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BRIEF REPORT

Pharyngeal *Chlamydia trachomatis* in Men Who Have Sex With Men (MSM) in The Netherlands: A Large Retrospective Cohort Study

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Pharyngeal *Chlamydia trachomatis* (CT) was diagnosed in 1.2% and pharyngeal-only CT in 0.5% of routinely universally tested men who have sex with men (MSM). In these 3-anatomic-site tested MSM, pharyngeal-only CT comprised 4.8% of all CT. The low positivity of pharyngeal-only CT indicates low public health impact of pharyngeal CT.

Keywords. men who have sex with men; *Chlamydia trachomatis*; testing policy; oral; sexually transmitted infection.

Chlamydia trachomatis (CT) is the most reported bacterial sexually transmitted infection (STI) in the world, with high occurrence among men who have sex with men (MSM) [1, 2]. The prevalence of pharyngeal CT in MSM ranges from 0.5% to 3.6% (median: 1.7%) [3–6]. Pharyngeal CT mostly remains asymptomatic [7], and detection of pharyngeal CT fully depends on testing. Pharyngeal CT can be detected by nucleic acid amplification tests (NAATs) [8] and can be effectively treated with azithromycin or doxycycline [9]. Pharyngeal-only CT—that is, without concurrent anogenital CT—is most important as MSM who have pharyngeal-only CT are not coincidentally treated with concurrent anogenital infections and might possibly contribute to ongoing transmission.

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There is ongoing international debate regarding the clinical and public health impact of pharyngeal CT. Some studies in animals suggested that pharyngeal CT possibly transmits to their own genital or rectal site via colonization or transient passage of the gastrointestinal tract [10, 11]. Evidence for this route in humans is currently lacking. With regard to the public health impact, 1 study suggested transmission to sexual partners from the male pharynx to the male urethra [12]. However, pharyngeal CT infections have been considered low-bacterial-load infections [13–15] that frequently clear (36–57%) without treatment within 9–10 days [14, 16]. Another route of transmission discussed includes saliva. One Australian study showed that chlamydia DNA in saliva was detected in three-quarters of MSM with pharyngeal CT [17], although the viability and implications for transmission are unknown. The uncertainty about impact is reflected in conflicting international testing guidelines; for example, the Australian [18] and British [19] guidelines recommend screening for pharyngeal CT in asymptomatic MSM, whereas the US guidelines [20] do not. In most settings, routine pharyngeal CT testing is not performed. In the Netherlands, MSM are routinely universally tested for pharyngeal, rectal, and urogenital CT since 2015. Using this large-scale set of routinely universal testing data, we provide an overview of the proportion positive, anatomical site distribution, and associated risk factors for pharyngeal CT and pharyngeal-only CT to help inform future testing policy and guidelines.

METHODS

Study Design

In this retrospective cohort study, coded surveillance consultations among MSM were used from all STI outpatient clinics in the Netherlands (25 public health services with 38 STI clinic locations) that were submitted to the National Institute for Public Health and Environment via an electronic patient registry between 2008 and 2017. Reporting to this national institute is standardized and mandatory for all STI clinics. The publicly funded Dutch STI clinics serve high-risk groups, such as MSM. We extracted consultation-level data on sociodemographic characteristics, sexual behavior in the past 6 months, and STI diagnoses for the entire study period. Sociodemographic characteristics and sexual behavior are obtained from standardized nurse-taken medical and sexual history.

Before 2015, the Dutch guidelines advocated selective testing on indication for pharyngeal and anorectal CT in men reporting receptive unprotected sex or symptoms. Since 2015, routine universal pharyngeal and anorectal testing for CT and *Neisseria gonorrhoeae* (NG) in MSM is recommended. All MSM are also tested for syphilis and human immunodeficiency

virus (HIV). Of all clinic consultations in MSM (N = 240 007), surveillance data from clinic years that selectively tested for pharyngeal CT (<85% of consultations tested for pharyngeal CT in that clinic year; n = 54 754) were excluded and data from clinic years that routinely universally tested for pharyngeal CT (≥85%; n = 185 253) were included in this study. Inclusion was based on testing practice (proportion of pharyngeal CT tests performed). The proportion of routine pharyngeal testing increased in 2015 compared with 2008–2014 (84.7% vs 70.0%, $P < .001$). In this routinely universally testing data, a selection was made for consultations in which MSM were tested on 3 anatomical sites: pharyngeal, urogenital, and anorectal (N = 161 275).

