001	1.8, (1.4, 2.5)	
History of sex work in the				

previous 12 months				
No	ref	—	ref	0.085
Yes	1.2 (0.7, 2.2)	0.527	1.2 (0.5, 2.6)	
Unknown	0.8 (0.6, 1.0)	0.040	0.9 (0.6, 1.2)	
History of injection drug use in the previous 12 months				
No	ref	—	ref	0.439
Yes	1.3 (0.8, 2.2)	0.352	1.0 (0.5, 1.8)	
Unknown	1.1 (0.9, 1.4)	0.335	1.1 (0.6, 1.8)	
History of non-injection recreational drug use in the previous 12 months				
No	ref	—	ref	<0.001
Yes	1.7 (1.3, 2.1)	<0.001	1.4 (1.1, 1.7)	
Unknown	1.7 (1.2, 2.2)	0.001	1.2 (0.7, 2.1)	
Gender of sex partner				
Males only (includes F-	ref	—	ref	<0.001

to-M transgender)				
Females only (includes M-to-F transgender)	0.4 (0.3, 0.6)	<0.001	0.5 (0.3, 0.8)	
More than 1 gender	1.0 (0.7, 1.4)	0.904	1.3 (0.9, 1.8)	
Unknown gender	0.4 (0.3, 0.7)	<0.001	0.4 (0.3, 0.7)	
Result of last HIV test				
Negative	ref	—	ref	0.004
Positive	1.1 (0.8, 1.5)	0.552	0.3 (0.04, 1.5)	
Never tested	0.4 (0.2, 0.6)	<0.001	0.8 (0.4, 1.5)	
Unknown	1.0 (0.6, 1.5)	0.866	1.1 (0.7, 1.9)	
Current PrEP use				
No	ref	—	ref	<0.001
Yes	1.6 (1.3, 2.0)	<0.001	1.4 (1.1, 1.8)	
Not applicable (HIV positive)	1.2 (0.9, 1.6)	0.197	3.2 (0.6, 17.5)	
Unknown	0.5 (0.4, 0.7)	<0.001	0.9 (0.6, 1.3)	

Antibiotic use during the previous 12 months				
No	ref	—	ref	0.406
Yes	0.8 (0.4, 1.5)	0.460	0.8 (0.4, 1.7)	
Unknown	0.9 (0.7, 1.1)	0.201	0.9 (0.7, 1.2)	

Table 3: Comparison of Antibiotic Resistance between Single and Repeat Gonococcal Infection Among Patients Attending PHSKC SHC Clinic, Feb. 2017 — Dec. 2020.

Antibiotics	Proportion of Resistance N (n%)		p-value (chi-square)
	Repeat N=450 (n%)	Single N=749 (n%)	
Azithromycin	57 (12.7)	64 (8.5)	0.022
Ciprofloxacin	248 (55.1)	270 (36.1)	<0.001
Penicillin	81(18.0)	84 (11.2)	0.001
Tetracycline	145 (32.2)	149 (19.9)	<0.001
Gentamicin	0	0	—
Cefixime	1 (0.2)	3 (0.4)	0.604
Ceftriaxone	1 (0.2)	1 (0.1)	0.716

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