Chlamydia trachomatis positivity was based on a positive NAAT. Pharyngeal CT proportion positive was calculated by dividing the number of positive tests by the total number of tests. Pharyngeal-only CT was defined as a single pharyngeal CT infection without concurrent urogenital or anorectal CT infection. Concurrent pharyngeal CT cases were defined as pharyngeal infections with concurrent urogenital and/or anorectal infections.

Statistical Analyses

We described CT proportion positive and anatomical site distribution by descriptive statistics. Univariable and multivariable logistic regression analyses using generalized estimating equations (GEE) were used to assess independent risk factors for pharyngeal CT and pharyngeal-only CT. GEE analyses were used to adjust for repeat visits by clients. These analyses were performed on a subset of the data, including all MSM who were routinely universally tested between 2016 and 2017, because a personal identifier and report of oral sex were available from 2016. The subset was largely comparable to the total study population (Supplementary Table 1). The variables assessed were age (≤21 years, 22–25 years, and ≥26 years; based on tertiles), ethnicity (Western vs non-Western; based on the definition of Statistics Netherlands), number of sex partners in the past 6 months (≤1, 2–3, and ≥4; based on tertiles), reporting commercial sex work (CSW), being notified for any STI by an (ex)partner, condom use during last receptive/insertive anogenital sex, reporting any STI-related symptoms, reporting insertive oro-penile oral sex, coinfection with NG, and concurrent CT infection.

Medical Ethics

Because the retrospective coded data originated from standard care and were analyzed anonymously, neither a full ethical review nor informed consent for data analysis was needed, as confirmed and approved by the Medical Ethical Committee of Maastricht University (METC 2017–0251).

RESULTS

Study Population

The median age was 37 years (interquartile range [IQR]: 27–47 years) in all MSM consultations. The majority (82%; 132 624/161 275) had a Western ethnicity. The median number of sex partners in the past 6 months was 5 (IQR: 3–10). Condom use during last anogenital sex was reported by 34% (55 244/161 275). Oral sex in the past 6 months was reported in almost all consultations (98%; 64 650/66 119) in 2016–2017. The CT proportion positive at any anatomic site was 10.6% (17 093/161 275). For NG this was 10.8% (17 386/161 275). An infectious syphilis infection was detected in 2.7%

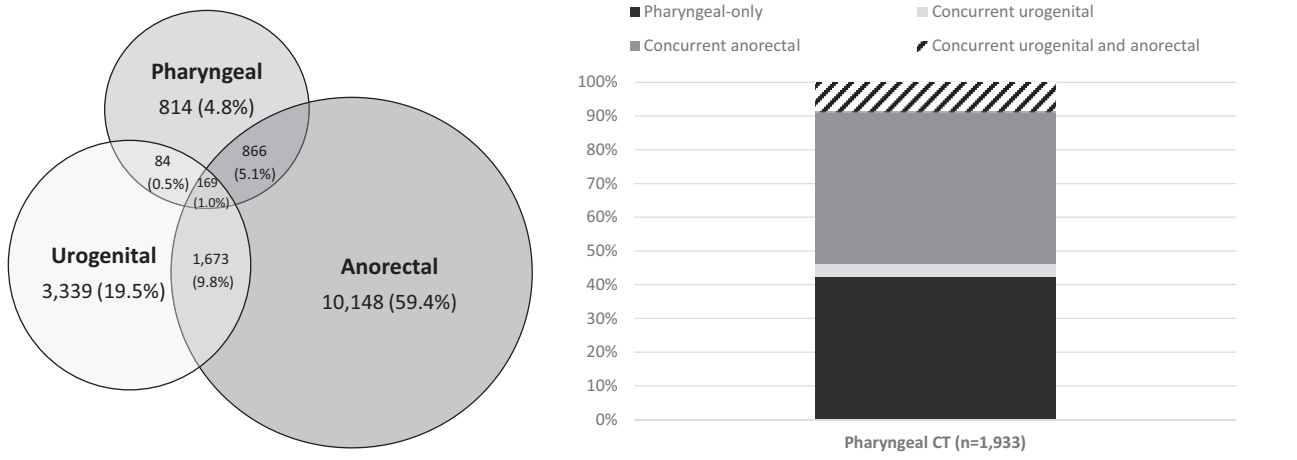

Figure 1. Anatomical site distribution of CT in routinely universally tested MSM attending STI clinics. The proportion positive was 1.2% (1933/161 275) for pharyngeal CT, 3.3% (5265/161 275) for urogenital CT, and 8.0% (12 856/161 275) for anorectal CT. Abbreviations: CT, *Chlamydia trachomatis*; MSM, men who have sex with men; STI, sexually transmitted infection.

Table 1. Risk Factors for Pharyngeal *Chlamydia trachomatis* (CT) and Isolated Pharyngeal-only CT in MSM Routinely Universally Tested Between 2016 and 2017 (n = 68 479) using Logistic Regression Generalized Estimating Equation Analyses

	Pharyngeal CT (730/68 479; 1.1%)			Pharyngeal-Only CT (283/68 479; 0.4%)		
	% (n/N)	OR (95% CI)	Adjusted OR (95% CI)	% (n/N)	OR (95% CI)	Adjusted OR (95% CI)
Age						
<31 years,	1.3 (339/25 390)	2.3 (1.5–3.5)[a]	1.7 (1.4–2.2)[a]	0.4 (111/25 390)	1.3 (1.0–1.8)[b]	1.5 (1.1–2.0)[b]
31–43 years	1.1 (233/20 866)	1.5 (1.3–1.9)[a]	1.5 (1.2–1.8)[c]	0.5 (101/20 866)	1.5 (1.1–2.0)[b]	1.5 (1.1–2.0)[b]
>43 years	0.7 (158/25 390)	1 (ref)	1 (ref)	0.3 (71/22 223)	1 (ref)	1 (ref)
Ethnicity[d]						
Non-Western	1.1 (144/12 959)	1.1 (.8–1.5)	NS	0.4 (57/12 959)	.9 (.7–1.3)	NS
Western	1.1 (585/55 387)	1 (ref)	NS	0.4 (226/55 397)	1 (ref)	1 (ref)
Number of sex partners						
<4	0.6 (124/20 196)	1 (ref)	1 (ref)	0.2 (41/20 196)	1 (ref)	1 (ref)
4–8	1.1 (265/23 331)	1.9 (1.5–2.4)[a]	1.8 (1.5–2.3)[a]	0.4 (100/23 331)	2.1 (1.4–3.0)[a]	2.1 (1.5–3.0)[a]
>8	1.3 (341/24 952)	2.3 (1.9–2.9)[a]	1.9 (1.6–2.5)[a]	0.6 (142/24 952)	2.8 (2.0–3.9)[a]	2.8 (2.0–4.0)[a]
Commercial sex work						
No	1.1 (698/66 421)	1 (ref)	1 (ref)	0.4 (273/66 421)	1 (ref)	1 (ref)
Yes	1.6 (26/1625)	1.6 (1.06–2.3)[b]	NS	0.6 (10/1625)	1.5 (.8–2.8)	NS
Notified for STI						
No	0.9 (480/54 386)	1 (ref)	1 (ref)	0.3 (190/54 386)	1 (ref)	1 (ref)
Yes	1.8 (250/14 054)	2.1 (1.8–2.4)[a]	1.4 (1.2–1.7)[a]	0.7 (93/14 054)	2.0 (1.5–2.5)[a]	1.7 (1.3–2.5)[a]
Condom use during last anogenital receptive/insertive sexual contact						
Yes	1.1 (265/24 844)	1.0 (.8–1.1)	NS	0.5 (120/24 844)	1.2 (.9–1.6)	NS
No	1.1 (439/40 869)	1 (ref)	1 (ref)	0.4 (154/40 869)	1 (ref)	1 (ref)
Insertive oro-penile sex						
No	0.5 (8/1469)	1 (ref)	1 (ref)	0.3 (4/1469)	1 (ref)	1 (ref)
Yes	1.1 (699/64 650)	2.2 (1.1–4.5)[b]	NS	0.4 (270/64 650)	1.4 (.6–3.8)	Ns
Any STI-related symptoms						
No	1.0 (537/53 719)	1 (ref)	1 (ref)	0.4 (210/53 719)	1 (ref)	1 (ref)
Yes	1.3 (192/4688)	1.5 (1.1–2.1)[b]	NS	0.5 (73/14 688)	1.4 (1.1–1.8)[b]	NS
Chlamydia trachomatis						
Urogenital						
No	1.0 (635/66 387)	1 (ref)	1 (ref)	NA	NA	NA
Yes	4.5 (95/2092)	7.3 (4.0–13.3)[a]	1.5 (1.1–1.9)[c]	NA	NA	NA
Anorectal						
No	0.5 (317/63 455)	1 (ref)	1 (ref)	NA	NA	NA
Yes	8.2 (413/5024)	17.7 (15.2–20.6)[a]	15.2 (12.7–18.2)[a]	NA	NA	NA
Neisseria gonorrhoeae						
Urogenital						
No	1.0 (697/66,579)	1 (ref)	NS	0.4 (272/66 579)	1 (ref)	NS
Yes	1.8 (33/1,876)	2.9 (1.2–7.0)[b]	NS	0.6 (11/1876)	1.5 (.9–2.7)	NS
Anorectal						
No	1.0 (608/63,293)	1 (ref)	NS	0.4 (240/63 293)	1 (ref)	1 (ref)
Yes	2.3 (121/5,150)	2.6 (2.0–3.3)[a]	NS	0.8 (42/5150)	1.9 (1.1–3.4)[b]	1.5 (1.0–2.2)[b]
Oropharyngeal						
No	1.0 (631/64,375)	1 (ref)	1 (ref)	0.4 (250/64 375)	1 (ref)	NS
Yes	2.4 (99/4,088)	2.5 (2.0–3.2)[a]	1.6 (1.2–2.1)[a]	0.8 (33/4088)	2.0 (1.2–3.5)[b]	NS
Syphilis						
Negative	1.0 (698/66,189)	1 (ref)	1 (ref)	0.4 (268/66 189)	1 (ref)	1 (ref)
Positive	1.9 (39/2,066)	1.6 (1.1–2.4)[b]	NS	0.7 (15/2066)	1.8 (1.1–3.1)[b]	NS
HIV						
Negative	1.1 (614/58,285)	1 (ref)	1 (ref)	0.4 (232/58 285)	1 (ref)	1 (ref)
Known positive	1.1 (100/9,185)	.9 (.7–1.3)	NS	0.5 (47/9185)	1.3 (.9–1.8)	NS
First positive test	2.6 (10/390)	2.1 (1.1–4.2)[b]	NS	0.8 (3/390)	1.9 (.6–6.1)	NS

These data included 51.3% repeated visits (35 115/68 479). The pharyngeal CT positivity was 1.0% (366/35 115) in repeat consultations and 1.1% (364/33 364) among MSM who visited the STI clinic once during this study period ($P = .39$). Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus; NA, not assessed; NS, not significant; OR, odds ratio; ref, reference; STI, sexually transmitted infection.

[a]$P < .001$.

[b]$P < .05$.

[c]$P < .01$.

[d]Ethnicity was based on self-reported country of birth of clients themselves and country of birth of their parents. Western ethnicity included persons who were born in Europe (Turkey excluded), North America, Oceania, Indonesia, or Japan. Non-Western ethnicity included persons who were born in, or with at least 1 parent who was born in Africa, Latin America, Asia (with the exception of Indonesia and Japan), or Turkey, as defined by Statistics Netherlands.

(4620/161 275). A first positive HIV test was detected in 1.0% of MSM consultations (1534/161 275).

Pharyngeal CT Positivity and Anatomical Site Distribution

Pharyngeal CT was detected in 1.2% of consultations (1933/161 275) and this comprised 11.3% (1933/17 093) of all CT infections. Pharyngeal-only CT was detected in 0.5% (814/161 275) and this comprised 4.8% (814/17 093) of all CT infections. Of 1933 consultations in which pharyngeal CT was detected, 42.1% (814) included pharyngeal-only CT (Figure 1).

Risk Factors for Pharyngeal CT and Isolated Pharyngeal CT

Using consultations from 2016 and 2017 among routinely universally tested MSM (n = 68 479), independent risk factors for both pharyngeal CT and pharyngeal-only CT were being aged under 43 years, a higher number of sex partners in the past 6 months (≥ 4), being notified for any STI, and having concurrent NG (Table 1). No specific risk factors were associated with pharyngeal-only CT versus concurrent CT (Supplementary Table 2).

DISCUSSION

This large study provides a comprehensive overview of pharyngeal CT in MSM visiting STI clinics. Routine universal pharyngeal CT testing in MSM has been widely implemented (85%) in Dutch STI clinics since 2015. We assessed the proportion positive of pharyngeal CT, the anatomical site distribution, and risk factors for pharyngeal CT among MSM visiting STI clinics without preselection on risk behavior. Pharyngeal CT was uncommon, with a proportion positive of 1.2% and the proportion of positive pharyngeal-only CT was 0.5%. The assessed proportion positive is slightly lower compared with the median prevalence (1.7%) estimated in a literature review [4]. However, as MSM tested at STI clinics represent a high-risk group, the actual prevalence in the general MSM population will possibly be lower, as suggested by a Canadian study in a community-based population [21]. The risks for acquisition of pharyngeal CT are similar to general risk factors for CT [3], including a higher number of sex partners, a younger age, and being notified for an STI. A limitation of this study (as with NAAT diagnoses of pharyngeal CT in general) is that false-positives could not be ruled out because most manufacturers' protocols do not advocate confirmatory testing for pharyngeal CT. Most pharyngeal CT infections are concurrent with anorectal CT (54%) and would therefore be treated coincidentally when testing MSM at the anorectal site. Almost half of pharyngeal CT infections (44%) were pharyngeal-only CT infections; these infections would not have been treated if testing had only been performed at the anogenital CT site. This finding is in line with other studies showing that pharyngeal-only CT was reported in 53–58% of MSM diagnosed with pharyngeal CT [14, 22]. However, this concerns only 0.5% of all MSM attending the STI clinics and the high proportion of spontaneous clearance indicates that the contribution of pharyngeal CT to the clinical and public health impact of CT in MSM is very limited. In contrast, pharyngeal NG has a higher proportion of pharyngeal-only infections [23], with stronger evidence to contribute to NG transmission and to cause clinical impact [24, 25], justifying pharyngeal NG testing. However, for pharyngeal CT, harms of routine universal pharyngeal CT testing and treating in terms of overtreatment, interfering with natural immune responses, and inducing antibiotic resistance in other pathogenic (STI and non-STI) microorganisms in relationship to limited public and clinical benefits of testing argue against routine universal pharyngeal CT testing.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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References

1. Newman L, Rowley J, Vander Hoorn S, et al. Global estimates of the prevalence and incidence of four curable sexually transmitted infections in 2012 based on systematic review and global reporting. PLoS One **2015**; 10:e0143304.
2. Centers for Disease Control and Prevention. Sexually transmitted disease surveillance 2013. Atlanta, GA: US Department of Health and Human Services, **2014**.
3. Dudareva-Vizule S, Haar K, Sailer A, Wisplinghoff H, Wisplinghoff F, Marcus U; PARIS Study Group. Prevalence of pharyngeal and rectal Chlamydia trachomatis and Neisseria gonorrhoeae infections among men who have sex with men in Germany. Sex Transm Infect **2014**; 90:46–51.
4. Chan PA, Robinette A, Montgomery M, et al. Extragenital infections caused by Chlamydia trachomatis and Neisseria gonorrhoeae: a review of the literature. Infect Dis Obstet Gynecol **2016**; 2016:5758387.
5. van Liere GA, Hoebe CJ, Dukers-Muijrers NH. Evaluation of the anatomical site distribution of chlamydia and gonorrhoea in men who have sex with men and in high-risk women by routine testing: cross-sectional study revealing missed opportunities for treatment strategies. Sex Transm Infect **2014**; 90:58–60.
6. Pinsky L, Chiarilli DB, Klausner JD, et al. Rates of asymptomatic nonurethral gonorrhea and chlamydia in a population of university men who have sex with men. J Am Coll Health **2012**; 60:481–4.
7. van Rooijen MS, van der Loeff MF, Morré SA, van Dam AP, Speksnijder AG, de Vries HJ. Spontaneous pharyngeal Chlamydia trachomatis RNA clearance: a cross-sectional study followed by a cohort study of untreated STI clinic patients in Amsterdam, The Netherlands. Sex Transm Infect **2015**; 91:157–64.
8. Ota KV, Tamari IE, Smieja M, et al. Detection of Neisseria gonorrhoeae and Chlamydia trachomatis in pharyngeal and rectal specimens using the BD Probetec ET system, the Gen-Probe Aptima Combo 2 assay and culture. Sex Transm Infect **2009**; 85:182–6.
9. Dukers-Muijrers NHTM, Wolffs P, Lucchesi M, et al. Oropharyngeal Chlamydia trachomatis in women; spontaneous clearance and cure after treatment (FemCure). Sex Transm Infect **2020**; 0:1–5.
10. Yeruva L, Spencer N, Bowlin AK, Wang Y, Rank RG. Chlamydial infection of the gastrointestinal tract: a reservoir for persistent infection. Pathog Dis **2013**; 68:88–95.

11. Bavoil PM, Marques PX, Brotman R, Ravel J. Does active oral sex contribute to female infertility? J Infect Dis **2017**; 216:932–5.
12. Bernstein KT, Stephens SC, Barry PM, et al. Chlamydia trachomatis and Neisseria gonorrhoeae transmission from the oropharynx to the urethra among men who have sex with men. Clin Infect Dis **2009**; 49:1793–7.
13. Wijers JNAP, Dukers-Muijrers NHTM, van Liere GAFS, et al. Men and women have an equal oropharyngeal and anorectal Chlamydia trachomatis bacterial load: a comparison of three anatomic sites. J Infect Dis **2021**; 223:1582–9.
14. van Rooijen MS, van der Loeff MF, Morré SA, van Dam AP, Speksnijder AG, de Vries HJ. Spontaneous pharyngeal Chlamydia trachomatis RNA clearance: a cross-sectional study followed by a cohort study of untreated STI clinic patients in Amsterdam, The Netherlands. Sex Transm Infect **2015**; 91:157–64.
15. Apewokin SK, Geisler WM, Bachmann LH. Spontaneous resolution of extragenital chlamydial and gonococcal infections prior to therapy. Sex Transm Dis **2010**; 37:343–4.
16. Dukers-Muijrers NHTM, Janssen KJH, Hoebe CJPA, et al. Spontaneous clearance of Chlamydia trachomatis accounting for bacterial viability in vaginally or rectally infected women (FemCure). Sex Transm Infect **2020**; 96:541–8. sextrans-2019-054267.
17. Philips TR, Fairley C, Maddaford K, et al. Bacterial load of Chlamydia trachomatis in the posterior oropharynx, tonsillar fossae, and saliva among men who have sex with men with untreated oropharyngeal chlamydia. J Clin Microbiol **2019**; 58(1):e01375.
18. Australian STI management guidelines for use in primary care. Australasian Sexual Health Alliance [database online]. Available at: http://www.sti.guidelines.org.au/sexually-transmissible-infections/chlamydia. Accessed 12 January 2021.
19. British Association for Sexual Health and HIV. BASHH Clinical Effectiveness Group 2015: summary guidance on tests for sexually transmitted infections. Available at: http://www.bashh.org/BASHH/Guidelines/Guidelines/BASHH/Guidelines/Guidelines.aspx. Accessed 12 January 2021.
20. Centers for Disease Control and Prevention. 2015 STD treatment guidelines. Available at: http://www.cdc.gov/std/tg2015. Accessed 12 January 2021.
21. Harvey-Lavoie S, Apelian HA, Cox LJ, et al. Community-based prevalence estimates of Chlamydia trachomatis and Neisseria gonorrhoeae infection among gay, bisexual and other men who have sex with men in Montreal, Canada. Sex Transm Dis. Published online **2021**. doi:10.1097/olq.0000000000001486.
22. Hiransuthikul A, Sungsing T, Jantarapakde J, et al. Correlations of chlamydia and gonorrhoea among pharyngeal, rectal and urethral sites among Thai men who have sex with men: multicentre community-led test and treat cohort in Thailand. BMJ Open **2019**; 9:e028162.
23. Van Liere GAFS, Dukers-Muijrers NHTM, Kuizenga-Wessel S, et al. Routine universal testing versus selective or incidental testing for oropharyngeal Neisseria gonorrhoeae in women in the Netherlands: a retrospective cohort study. Lancet Infect Dis **2021**; 21:858–67.
24. Hui B, Fairley CK, Chen M, et al. Oral and anal sex are key to sustaining gonorrhoeae at endemic levels in MSM populations: a mathematical model. Sex Transm Infect **2015**; 91:365–69.
25. Hook EW, Bernstein K. Kissing, saliva exchange, and transmission of Neisseria gonorrhoeae. Lancet Infect Dis **2019**; 19:e367–9.